Class 1* Permit Modification Request

Change to Closure Schedule for Panels 1 through 8

Waste Isolation Pilot Plant
Carlsbad, New Mexico

WIPP HWFP #NM4890139088-TSDF

January 2007

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Acronyms and Abbreviations

CCD	Compliance Certification Decision
CFR	Code of Federal Regulations
DOE	Department of Energy
EPA	Environmental Protection Agency
HWDU	Hazardous Waste Disposal Unit
HWFP	Hazardous Waste Facility Permit
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
PCS	Panel Closure System
PMR	Permit Modification Request
SMC	Salado Mass Concrete
VOC	Volatile Organic Compound
WPC	WIPP Panel Closure
WIPP	Waste Isolation Pilot Plant

Overview of the Permit Modification Request

This document contains a Class 1* Permit Modification Request (**PMR**) to the Hazardous Waste Facility Permit (**HWFP**) at the Waste Isolation Pilot Plant (**WIPP**), Permit Number NM4890139088-TSDF hereinafter referred to as the WIPP HWFP. This request requires approval of the New Mexico Environment Department (**NMED**) prior to implementation.

This PMR is being submitted by the U.S. Department of Energy (**DOE**) and Washington TRU Solutions, LLC, 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 of the Code of Federal Regulations (**CFR**) § 270.42(a)). This change does not reduce the ability of the Permittees to continue to protect human health and the environment.

The modification 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 revision bar in the right hand margin for added information, and a ~~strikeout~~ font for deleted information. All direct quotations are indicated by *italicized* text.

Attachment A

Description of the Class 1* Permit Modification Request

Table 1. Class 1* Hazardous Waste Facility Permit Modification Notification

No.	Affected Permit Section	Item	Category	Attach A Page #
1	a.1. Module IV	Specify ongoing Disposal Room VOC Monitoring in Panel 3 after waste disposal has been completed.	A.4.a	A-3
	a.2 Attachment I, Section I-1d(1) and Table I-1	Extension of the closure period for Panel Closure for Panel 3. Revise Section I-1d(1) and Table I-1 to update current anticipated operations and closure dates for Panels 3-8.	D.1.b	
	a.3 Attachment N, Section N-3a(2) and N-3a(3)	Specify ongoing Disposal Room VOC Monitoring in Panel 3 after waste disposal has been completed.	A.4.a	
2	b.1. Attachment I, Section I-1d(1) and Table I-1	Further extension of the closure period for Panels 1 and 2. Revise Section I-1d(1) and Table I-1 to update current anticipated operations and closure end dates for Panels 1 and 2. Provides documentation that further extension of the closure period is protective of human health and the environment.	D.1.b	A-11

Item 1

Description:

Item 1 of this PMR is seeking NMED approval for:

1. an extension in the closure schedule for Panel 3,
2. an update to the current anticipated operations and closure dates for Panels 3-8,
3 ongoing Disposal Room Volatile Organic Compound (**VOC**) Monitoring in Panel 3 after waste disposal has been completed.

Basis:

Panel 3 is the third hazardous waste disposal unit (**HWDU**) that will be closed under the WIPP HWFP. It is anticipated that the closure activities will not be completed within the 180 days provided in the Closure Plan (HWFP Attachment I).

Section 20.4.1.900 NMAC (incorporating 40 CFR § 270.42, Appendix I, Item D.1.b) classifies changes to the closure schedule, including extensions of the closure period, for any unit as a Class 1* consistent with 20.4.1.900 NMAC, incorporating 40 CFR § 270.42(a)(2).

Section 20.4.1.900 NMAC (incorporating 40 CFR § 270.42, Appendix I, Item A.4.a) classifies changes in the frequency of monitoring to provide for more frequent monitoring as a Class 1 consistent with 20.4.1.900 NMAC, incorporating 40 CFR § 270.42(a).

Discussion:

When the NMED issued the HWFP in October 1999 it stipulated that the design of the panel closure will follow that described in the application as Option D, consisting of a concrete monolith and an 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."*

The Permittees are seeking changes to the panel closure design in a stepwise manner. The first step involved evaluating the required panel closure system to assure that the closure is constructable and protective of human health and the environment as required by RCRA. Data were collected on Salado Mass Concrete and the Permittees determined that the approved panel closure was not constructable as specified by the NMED. Therefore it became necessary to re-design the panel closure system. As a result, a new design was submitted to the NMED for approval in October 2002. The October 2002 PMR is pending before the NMED.

With regard to the second step in the Permittees' process for changing the panel closure design, the current panel closure design is based on models of gas generation that were conservatively applied. Removing some of the conservatism could result in a different closure design that meets the requirements of RCRA to protect human health and the environment. One effective method to address this conservatism is to make gas measurements in filled panels. Therefore, the second step, which is underway at this time, involves changes to the closure design to allow the collection of gas data in Panel 3 after waste disposal in the panel has been completed. These data will form a basis for a subsequent panel closure design as indicated in Attachment I of the HWFP as shown below:

> *"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 order to fully implement this second step, three documents are being submitted and/or developed for submittal to the NMED.

The first document is this Class 1* PMR which proposes to extend the closure schedule for Panel 3. The reasons for the schedule extension in this PMR is to preserve the ability to collect gas generation data in Panel 3 and to allow the NMED to act upon the Class 3 PMR which was submitted in October 2002. The Permittees do not believe that the NMED will be able to complete the PMR process in the time frame allocated in the Panel 3 closure in the current HWFP.

The second document is a Notification of Planned Change to the Permitted Facility which discusses the installation of barriers in Panel 3 which will include:

1. installation of a substantial barrier in conjunction with the chain link and brattice cloth,
2. installation of an isolation barrier, and
3. installation of five additional data collection points.

The Notification of Planned Change to the Permitted Facility supports this Class 1* PMR. The planned change assures protection of human health and the environment during the period of the closure schedule extension and allows the Permittees to begin collecting data regarding gas generation in filled panels.

The substantial barrier serves to protect waste from events such as ground movement or vehicle impacts. It will be constructed from available materials such as magnesium oxide or mined salt.

The isolation barrier is constructed as a typical WIPP bulkhead with no access doors or panels. It serves the functions of blocking ventilation and preventing personnel access to Panel 3 as required by the WIPP HWFP.

Steel bulkheads have been used in the WIPP underground since the first openings were mined over 20 years ago. Their primary function is to regulate or direct ventilation air and to isolate different air streams from each other. While the WIPP openings creep and close, bulkheads are designed to accommodate such movement by their construction. Although the center portion of the bulkhead is constructed of rigid steel panels, this is supported and connected to the surrounding mine opening with supports that automatically adjust by sliding in their mounts. These supports are typically designed to have about 18 inches of available adjustment. In addition, flexible flashing is installed to provide a ventilation seal between the rigid center and the mine openings.

WIPP bulkheads typically do not deteriorate and maintenance is usually limited to actively moving parts, such as pneumatically operated doors which are not components of the isolation barriers. Vertical closure in access drifts in existing panels (1, 2, 3 and 4) ranges from 1-3 inches per year. Assuming that similar rates are observed in future panels, this means that the isolation barrier may reasonably be expected to last without structural impact due to creep closure for as long as 6 - 18 years depending upon salt creep rate.

The additional data collection locations include:

1. the inlet of room 1,
2. the inbye side of the south isolation barrier,
3. the outbye side of the south isolation barrier,
4. the inbye side of the north isolation barrier, and
5. the outbye side of the north isolation barrier.

These components may be removed in the future if necessary to complete Panel 3 closure.

The third document, a new Class 3 PMR to amend the closure design, is being developed as indicated below:

- Beginning with Panel 3, add a steel bulkhead, of the type typically in use and with no personnel access, to the closure design
- Monitor the panel for methane and hydrogen after waste disposal has been completed.
- Establish action levels that would trigger the installation of other panel closure components in the event of the accumulation of methane and/or hydrogen within a panel after waste disposal has been completed.

