Class 2 Permit Modification Request

Monitor for Hydrogen and Methane until Final Panel Closure

September 2007

Overview of the Permit Modification Request

This document contains a Class 2 Permit Modification Request (**PMR**) for the Waste Isolation Pilot Plant (**WIPP**) Hazardous Waste Facility Permit (**HWFP**), Number NM4890139088-TSDF, hereinafter referred to as the WIPP HWFP.

This PMR is being submitted by the U.S. Department of Energy (**DOE**), Carlsbad Field Office (**CBFO**) and Washington TRU Solutions LLC (**WTS**), collectively referred to as the Permittees, in accordance with the WIPP HWFP, Condition I.B.1 (20.4.1.900 New Mexico Administrative Code (**NMAC**) incorporating Title 40, Code of Federal Regulations (**CFR**), §270.42(b)). In this modification the Permittees propose to:

- monitor for hydrogen and methane until final panel closure;
- respond to action levels for hydrogen and methane that are proposed in this PMR;
- install substantial barriers and steel bulkheads to isolate a full panel for monitoring purposes;
- evaluate the data to determine an appropriate final performance-based closure system;
- revise the location and frequency of Volatile Organic Compound (**VOC**) monitoring in full panels until final panel closure;
- inspect and certify the isolation walls in Panels 1 and 2 and inspect the bulkheads in Panels 3 through 7 until final panel closure, and
- extend the final closure in Panels 1 through 7 to 2016.

The proposed changes will not reduce the ability of the Permittees to provide continued protection to human health and the environment.

The requested modifications to the WIPP HWFP and related supporting documents are provided in this PMR. The proposed modifications to the text of the WIPP HWFP have been identified using a double underline, and a ~~strikeout~~ font for deleted information. All direct quotations are indicated by italicized text. The following information specifically addresses how compliance has been achieved with the WIPP HWFP requirement, Permit Condition I.B.1 for submission of this Class 2 PMR.

Current Regulatory Status

The Permittees submitted a Class 3 modification to NMED in October 2002 entitled Panel Closure Redesign.

Subsequent to the October 2002 submittal, the Permittees submitted a Class 1* modification to NMED requesting an extension of the time to close Panel 1. Specifically the request was to install the isolation wall component of the approved, Option D 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 isolation wall.

This Class 1* request was approved in a letter to the Permittees from NMED in December 2002.

A similar Class 1* request for Panel 2 was approved by NMED in 2005.

A Class 1* request to extend the closure period for Panels 1-3 was submitted to the NMED in January 2007 and approved by the NMED in February 2007.

The Permittees are currently emplacing waste in Panel 4.

The October 2002 Class 3 PMR has been withdrawn by the Permittees.

1. 20.4.1.900 NMAC (incorporating 40 CFR §270.42(b)(1)(i)) requires the applicant to describe the exact change to be made to the permit conditions and supporting documents referenced by the permit.

This Permit Modification Request (**PMR**) is being submitted to request the following changes to Module IV, Attachment D, Attachment I and Attachment N in the HWFP, to incorporate changes to the monitoring program, closure plan and inspection program:

1) Monitor each full panel for methane and hydrogen until final panel closure.

2) Establish action levels for methane and hydrogen that would trigger various activities which may include the installation of panel closure.

3) Beginning with Panel 3, add a substantial barrier and a steel bulkhead, in each drift of the panel, of the type typically in use at WIPP with no personnel access as part of the monitoring program.

4) Collect data to be used in determining a performance-based final closure for each panel.

5) Propose an inspection schedule and inspection criteria for the isolation walls in Panels 1 and 2 as well as the bulkheads in Panel 3 through 7 until final panel closure.

6) Revise VOC monitoring locations in full panels and revise the frequency of VOC monitoring in full panels to monthly until final panel closure.

7) Extend final closure dates for Panels 1 through 7 to 2016.

The exact changes to permit conditions and supporting documents is included in Attachment B.

2) 20.4.1.900 NMAC (incorporating 40 CFR §270.42(b)(1)(ii)) requires the applicant to identify that the modification is a Class 2 modification.