The changes proposed in the Class 3 PMR represent additional components that will work with any panel closure and are therefore independent of the panel closure design and do not rely on approval of the October 2002 Class 3 PMR.

The third step will be to evaluate the data obtained from monitoring in filled panels to determine the appropriate panel closure design. The results of the monitoring may require installation of the currently approved panel closure design, the WIPP Panel Closure System proposed in the October 2002 Class 3 PMR or it may be determined that the bulkhead is a sufficient closure. This Class 1* will support any of these closure options.

The Closure Plan provides a general schedule (Attachment I, Figure I-2) for closing each WIPP HWDU (i.e., panel). The schedule estimates closing each panel 180 days after the completion of waste disposal operations in the panel. In addition, Attachment I, Table I-1, *Anticipated Earliest Closure Dates for the Underground HWDUs*, provides anticipated operations end, closure start, and closure end dates for each of the panels. The Permittees have identified the need to adjust these dates as discussed below.

Based on current shipping rates, disposal operations in Panel 3 will be completed in January 2007. This PMR proposes an extension in the closure period for Panel 3 by modifying Attachment I to indicate the anticipated dates for the end of operations, the beginning of closure, and the end of closure for Panels 3 through 8 (although Panel 8 cannot be filled under the current HWFP). These changes are based upon previous experience which indicates that filling a panel takes approximately 24 months.

This Class 1* PMR proposes to modify Attachment I, Table I-1 to reflect the proposed revision to the WIPP Panel Closure Schedule until such time as the NMED and EPA complete action on both the existing and new Class 3 PMRs and Planned Change Request, respectively. It is anticipated that these decisions will occur prior to June 2009 and that date is reflected in the revised Attachment I, Table I-1.

The Permittees propose to install the brattice cloth and chain link room barricade to block ventilation as required by Permit Attachment M2 and conduct surveys of the openings as required in Permit Attachment I, Section I-1d(1). At this point the Permittees will delay the schedule for installation of additional closure components.

Protection of human health and the environment is provided by:

prevention of access into Panel 3,

restriction of releases of hazardous waste constituents from the panel into the underground atmosphere.

In addition, the Permittees will continue to monitor for volatile organic compounds in the closed rooms in Panel 3 as specified in Permit Condition IV.D, Table IV.D.1.

In response to concerns raised related to the possibility that hydrogen and methane may reach explosive levels during the time of schedule extension for Panel 3, the Permittees conducted a review of the WIPP Resource Conservation and Recovery Act Part B Permit Application, Appendix I1, and other available literature. The findings and conclusions, included as Attachment D, indicate that under inundated conditions methane and hydrogen concentration would not exceed 20 percent and 30 percent of the respective lower explosive limits (LEL), or 50 percent of the combined LEL within 5 years. The Permittees have therefore concluded that even though they will be collecting data regarding the concentrations of these gases during the requested time of extension, until June 30, 2009, there is no need to establish action levels for hydrogen or methane for this short period of time.

The concern has also been raised that the small tubular lines used to withdraw air samples from closed rooms in closed panels could be restricted or blocked by salt dust or fluid accumulations. Because of the multiple closures (i.e.chain link and brattice cloth and panel closure bulkheads it is reasonable to conclude that air within the panel will be stagnant.

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 formations 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 of 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 about 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.

The tubing used in disposal room VOC monitoring is stainless steel. This ensures that it is a substantial tough sampling line. The tubing is installed on chain link used to act 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. 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 there have been very minor maintenance issues. The longest serving lines were in panel 2 which were used for 1 year and 10 months. All sampling lines that have been removed from service have been terminated due to the installation of the explosion 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 PMRs being prepared for methane and hydrogen monitoring.

A Notification of Planned Change to the Permitted Facility is being submitted with this modification as described above (See Attachment B).

Note that this modification addresses changes to the panel closure schedule and dates. It also identifies the Permittees' intent to modify the closure plan in the future to include the bulkhead ventilation barrier and to perform monitoring for gases. That request is being made in the Class 3 PMR for the Amended Closure Plan also discussed above.

This proposal to extend the closure for Panel 3 is protective of human health and the environment because:

1. the requirements of Permit Attachment M2 to close the room by blocking ventilation are satisfied;
2. Disposal Room VOC Monitoring as defined in Permit Condition IV.D.3 will protect underground workers;
3. repository VOC monitoring as defined in Permit Condition IV.F.2 will protect non-waste workers, the public, and the environment.

Revised Permit Text:

a.1 Permit Condition IV.D.3

IV.D.3 Ongoing Disposal Room VOC Monitoring in Panel 3

The Permittees will continue VOC monitoring in Panel 3 after closure has begun. The measured concentration of VOCs in Panel 3 shall not exceed the limits specified in Table IV,D.1 above.

a.2 Section I-1d(1)

The anticipated schedule for the closure of the underground HWDUs known as Panels 3 through 8 is shown in Figure I-2. This schedule assumes there will be little contamination within the exhaust drift of the panel. Underground HWDUs should be ready for closure according to the schedule in Table I-1. These dates are estimates for planning and permitting purposes. Actual dates may vary depending on the availability of waste from the generator sites.

In the schedule in Figure I-2, notification of intent to close occurs thirty (30) days before placing the final waste in a panel. Once a panel is full, the Permittees will initially block ventilation through the panel as described in Permit Attachment M2 and then will assess the closure area for ground conditions and contamination so that a definitive schedule and closure design can be determined. If as the result of this assessment the Permittees determine that a panel closure cannot be emplaced in accordance with the schedule in this Closure Plan, a modification will be submitted requesting an extension to the time for closure.

The Permittees will initially block ventilation through Panel 2 as described in Permit Attachment M2 once Panel 2 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 will not exceed 180 days after the last receipt of waste in Panel 2. Final closure of Panels 1 and 2 will be completed as specified in this Permit no later than five years after completion of their respective explosion isolation wall.

The Permittees will initially block ventilation through Panel 3 as described in Permit Attachment M2 once waste disposal in Panel 3 has been completed to ensure continued protection of human health and the environment. Final closure of Panel 3 will be completed as specified in this Permit no later than June 30, 2009.

a.2 Table I-1

TABLE I-1
ANTICIPATED EARLIEST CLOSURE DATES FOR
THE UNDERGROUND HWDUs

HWDU	OPERATIONS START	OPERATIONS END	CLOSURE START	CLOSURE END
PANEL 1	3/99	2/03	3/03	9/03 SEE NOTE 5
PANEL 2	3/03	6/05	7/05	1/06 SEE NOTE 5
PANEL 3	7/05	~~11/06~~ 1/07	~~12/06~~ 2/07	~~6/07~~ 8/07 SEE NOTE 6
PANEL 4	~~11/06~~ 1/07	~~6/08~~ 1/09	~~7/08~~ 2/09	~~1/09~~ 8/09
PANEL 5	~~6/08~~ 1/09	~~11/09~~ 1/11	~~12/09~~ 2/11	~~6/10~~ 8/12
PANEL 6	~~11/09~~ 1/11	~~2/11~~ 1/13	~~3/11~~ 2/13	~~9/11~~ 8/14
PANEL 7	~~2/11~~ 1/13	~~6/12~~ 1/15	~~7/12~~ 2/15	~~1/13~~ 8/16
PANEL 8	~~6/12~~ 1/15	~~1/14~~ 1/17	~~2/14~~ 2/17	~~8/14~~8/18
PANEL 9	1/14	1/28	2/28	SEE NOTE 4
PANEL 10	1/28	9/30	10/30	SEE NOTE 4

NOTE 1: Only Panels 1 to ~~7~~ 4 will be closed under the permit covered by this application. Closure schedules for Panels ~~8~~ 5 through 10 are projected assuming new permits will be issued in 2009 and 2019.

NOTE 2: The point of closure start is defined as sixty (60) days following notification to the NMED of closure.

NOTE 3: The point of closure end is defined as one hundred eighty (180) days following placement of final waste in the panel.

NOTE 4: The time to close these areas may be extended depending on the nature and extent of the disturbed rock zone. The excavations that constitute these panels will have been opened for as many as forty (40) years so that the preparation for closure may take longer than the time allotted in Figure I-2. If this extension is needed, it will be requested as an amendment to the Closure Plan.

NOTE 5: The anticipated closure end date for Panels 1 and 2 is for installation of the 12-foot explosion isolation wall. Final closure of Panels 1 and 2 will be completed as specified in this Permit no later than ~~five years after completion of their respective explosion isolation wall~~ June 30, 2009.

NOTE 6: The anticipated closure end date for Panel 3 is for initially blocking ventilation through the closed panel. Final Closure of Panel 3 shall be completed as specified in this Permit but no later than June 30, 2009.

a.3 Attachment N. Section N-3a(2)

For purposes of compliance with Section 310 of Public Law 108-447, the VOC monitoring of airborne VOCs in underground disposal rooms in which waste has been emplaced will be performed as follows:

- A sample head will be installed inside the disposal room behind the exhaust drift bulkhead and at the inlet side of the disposal room.

- TRU mixed waste will be emplaced in the active disposal room.

- When the active disposal room is filled, another sample head will be installed to the inlet of the filled active disposal room. (Figure N-3 and N-4)

- The exhaust drift bulkhead will be removed and re-installed in the next disposal room so disposal activities may proceed.

- A ventilation barrier will be installed where the bulkhead was located in the active disposal room's exhaust drift. Another ventilation barrier will be installed in the active disposal room's air inlet drift, thereby closing that active disposal room.

- Monitoring of VOCs will continue in the now closed disposal room. Monitoring of VOCs will occur in the active disposal room and all closed disposal rooms in which waste has been emplaced until commencement of panel closure activities (i.e., completion of ventilation barriers in Room 1) <u>except as indicated below in Section N-3a(3)</u>.

This sequence for installing sample locations will proceed in the remaining disposal rooms until the inlet air ventilation barrier is installed in disposal room one. An inlet sampler will not be installed in disposal room one because disposal room sampling proceeds to the next panel.

<u>Section N-3a(3) Ongoing Disposal Room VOC Monitoring in Panel 3</u>

<u>The Permittees will continue VOC monitoring in Panel 3 after closure has begun. The measured concentration of VOCs in Panel 3 shall not exceed the limits specified in Table IV,D.1.</u>

Item 2

Description:

This permit modification requests approval of an extension of the closure schedule for Panels 1 and 2.

Basis:

Panels 1 and 2 are the first two hazardous waste disposal units (**HWDU**s) that will be closed under the WIPP HWFP. It is anticipated that the closure activities will not be completed within the 180 days provided in the Closure Plan (HWFP Attachment I).

Section 20.4.1.900 NMAC (incorporating 40 CFR § 270.42, Appendix I, Item D.1.b) classifies changes to the closure schedule, including extension in the schedule for closure for any unit as a Class 1* consistent with 20.4.1.900 NMAC, incorporating 40 CFR § 270.42(a)(2).

Discussion:

The Closure Plan (Attachment I, Figure I-2) provides a general schedule for closing each WIPP HWDU (i.e., panel). The schedule estimates closing each panel 180 days after the completion of waste disposal operations in the panel. In addition, Attachment I, Table I-1, *Anticipated Earliest Closure Dates for the Underground HWDUs*, provides operations end, closure start, and closure end dates for each of the panels.

Closure of Panels 1 and 2 has begun with the construction of 12 foot explosion isolation walls which have been emplaced in the access drifts of the respective panels. Two previous, individual permit modifications requesting approval of an extension in the closure schedule for Panels 1 and 2 were approved by the NMED. These permit modifications requested extension in the closure schedule between completion of the 12-foot explosion isolation wall and the completion of panel closure. This extension provided the NMED and EPA time to consider a Class 3 permit modification request and Planned Change Request respectively proposing a redesign of the panel closure system (**PCS**). The 12' explosion isolation walls have been constructed in the respective panels.

In granting the previous closure schedule delays for Panels 1 and 2, the NMED allowed for five years upon completion of the 12' explosion isolation wall for the Permittees to complete final panel closure. It does not appear the final agency action will be completed before the end of these five year periods. Therefore, the Permittees are seeking additional time to complete final panel closure as proposed in the attached modification to Attachment I, Table I-1. The attached report (Attachment C) entitled: "*Further Assessment of the Short Term Stability of the 12 Foot Explosion Isolation Wall*", dated June 30, 2006, indicates that the explosion isolation wall for Panel 1 will be stable for at least three more years. Since this report is for the stability of the explosion isolation wall for Panel 1, it bounds the explosion isolation wall for Panel 2 which was constructed later.

The three year period in the attached report is sufficient time for the agencies to act upon both Class 3 PMRs and Planned Change Request respectively. Therefore, the Permittees are requesting a three year extension from the date of the June 30, 2006 assessment report, prior to initiating final closure in Panels 1 and 2.

Revised Permit Text:

Note: The changes made to the Revised Permit text in Item 1 appear in the Revised Permit Text for Item 2 as well.

b.1 Section I-1d(1)

The anticipated schedule for the closure of the underground HWDUs known as Panels 3 through 8 is shown in Figure I-2. This schedule assumes there will be little contamination within the exhaust drift of the panel. Underground HWDUs should be ready for closure according to the schedule in Table I-1. These dates are estimates for planning and permitting purposes. Actual dates may vary depending on the availability of waste from the generator sites.

In the schedule in Figure I-2, notification of intent to close occurs thirty (30) days before placing the final waste in a panel. Once a panel is full, the Permittees will initially block ventilation through the panel as described in Permit Attachment M2 and then will assess the closure area for ground conditions and contamination so that a definitive schedule and closure design can be determined. If as the result of this assessment the Permittees determine that a panel closure cannot be emplaced in accordance with the schedule in this Closure Plan, a modification will be submitted requesting an extension to the time for closure.

The Permittees will initially block ventilation through Panel 2 as described in Permit Attachment M2 once Panel 2 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 will not exceed 180 days after the last receipt of waste in Panel 2. Final closure of Panels 1 and 2 will be completed as specified in this Permit no later than June 30, 2009 ~~five years after completion of their respective explosion isolation wall~~.

The Permittees will initially block ventilation through Panel 3 as described in Permit Attachment M2 once waste disposal in Panel 3 has been completed to ensure continued protection of human health and the environment. Final closure of Panel 3 will be completed as specified in this Permit no later than June 30, 2009.

b.2 Table I-1

TABLE I-1
ANTICIPATED EARLIEST CLOSURE DATES FOR THE UNDERGROUND HWDUs

HWDU	OPERATIONS START	OPERATIONS END	CLOSURE START	CLOSURE END
PANEL 1	3/99	2/03	3/03	9/03 SEE NOTE 5
PANEL 2	3/03	6/05	7/05	1/06 SEE NOTE 5
PANEL 3	7/05	~~11/06~~ 1/07	~~12/06~~ 2/07	~~6/07~~ 8/07 SEE NOTE 6
PANEL 4	~~11/06~~ 1/07	~~6/08~~ 1/09	~~7/08~~ 2/09	~~1/09~~ 8/09
PANEL 5	~~6/08~~ 1/09	~~11/09~~ 1/11	~~12/09~~ 2/11	~~6/10~~ 8/12
PANEL 6	~~11/09~~ 1/11	~~2/11~~ 1/13	~~3/11~~ 2/13	~~9/11~~ 8/14
PANEL 7	~~2/11~~ 1/13	~~6/12~~ 1/15	~~7/12~~ 2/15	~~1/13~~ 8/16
PANEL 8	~~6/12~~ 1/15	~~1/14~~ 1/17	~~2/14~~ 2/17	~~8/14~~8/18
PANEL 9	1/14	1/28	2/28	SEE NOTE 4
PANEL 10	1/28	9/30	10/30	SEE NOTE 4

NOTE 1: Only Panels 1 to ~~7~~ 4 will be closed under the permit covered by this application. Closure schedules for Panels ~~8~~ 5 through 10 are projected assuming new permits will be issued in 2009 and 2019.