The proposed modification is classified as a Class 2 permit modification in accordance with 20.4.1.900 NMAC incorporating 40 CFR §270.42, Appendix I, item A.4.b, “Changes in the frequency of or procedures for monitoring, reporting, sampling, or maintenance activities by the Permittee; other changes” and item B.4 “Changes in the frequency or content of inspection schedules”.

3) 20.4.1.900 NMAC (incorporating 40 CFR §270.42(b)(1)(iii)) requires the applicant to explain why the modification is needed.

Hydrogen and Methane Monitoring Program

Protection of Human Health and the Environment

The hazardous waste constituents which might routinely escape from the panels are volatile organic compounds (**VOCs**). Hydrogen and methane which might accumulate in panels are non-VOC gases. Nine VOCs are monitored during waste operations in a panel through a network of tubing installed in the rooms, as well as in the repository as a whole. Disposal room VOC monitoring is used in conjunction with the bulkhead and chain link and brattice cloth room closures to protect workers from exposure to harmful levels of VOCs before panel closure is initiated. Repository VOC monitoring measures VOC concentrations in the air that is being discharged from the repository to protect workers and members of the public outside the repository. Action Levels have been established for both disposal room and repository VOCs to assure that they do not accumulate to concentrations that would pose a threat to human health. These Action Levels are currently part of the HWFP and are not being proposed for change in this PMR.

Hazardous wastes in particulate form will not escape from waste panels because wastes are disposed in intact containers that remain closed. Ventilation barriers and panel closure components prevent the release of particulate material under conditions that would breach disposed containers.

The non-VOC gases of concern in full panels are the flammable gases methane and hydrogen, which may be generated by waste degradation. These flammable gases, although not directly regulated as hazardous waste constituents, are of concern because of the potential for them to buildup to explosive levels which, if ignited, could lead to a release of hazardous waste.

The Permittees propose to begin monitoring for hydrogen and methane in each filled room in full panels 3 through 7 until final panel closure, and on the inside and outside of each monitoring bulkhead to ensure that these gases do not accumulate to harmful concentrations.

Monitoring of Explosive Gases

Gas may be generated in full panels that contain waste. Methane may be generated under humid conditions by the microbial degradation of organic material such as cellulosic, plastic and rubber (**CPR**) in the waste. Hydrogen may be generated by radiolysis, or by corrosion of the steel drums and other steel materials in the waste under inundated (flooded) conditions. Inundated conditions are not expected to occur during operations and closure. For both gases, there are considerable uncertainties in the rates of gas generation under the conditions expected at the WIPP. These include brine/moisture availability, the viability of microbes 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 thereby inhibiting corrosion. As a result of the uncertainty, panel closures have been designed assuming the worst possible conditions for flammable gas generation (e.g., availability of moisture, availability of microbes and nutrients, lack of alpha source depletion).

Monitoring of the quantities of hydrogen and methane present in Panels 3 through 7 until final panel closure is an effective way to gather data to establish whether generation of these gases actually occurs and if so, determine more realistic generation rates. More realistic generation rates may lead to panel closure designs that are less complex than the current design. In addition, collecting data under a monitoring program will provide data to assure worker safety during operation of the repository. Collecting data regarding the generation of these gases also fulfills a recommendation from the National Academy of Science (**NAS**) WIPP committee: ("*Improving Operations and Long-Term Safety of the Waste Isolation Pilot Plant: Final Repor*t" (2001))

> *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 for the following reasons:

- Hydrogen and methane are the only gases which could be generated in quantities that could pose a threat to human health or the environment.
- Hydrogen and methane generation may not develop a potentially explosive mixture over a long period of time.
- The presence or absence of methane as a generated gas may provide data useful for evaluating the current microbial gas generation models.
- The presence or absence of hydrogen as a generated gas may provide data useful for evaluating the current radiolysis and corrosion models.

The NAS recommended collecting data on carbon dioxide concentrations. The Permittees will implement that suggestion separate from the requirements for flammable gas monitoring proposed in this PMR.

<u>Target Gases to be Monitored</u>

The target gases proposed for monitoring are methane and hydrogen. Action levels are proposed for these gases. These action levels are discussed later.