NOTE 2: The point of closure start is defined as sixty (60) days following notification to the NMED of closure.

NOTE 3: The point of closure end is defined as one hundred eighty (180) days following placement of final waste in the panel.

NOTE 4: The time to close these areas may be extended depending on the nature and extent of the disturbed rock zone. The excavations that constitute these panels will have been opened for as many as forty (40) years so that the preparation for closure may take longer than the time allotted in Figure I-2. If this extension is needed, it will be requested as an amendment to the Closure Plan.

NOTE 5: The anticipated closure end date for Panels 1 and 2 is for installation of the 12-foot explosion isolation wall. Final closure of Panels 1 and 2 will be completed as specified in this Permit but no later than June 30, 2009 ~~no later than five years after completion of their respective explosion isolation wall.~~

NOTE 6: The anticipated closure end date for Panel 3 is for initially blocking ventilation through the closed panel. Final Closure of Panel 3 shall be completed as specified in this Permit but no later than June 30, 2009.

Attachment B

Notification of Planned Change to the Permitted Facility

Notification of Planned Change to the Permitted Facility

The purpose of this Notification of Planned Change to the Permitted Facility is to inform NMED of the Permittees' intent to perform the following activities in Panel 3:

1. install a substantial barrier in conjunction with the chain link and brattice cloth,
2. install an isolation barrier, and
3. install five additional data collection points.

The Notification of Planned Change to the Permitted Facility supports the *Change to Closure Schedule for Panels 1-8*, Class 1* PMR being submitted simultaneously. The planned change assures protection of human health and the environment during the period of the schedule extension, until June 30, 2009, and allows the Permittees to begin collecting data regarding gas generation in filled panels.

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

The isolation barrier is constructed as a typical WIPP bulkhead with no access doors or panels. It serves the functions of blocking ventilation to Panel 3 and preventing personnel access as required by the WIPP HWFP.

Steel bulkheads have been used in the WIPP underground since the first openings were mined over 20 years ago. Their primary function is to regulate or direct ventilation air and to isolate different air streams from each other. While the WIPP openings creep and close, bulkheads are designed to accommodate such movement by their construction. Although the center portion of the bulkhead is constructed of rigid steel panels, this is supported and connected to the surrounding mine opening with supports that automatically adjust by sliding in their mounts. These supports are typically designed to have about 18 inches of available adjustment. In addition, flexible flashing is installed to provide a ventilation seal between the rigid center and the mine openings (see Figure B).

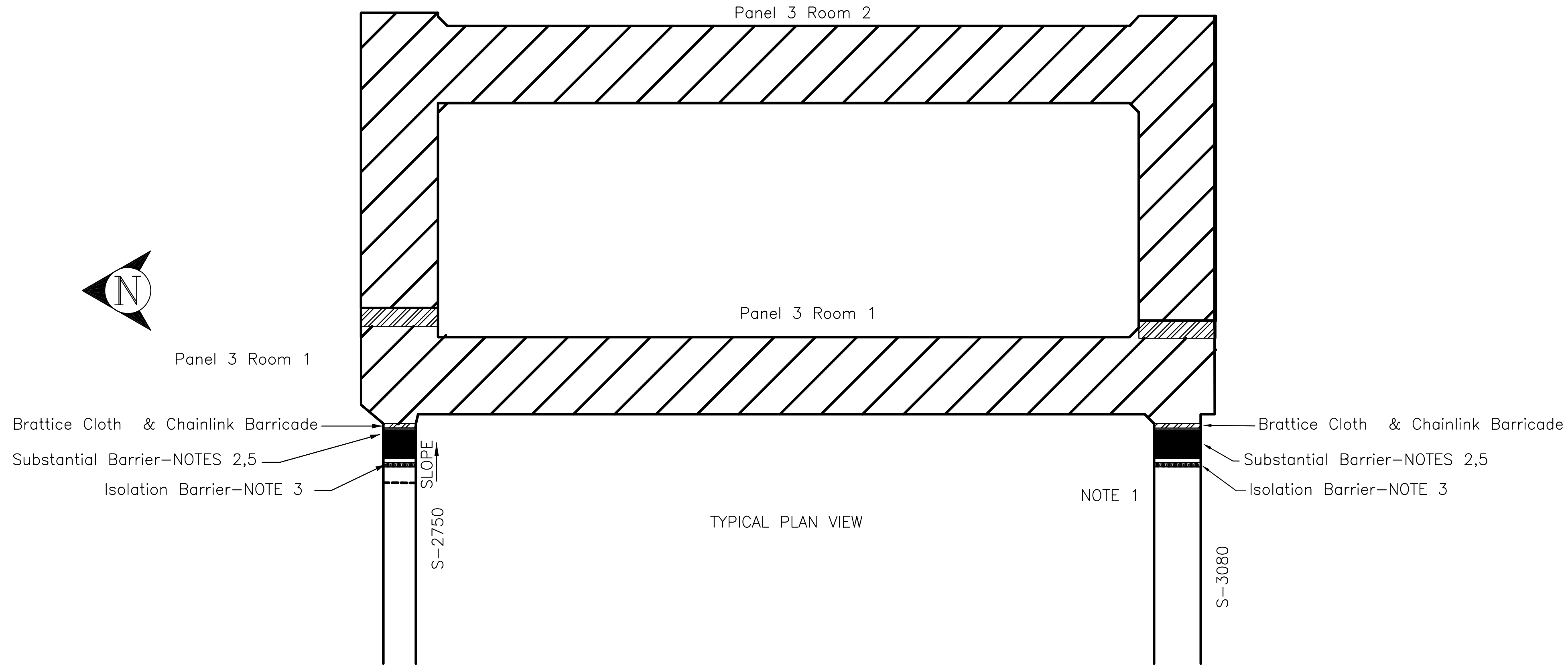
WIPP bulkheads typically do not deteriorate and maintenance is usually limited to actively moving parts, such as pneumatically operated doors which are not components of the isolation barriers. Vertical closure in access drifts in existing panels (1, 2, 3 and 4) ranges from 1-3 inches per year. Assuming that similar rates are observed in future panels, this means that the isolation barrier may reasonably be expected to last without structural impact due to creep closure for as long as 6 - 18 years depending upon salt creep rate.