Oxygen, which is also needed for an explosive mixture to develop, will not be monitored. The reason for this is that the LELs for both methane and hydrogen are inversely related to oxygen content, that is, as the oxygen level decreases the LEL increases. Thus, because the expectation is that oxygen will decrease over time, assuming an oxygen content equivalent to that of air is a conservative approach.

<u>Potential Sources of Hydrogen</u>

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 after inundated conditions exist ("*Estimation of Hydrogen Generation Rates From Radiolysis in WIPP Panels*", July 26, 2006), neglecting any loss of hydrogen by diffusion. However, hydrogen generation by radiolysis should decrease asymptotically to a very low value due to source depletion. That is, without actively mixing the waste, the radiolytic effects of alpha particles are greatest nearby the source of the alpha particles and fall off with distance due to the low energy of the alpha particles. As nearby sites are depleted, the rate of hydrogen generation will decrease.

In addition to radiolysis, hydrogen can be generated by anoxic corrosion of various metal components of the waste and packaging (primarily iron and aluminum based materials) under inundated conditions. It should be noted that aluminum and aluminum alloy corrosion rates are much slower than those for iron based materials. Estimates of the rates of hydrogen production under anoxic and fully brine inundated conditions may be made however these rates are quite uncertain in the short-term being considered here. Inundated conditions cannot reasonably be expected during the operational period of the repository. Information presented in the WIPP HWFP application shows that during the operational period of the repository the maximum brine saturation in the repository is predicted to be extremely low.

Specifically:

- Active corrosion of the metals requires inundated conditions, which modeling has shown is highly unlikely to occur. Some corrosion may occur under humid conditions, but the rates will be very low as indicated in the HWFP Application modeling.
- Initially corrosion will be inhibited until paint on the drum surfaces is removed, and internal steel components are accessible.
- On initial closure of a panel oxic (oxygen rich) conditions will prevail, and oxic corrosion may be expected to commence in the presence of brine. Under these conditions oxygen is consumed and iron oxides formed and no hydrogen is generated. At some point the oxygen in the full panels is expected to be consumed due to corrosion and microbial degradation reactions, though some oxygen may be produced by radiolysis. Only after the oxygen is depleted and in the presence of brine, anoxic corrosion may be expected to occur with generation of hydrogen.

Therefore it is likely that the rates of hydrogen generation by corrosion will be very low for some extended period of time after a panel is filled. This notwithstanding, the accumulation of hydrogen is mitigated by the ease of diffusion of hydrogen through even highly impermeable materials.

<u>Potential Sources of Methane</u>

Methane can be produced from microbial degradation of organic materials such as CPR. Microbial processes are conceptualized to occur sequentially, with the organic carbon being consumed by denitrification (bacterial reduction of nitrates and nitrites to nitrogen), followed by sulfate reduction, both of which produce carbon dioxide, and ultimately by methanogenesis (bacterial formation of methane) which produces carbon dioxide and methane (Brush 1990; Brush 1995; Wang and Brush 1996). 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 brine, and the sulfate minerals in the surrounding rock mass) to inhibit 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 the CPR materials, respectively (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 at least 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 the start of methane generation for a 5% methane concentration to be achieved (DOE 1996, Appendix PCS).

Flammable VOCs

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 in large quantities, if at all, the quantities of the flammable VOC components are expected to remain quite small and further diminish over time and hence are not considered a significant issue related to the development of an explosive atmosphere in a full panel.

Consideration of RH TRU Mixed Waste

As stated previously, gas can be generated in TRU waste by one of three mechanisms:

- Corrosion of metals
- Microbial degradation of CPR materials
- Radiolysis, primarily of CPR materials and water

These gas generation mechanisms are the same for CH and RH TRU mixed waste. The contribution of RH waste to gas generation is expected to be small since the volumes of potential sources of gas in RH are much smaller than in CH. The WIPP Compliance Recertification Application (**CRA**) (DOE 2004, Appendix TRU WASTE, Section 2.1.2) confirms this as indicated below:

> *"The WIPP Land Withdrawal Act (LWA), Pub. L. No. 104-201, 110 Stat. 2422 defines the amount of TRU waste allowed in the WIPP to 175,564 m^3 (6,200,000 ft^3). The "Agreement for Consultation and Cooperation" limits the remote handled (RH)-TRU waste inventory to 7,079 m^3 (250,000 ft^3) (State of New Mexico vs DOE, 1981). By difference, the contact handled (CH)-TRU waste inventory is limited to 168,485 m^3 (5,950,000 ft^3)"*

Data from Table TRU WASTE-1 of this reference gives the following current densities for those solid materials which can generate gas.