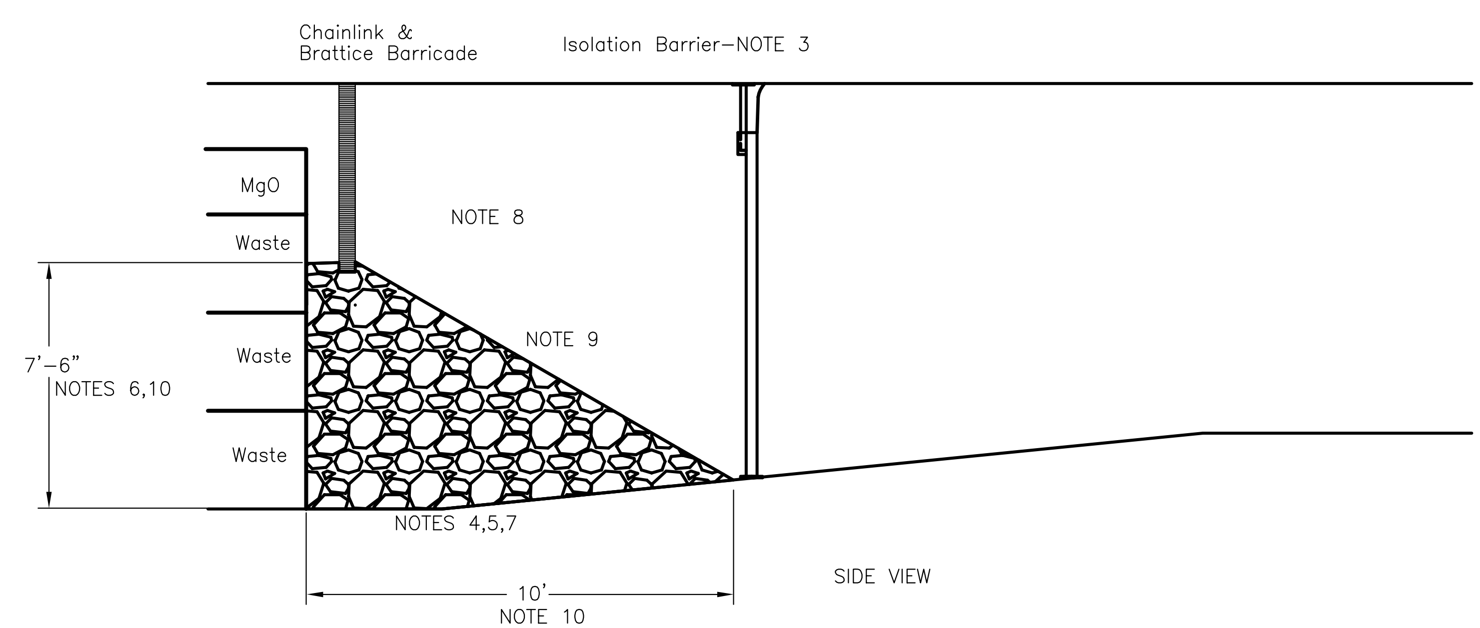
The additional data collection locations include:

the inlet of room 1,
the inbye side of the south isolation barrier,
the outbye side of the south isolation barrier,
the inbye side of the north isolation barrier, and
the outbye side of the north isolation barrier.

These components may be removed in the future if necessary to complete Panel 3 closure.

The intention of this planned change is to isolate Panel 3 by preventing unintended personnel entry and by removing the panel from active ventilation while the NMED and the EPA review the Permittees' proposed panel closure modifications.





NOTES

1. A SUBSTANTIAL BARRIER AND ISOLATION BARRIER INSTALLATION WILL BE INSTALLED IN THE INTAKE AND EXHAUST DRIFTS OF THE PANEL. THE EXACT CONFIGURATION OF THE INSTALLATION WILL BE DEPENDENT ON THE AS–FOUND CONDITIONS OF THE DRIFTS.
2. CONFIGURATION AND PLACEMENT OF THE SUBSTANTIAL BARRIER WILL BE DICTATED BY FIELD CONDITIONS.
3. TYPICAL ISOLATION BARRIER IS DEPICTED ON FIGURE B.
4. AMOUNT AND HEIGHT OF THE SUBSTANTIAL BARRIER WILL BE DETERMINED BY THE COGNIZANT ENGINEER, BASED ON FIELD CONDITIONS.
5. SUBSTANTIAL BARRIER MATERIAL WILL CONSIST OF RUN–OF–MINE SALT OR OTHER SUITABLE NON–FLAMMABLE MATERIAL AS DESIGNATED BY THE COGNIZANT ENGINEER.
6. THE HEIGHT OF THE SUBSTANTIAL BARRIER NEAR THE WASTE WILL BE AT LEAST EQUAL TO THE HEIGHT OF THE BOTTOM OF THE TOP ROW OF WASTE.
7. SUBSTANTIAL BARRIER MATERIAL SHOULD BE AGAINST THE WASTE FACE.
8. ANCHOR CHAIN LINK AND BRATTICE BARRIER IN THE SUBSTANTIAL BARRIER AS DETERMINED BY THE COGNIZANT ENGINEER.
9. SLOPE TO SUIT. COMPACT AS DETERMINED BY THE COGNIZANT ENGINEER.
10. DIMENSIONS INDICATED FOR THE HEIGHT AND LENGTH OF THE SUBSTANTIAL BARRIERS ARE MINIMUMS. THE HEIGHT OF THE SUBSTANTIAL BARRIER IS MEASURED AT THE WASTE FACE. THE LENGTH OF THE SUBSTANTIAL BARRIER IS MEASURED FROM THE BOTTOM OF THE WASTE FACE TO THE TOE OF THE SUBSTANTIAL BARRIER MATERIAL.

FIGURE A–TYPICAL LAYOUT
PANEL SUBSTANTIAL AND ISOLATION BARRIERS

Not to Scale

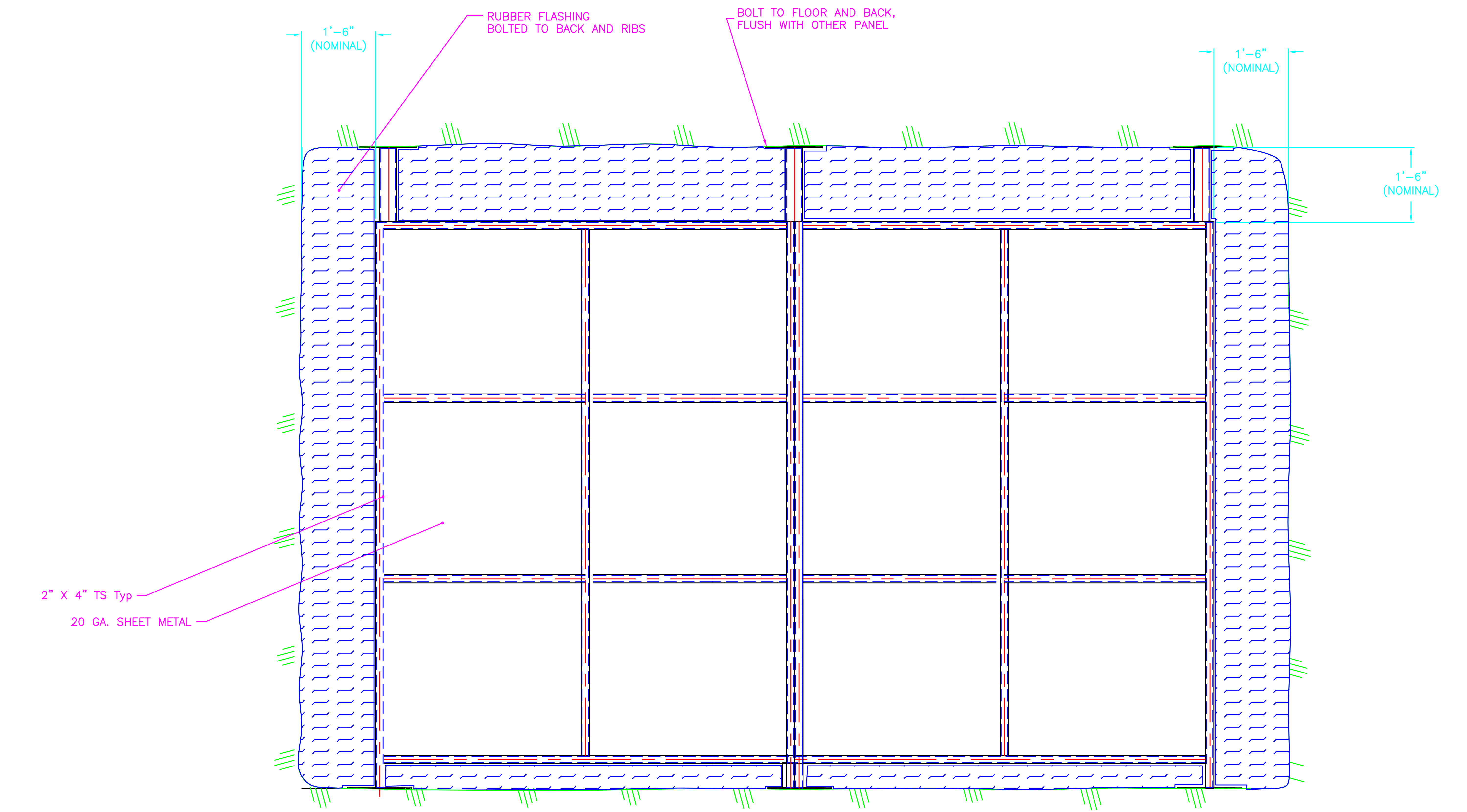


FIGURE B
TYPICAL ISOLATION BARRIER

Not to Scale

Attachment C

Further Assessment of the Short-term Stability of the 12 Foot Explosion Isolation Wall

(Editor's Note: In the attached report the statement "*NMED has since stated that it will not be able to complete the PMR process for the revised Panel Closure system within the initial five year period,*" should state "*The Permittees do not expect NMED will be able to complete the PMR process for the revised Panel Closure system within the initial five year period*."

(Report Attached in the pdf Version of This Modification)

Further Assessment of the Short-term Stability of the 12 Foot Explosion Isolation Wall

June 30, 2006

Prepared for

Washington TRU Solutions, LLC
Waste Isolation Pilot Plant
Carlsbad, New Mexico

Prepared by

RockSol Consulting Group, Inc.
Boulder, Colorado

Certification

I certify under penalty of law that this document was prepared under my supervision for Washington TRU Solutions, LLC, under the RockSol Consulting Group, Inc. Quality Assurance Program. This quality assurance program is designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete.

Saeid Saeb, Ph.D., P.E.
New Mexico
Certification No. 11777
Expires December 31, 2007

1 Introduction

The Waste Isolation Pilot Plant (WIPP), located near Carlsbad, New Mexico, was established for the safe disposal of defense-generated transuranic waste. One important repository operation of the WIPP is the closure of waste disposal panels. Each panel consists of access drifts and seven rooms (Figure 1). The closure of individual panels during the operational period must be accomplished within conditions stated in the Hazardous Waste Facility Permit (HWFP).

The original panel closure system design is contained in a report entitled “Detailed Design Report for an Operational Phase Panel-Closure System” (DOE, 1996). This report was attached to the HWFP Application as Attachment I1. The HWFP issued in October 1999 reflects Option D as described in DOE, 1996, with certain changes in the Technical Specifications. Option D consists of a 12 foot long explosion isolation wall and a concrete monolith. The explosion isolation wall was intended to provide isolation from the temperature and pressure effects of a methane gas explosion during installation of the monolith portion of Option D.

A Class 3 Permit Modification Request (PMR) for a revision of the panel closure system design has been submitted. The revised WIPP Panel Closure (WPC) system (DOE, 2002) consists of a 30 foot long mortared concrete block, explosion isolation wall and 100 feet of run of mine salt backfill. The implementation of the WPC design requires submittal and approval of this PMR for the HWFP, and was determined through discussions with the New Mexico Environment Department (NMED) and interested parties that a period of up to five years may be required to complete the PMR process.

Waste disposal operations in Panel 1 finished in early March 2003 and a Class 1* PMR was submitted in November 2002 requesting an extension of time to perform closure of Panel 1 while NMED acted upon the Class 3 PMR. In the Class 1* PMR, it was proposed to emplace the 12 foot explosion isolation wall component of the Option D design that is in the current HWFP using 5000 psi concrete blocks. A December, 2002 report entitled “Assessment of the Short-term Stability of the 12 Foot Explosion Isolation Wall” which included a structural analysis of the stability of the walls in Panel One for a period of 5 years was provided in support of the Class 1* PMR. The Class 1* PMR was approved in December 2002 for a period of 5 years and explosion isolation walls were built to the configuration in the current HWFP using the mortared 5000 psi concrete block specifications from the WPC design. NMED has since stated that it will not be able to complete the PMR process for the revised Panel Closure system within the initial five year period.

This report extends the structural analysis of the walls to ten years after installation. In addition, the performance to date of the wall is also analyzed and incorporated into the assessment.

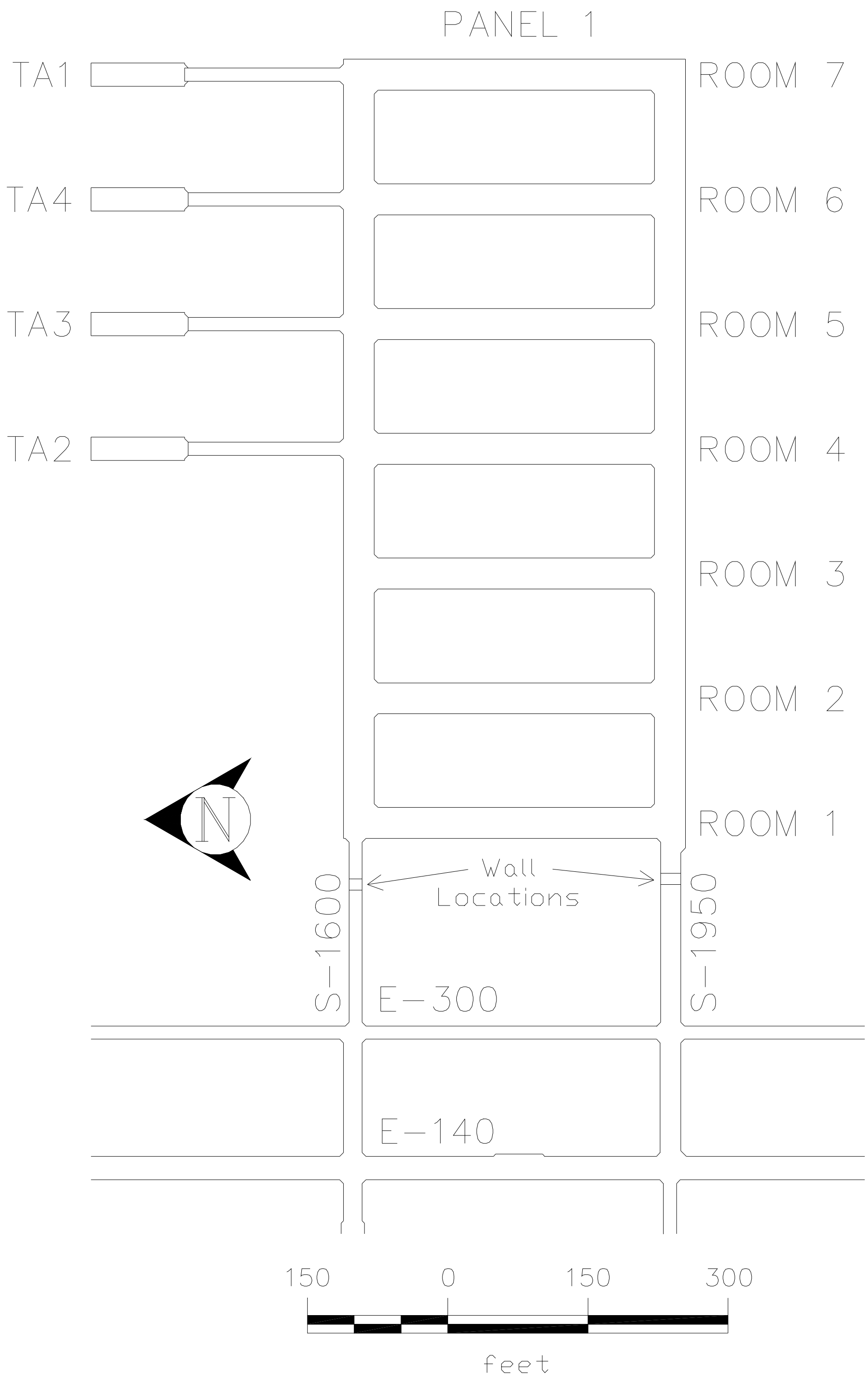


Figure 1. Panel 1 layout with wall locations.