Waste Material	CH-TRU Waste		RH-TRU Waste		RH as a % of Total TRU Waste
	Average Mass Density (kg/m^3)	Projected Mass (kg)	Average Mass Density (kg/m^3)	Projected Mass (kg)	
Fe-based Metal/Alloys	110	1.8×10^7	110	7.8×10^5	4.2
Al-based Metal/Alloys	14	2.4×10^6	2.5	1.8×10^4	0.7
Total Fe + Al		2.1×10^7		7.9×10^5	3.8
Cellulosic Materials	58	9.8×10^6	4.5	3.2×10^4	0.3
Rubber Materials	14	2.4×10^6	3.1	2.2×10^4	0.9
Plastic Materials	42	7.1×10^6	4.9	3.5×10^4	0.5
Total CPR		4.0×10^7		8.7×10^4	0.5

Thus the percentages of the gas generating solids in RH-TRU are small relative to CH-TRU waste and do not merit special consideration.

Radiolysis and microbial generation of gas from CPR will be small for RH compared to CH given the relatively small content of CPR (less than 1% of that in CH).

<u>Substantial Barrier and Bulkhead</u>

The proposed substantial barrier and bulkhead, which is part of the monitoring system that will be used in the panel entries, will be constructed similar to those currently used for ventilation control in the WIPP underground.

The substantial barrier serves to protect waste from events such as ground movement or vehicle impacts. This barrier will be constructed from available non-flammable materials such as mined salt or magnesium oxide (Figure 1).

The bulkhead serves to block ventilation to the panel for monitoring purposes. 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 2). 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. The following provides a description of the materials and construction of bulkheads used at the WIPP.

The materials are rectangular steel tube, galvanized sheet metal, rubber conveyor belt, and steel fasteners (e.g. bolts, screws, battens). The bulkheads are fabricated using the rectangular steel tubes for the posts, headers, horizontal, and vertical members of the frame. Steel is used because it is a non-combustible material. Pre-drilled steel plates are welded across the bottoms of the posts. These plates are bolted to the salt floor to hold the bottom of the bulkhead in place.

The physical properties of salt are such that, under pressure and over time, the salt will "creep" or slowly deform into any opening. Gradually over time the cross-section area, or size, of the drifts (passageways) underground become smaller. To account for the movement of the ground and the diminishing size of the drifts, the bulkheads are attached to the roof of the drifts using a moveable system. The system consists of a large bracket welded to the top of the post. A pre-drilled plate is welded to a piece of tubular steel that is small enough to fit into the bracket. The piece of tubular steel is placed into the bracket and the plate is bolted to the roof. The tubular steel can slide in the bracket and this allows the top fastening of the bulkhead to accommodate the slow convergence of the roof and floor.

Once the frame has been bolted to the floor and the roof, it is covered with galvanized sheet metal. The sheet metal is screwed to the posts, vertical, and horizontal members of the bulkhead frame. The sheet metal covers the frame much as sheet rock covers the frame of a house.

Even though the salt roof, sides and floor of the drifts are carefully scaled before installation, these surfaces are not perfectly smooth. The steel sheet metal used over the tubular framework is rigid and will not bend to conform to every uneven nuance in these salt surfaces. For this reason, the main posts and headers of the bulkhead are placed about 12” to 18” from the roof, sides and floor of the drift. This gap, between the bulkhead frame and the salt, is covered with rubber conveyor belt. The conveyor belt is attached to the salt using a 1" steel strap and special nails that are shot from a nail-gun. The rubber is attached to the steel frame with screws and 1” steel strap. The strap acts as both a washer, so that the screws and nails will not pull through the rubber, and a batten, so that the belting conforms closely to the surface to which it is attached.

Bulkheads at WIPP are prefabricated before installation and a bulkhead of the sizes likely to be used for panel seal purposes requires about two shifts (15 to 20 hours) to install. Bulkheads of these sizes typically require minimal maintenance.

The bulkheads for gas monitoring will be constructed without vehicle doors, man doors, or regulators. Figure 2 shows a typical bulkhead of the size that will be used to seal the panel while monitoring takes place. They will be solid in the sense that there will be no openings of any sort such that a vehicle or person could pass through to the waste side of the bulkhead. While the bulkhead installations at the WIPP are solid and tight, they are neither leak-proof nor explosion-proof. However, the amount of air that can pass through the very small openings that occur between the rubber flashing and the salt is so small that it cannot be measured with the sensitive airflow measuring equipment in use at WIPP. A solid bulkhead of the type described will effectively remove the panel from the active ventilation system.

Experience at the WIPP shows that bulkheads constructed as described stand up to substantial pressures without failing in any way and are conservatively constructed for the conditions encountered at the WIPP. Many WIPP bulkheads typically experience a pressure of 3” water gage but it is not uncommon to expose them to pressures of 5” water gage or more, for example during testing and balancing of the ventilation system at the WIPP Site.

Bulkhead inspection and maintenance activities are detailed in Attachment D of the HWFP. The accessible portions of the bulkheads will be inspected monthly for deterioration and integrity.

Monitoring Methods

Monitoring of hydrogen and methane will be conducted using SUMMA® canister methods similar to those described in Attachment N of the HWFP. General information on this method is provided below:

Samples for analysis of hydrogen and methane concentrations will be collected using the subatmospheric pressure grab sampling technique described in USEPA Method TO-15. This method uses an evacuated SUMMA® passivated canister (or equivalent) that is under vacuum (0.05 mmHg) to draw the air sample from the sample lines into the canister. The sample lines will be purged prior to sampling as recommended by the method. The passivation of tubing and canisters used for hydrogen and methane sampling effectively seals the inner walls and prevents compounds from being retained on the surfaces of the equipment. By the end of each sampling period, the canisters will be near atmospheric pressure.

There are no EPA specific analytical methods which address hydrogen, methane or carbon dioxide. However, non-EPA methods are available (e.g., ASTM D 1945-03). The Carlsbad Environmental Monitoring and Research Center (**CEMRC**) has developed a procedure for analyzing these gases (CEMRC Procedure "*CCP-TP-143, Carlsbad Environmental Monitoring and Research Center Headspace Gas Analysis*"). Alternate procedures or laboratories may be used as approved by the Permittees.

Monitoring Locations

The existing VOC monitoring lines will be used for sample collection in each disposal room for Panels 3 through 7. The sample lines and their construction are shown in Attachment N, Figure N-4 of the HWFP.

In addition to the existing VOC monitoring lines, five more sampling locations will be used to monitor for hydrogen, methane, and carbon dioxide. These additional locations include:

- the inlet of room 1
- the waste side of the south bulkhead,
- the accessible side of the south bulkhead,
- the waste side of the north bulkhead,
- the accessible side of the north bulkhead.

These additional sampling locations will use a single inlet sampling point placed near the back. This will maximize the sampling efficiency for these lighter compounds.

The concern has been raised that the small tubular lines used to withdraw air samples from closed rooms in closed panel could be restricted or blocked by salt dust or fluid accumulations.

With regard to salt dust, blockage of the lines would require movement of the air at a sufficient rate to entrain the dust particles. However, because of the chain link, brattice cloth, substantial barriers and bulkheads it is reasonable to conclude that virtually all the air within the panel will be stagnant which has been confirmed as indicated below.