2 Stability Assessment

The American Concrete Institute (ACI) publication ACI 318, Building Code and Commentary, provides guidance for Strength Evaluation of Existing Structures in Part 6, Chapter 20. The ACI Code allows for extended service life of a concrete structure if it is periodically re-evaluated. The ACI calls for performing load testing, numerical analyses, and monitoring to determine the acceptability for service of existing structures such as the temporary explosion walls constructed for the closed WIPP underground panels. Because of the difficulties involved in monitoring the physical performance of the walls, for example coring them to obtain stress measurements, the assessment is essentially limited to analyses and field monitoring. However, the detailed and comprehensive specifications, the intensive construction inspection, and external verification give confidence that necessary calculations can be performed based on actual field conditions.

2.1 Stress Analysis

The purpose of performing a stress analysis is to evaluate the interaction of the explosion isolation wall with the surrounding salt. Stresses are expected to develop in the wall due to continued creep closure of the air-intake and air-exhaust drifts after installation of the wall. The wall may also be subjected to stresses from a postulated methane explosion.

2.1.1 Previous Modeling

For the 2002 analysis, detailed two-dimensional axisymmetric representations of the explosion isolation wall were developed using the FLAC (Itasca, 2000) computer code. The models did not account for the local geologic features such as clay seams and the thick anhydrite MB139 in the floor. The effects of nearby excavations, such as Room 1, were also ignored. Finally, the wall was modeled as a cylinder equivalent to its true shape. These simplifications were necessary because development and execution of a three-dimensional model was not practical or economic at that time.

Three cases were run for the 2002 exercise with different loadings as called for by the ACI Ultimate Strength Design Method (ACI 318-02). The results of these cases showed that while some failure occurs on the exposed surfaces of the explosion isolation wall, the wall maintains a sizeable intact confined core in every case.

2.1.2 New Modeling

In the current exercise, FLAC3D (Itasca, 2004) was used to develop three-dimensional representations of the walls and the surrounding excavations. The as-built locations of the walls in the South 1600 and South 1950 drifts were used. Clay seams E, G, and H were modeled along with Marker Bed 139. The rest of the rock was modeled as halite. Because the continued stability of an existing structure is assessed, only the service load (in-situ loading) case was run for each wall. A strength reduction factor of 0.8 was used, as in the previous models. The nominal postulated methane explosion based on likely gas accumulation in a closed panel (DOE, 2002) was applied to each wall at five and ten years after wall installation. Figures 2 and 3 show the geometry of the South 1950 and South 1600 drift wall models. The models use the same material properties presented in Appendix C of the WPC report.

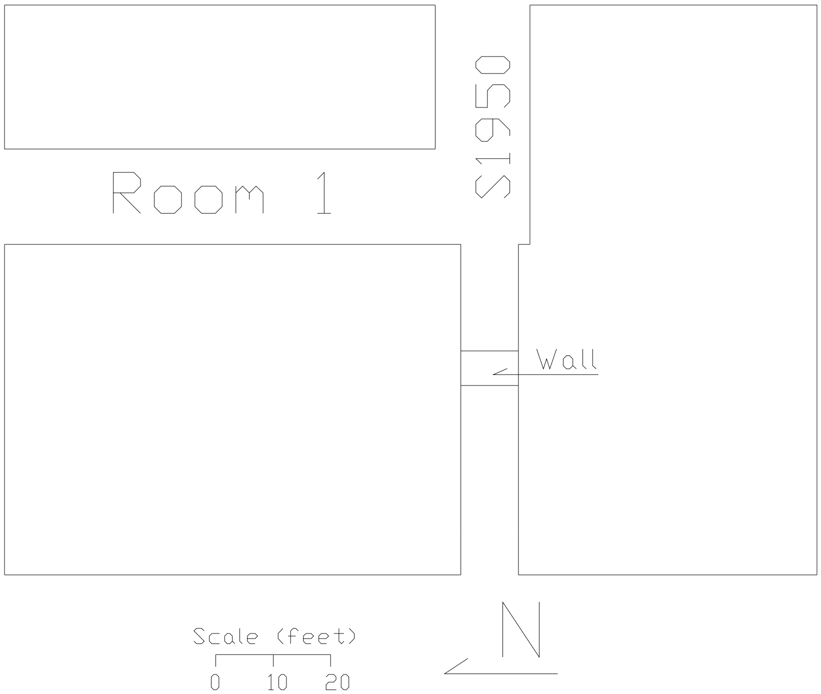


Figure 2. South 1950 wall model extents.

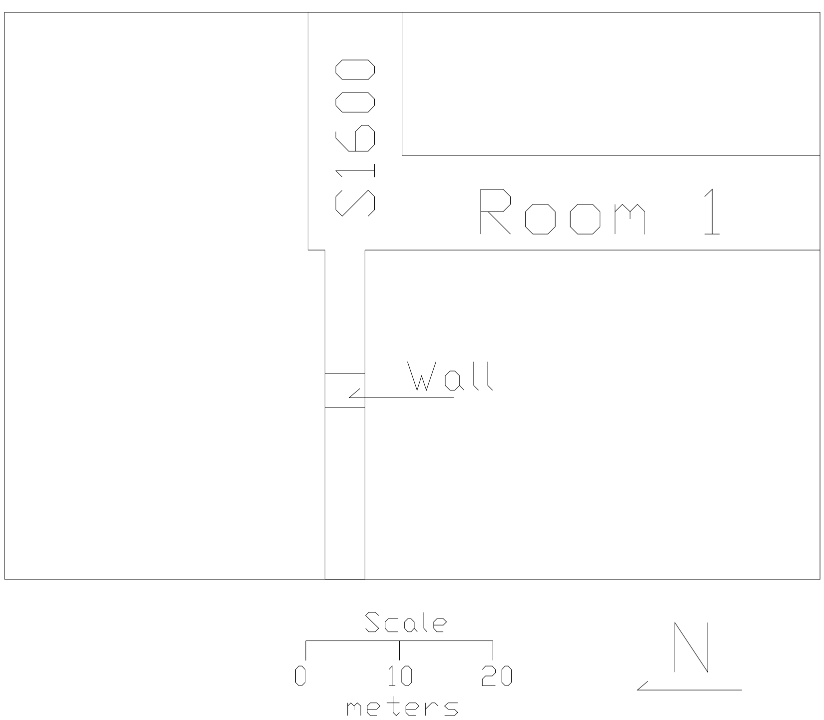


Figure 3. South 1600 wall model extents.

2.1.2.1 New Model Results

The results from the new models are similar to those of the 2002 cases. After wall installation, stress builds up over several years as the creep pressures increase. Plots of maximum principal stress at each end and in the center of the walls are shown in Figures 4 and 5. Stresses on the outside edges of the walls are higher than at the center due to edge effects. Figures 6 to 11 show plasticity shear failure state in the walls. In the figures the walls are cut on east-west cross-sections through the center of the two walls and only half the wall is shown for clarity. The dark blue zones have not failed. All other zones are either failed at the model time shown or have failed in the past. In all cases there is a thin zone of failure near the ribs and free faces that slowly migrates inward with time. Figures 8 and 11 show the state at ten years combined with the nominal explosion. Even in the cases with explosions, more than half the width of the walls remains intact after ten years. Also note that the conditions for three years after installation closely match field observations as discussed in Section 2.2.

Because more than half the width of the walls is still intact after ten years, the model results indicate that the wall will continue to perform its design functions for at least ten years after installation.