With regard to fluid accumulations, it is known that minor amounts of moisture are present in salt inclusions and in clay seams. When areas withdrawn from ventilation have been re-entered some areas have shown moisture accumulations sufficient to create salt incrustations and "saltsicles" due to evaporation. When these occur in actively ventilated areas, the effect of air flow on the evaporation process can be easily seen as the flow, even when slight, creates a bend in the formation. Evaporation does occur in closed areas since no signs of significant fluid accumulation were visible. The saltsicles seen in closed areas are straight and very fragile, indicating that there was no flow and no disturbance during the evaporation process. None of these areas had either waste or magnesium oxide present and both of these could have a significant effect on the humidity within a closed room and a full panel. It is reasonable to conclude that even if there is significant moisture present due to the inclusions and clays known to be present, there will be little if any local accumulation of that moisture and there will be little if any increase in the humidity.

Given the points noted above concerning the effectiveness of closures and absence of fluid accumulation, it is reasonable to conclude that accumulation of dust or moisture within sampling lines is unlikely to occur.

Mechanical damage to the tubing is also unlikely. The tubing used in disposal room monitoring is stainless steel. This ensures that it is a substantial, tough sampling line. The tubing is installed on chain link used as a ground control measure. This chain link actually acts as a buffer to any specific point damage that could occur from the wall of the panel. The tubing is also coiled during production, and therefore has some flexibility. This is a positive feature that allows for the tubing to bend as any room creep occurs.

The tubing has been in use at WIPP in panels 1, 2, and 3. To date maintenance needs have been minor. The longest serving lines were in Panel 2 which were used for 22 months. All sampling lines that have been removed from service have been terminated due to the installation of the isolation walls in Panels 1 and 2. The tubing installed in panel 3 is the only active sampling tubing for the disposal room monitoring at this time, having been installed in early 2005. It is expected that the tubing would last well beyond the data collection period associated with the methane and hydrogen monitoring.

To further address this concern the following will be used to evaluate the loss of one or more sampling lines:

1. Any loss of the ability to obtain a sample from a sample line will be evaluated.
2. The criteria used for evaluation include:
    a. location of the line (e.g., loss of lines in rooms closest to the bulkheads may pose greater risk than elsewhere in the panel)
    b. number of lines that have failed (e.g., loss of all lines in adjacent rooms may leave large portions of the panel unmonitored)
    c. the flammable gas concentration observed immediately before failure (e.g., little or no flammable gas accumulation may indicate that additional monitoring is not important in the area where the lines are lost)

3. If safety cannot be assured the isolation wall will be constructed. That is, if a positive statement regarding the build up of flammable gases in areas that are not monitored cannot be made (e.g., it is unlikely that gas will accumulate to hazardous levels because the accumulation rates are low and adjacent monitoring will detect such increases), the isolation wall will be constructed.
4. Whenever the evaluation leads to a decision to continue monitoring in spite of the loss of the ability to take a sample from one or more sample lines, the decision will be re-evaluated periodically (e.g., after each sampling event), as appropriate to assure continued safety.

Monitoring Frequency

The monitoring interval will vary depending upon the conditions under which monitoring is occurring. Three separate conditions are detailed below.

- *Developing an initial baseline*. At the start of monitoring an attempt will be made to establish the baseline rates of gas generation. Establishing a baseline will begin for each room within a panel upon the completion of waste emplacement in that panel. The baseline will consist of monthly samples collected over a 12-month timeframe.

- *Monitored levels are below the first action level*. The first action level is proposed as the condition when the concentrations of hydrogen and methane reach 10% of the combined LEL. After establishment of the baseline, but before this level is reached, monitoring will occur on a bi-monthly (every 2 months) basis.

- *Monitored levels above the first action level*. If the first action level is reached, then monitoring frequency will be increased to weekly until the levels fall below the first action level.

Hydrogen and methane will be monitored using the monitoring lines installed for VOC monitoring during operations in each panel. Hydrogen and methane will be monitored using a similar technique to that currently used for VOC determinations, that is, a period of purging of the lines followed by collection of samples for analysis. Monitoring will occur in each of the closed rooms, behind the bulkhead and immediately outside of each bulkhead.

Action Levels

The monitoring plan includes Action Levels based on the concentration of the flammable gases relative to their LELs in order to ensure that if an explosive mixture continues to develop within a panel, the panel will be closed using the approved panel closure design. These Action Levels have been designed to ensure the protection of human health and the environment.

The flammable gases which might be generated are some combination of hydrogen and methane. In air, hydrogen has a LEL of 4% while the LEL for methane is 5%.

The lower Action Level for a mixture of methane and hydrogen in a panel is 10% of the mixtures' composite LEL.

The upper Action Level for a mixture of hydrogen and methane in a panel is 20% of the mixtures' composite LEL.

Composite LEL Calculation

The LELs for methane and hydrogen are 5% and 4% respectively. The Action Levels will be set based on the composite LEL computed as follows:

$$\frac{p_t}{L_t} = \frac{p_m}{L_m} + \frac{p_h}{L_h}$$

Where p_t, p_m, p_h are the percentage concentrations of the total (mixture) flammable gases, methane, and hydrogen, respectively and
L_t, L_m, L_h are the LELs for the total (mixture), methane, and hydrogen respectively

As an example, if the methane and hydrogen concentrations are at 20% of their individual LELs (i.e. 1% methane and 0.8% hydrogen) the total (mixture) concentration is 1.8% and the total (mixture) LEL is 4.5%.

Activities Required if Action Levels Are Reached

Action Levels for the monitored panels, and the resulting required activities are based on the monitored levels of the flammable gases relative to the total (mixture) LEL. Specific levels and the prescribed activities are as follows:

- If the total (mixture) concentration of methane and hydrogen for three consecutive samples from the same sampling point exceeds 10% of the calculated total (mixture) LEL in a single panel, then the Permittees will continue to monitor and increase the monitoring frequency for that panel

- If the total (mixture) concentration of methane and hydrogen for three consecutive samples from the same sample point reaches 20% of the calculated total (mixture) LEL in a single panel, then the 12 foot isolation wall will be installed

The use of the bulkhead, the accompanying monitoring, and related Action Levels will maintain safe and protective operations by ensuring that:

- physical access to the full panel is prevented,
- the panel is removed from active ventilation, and
- conditions inside the panel are regularly monitored so that preventive actions can be taken well in advance of their need.

Actions After Sufficient Data Are Collected in Panels 3 Through 7

Flammable gas monitoring in Panels 3 through 7 will continue until panel closure is initiated. It is anticipated that once sufficient data are collected the Permittees can perform a comprehensive assessment of the data and determine an appropriate final panel closure design. A PMR will be developed and submitted to terminate the monitoring and to initiate a panel closure that either incorporates an isolation wall or substantial barriers and bulkheads. Other closure components such as run of mine salt may also be included.

Closed Room VOC Monitoring

This modification proposes to reduce disposal room VOC monitoring in filled panels to Room 1 only on a monthly basis to assure worker safety and protection. Only VOCs in the adjacent closed room (Room 1 in filled panels) pose a health risk to workers in the immediate vicinity. VOC sampling will occur in the same manner as currently specified in the HWFP.

Extension of Final Closure in Panels 3 Through 7

In order to allow sufficient time to collect and analyze data on hydrogen and methane concentrations in Panels 3 through 7 it is necessary to extend the final closure date for those units.

The Permittees propose to monitor Panels 3 through 7 until 2014. At that time an assessment of the data will be performed and a PMR developed and submitted to the NMED requesting the appropriate panel closure design and terminating filled room monitoring.

This modification will request an extension of final closure as indicated in Attachment I, Table I-1 until 2016 which will allow sufficient time for the data evaluation, PMR development and action on the PMR by the NMED.

Changes to the Inspection Schedule

The Permittees are proposing a change to the Inspection Schedule in Attachment D of the HWFP to include inspections of the accessible portions of the isolation walls in Panels 1 and 2 (and any other isolation walls that may be constructed prior to final panel closure) on a quarterly basis and have a registered professional engineer certify the stability of the isolation walls on an annual basis. The certification with supporting information will be submitted to the NMED in the WIPP Mine Ventilation Rate Monitoring Plan no later than October 27 of each calendar year.

The Permittees will also inspect on a monthly basis, the accessible portions of each monitoring bulkhead in each filled panel and include the results of those inspections in the WIPP Operating Record.

The proposed changes to the WIPP HWFP text are presented in Attachment B of this PMR.