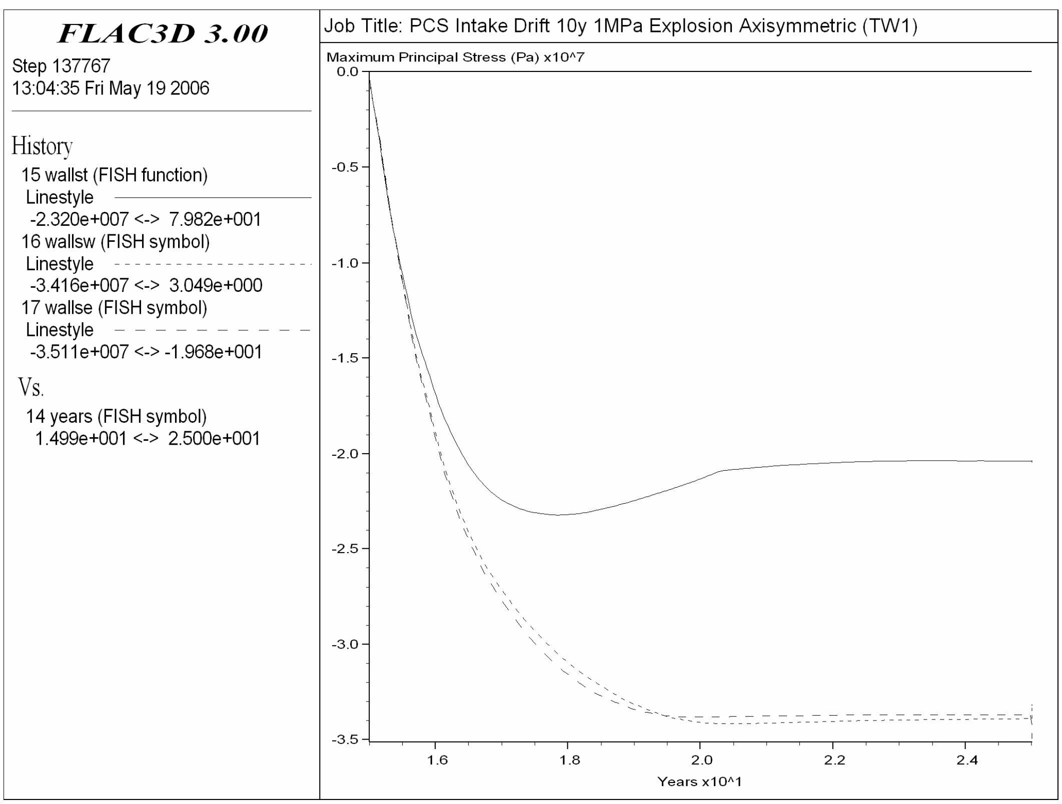


Figure 4. Maximum principal stress histories at the center of the wall (wallst), center of the west face (wallstw) and center of the east face (wallste).

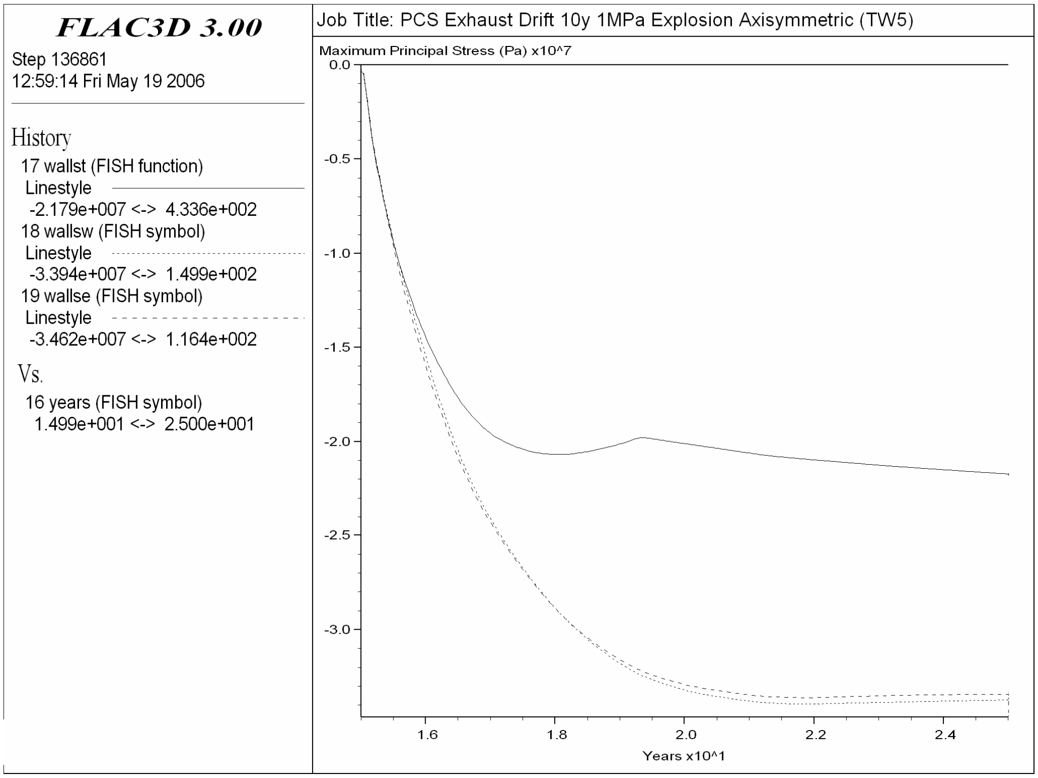


Figure 5. Maximum principal stress histories at the center of the wall (wallst), center of the west face (wallstw) and center of the east face (wallste)

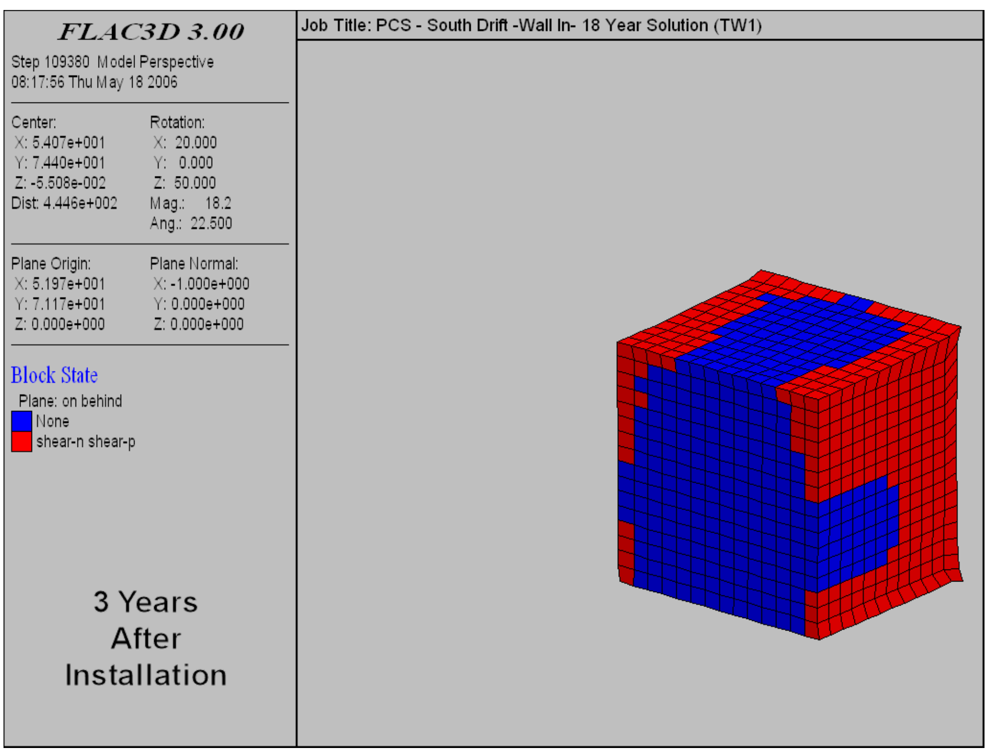


Figure 6. Shear failure in South 1950 wall three years after installation.

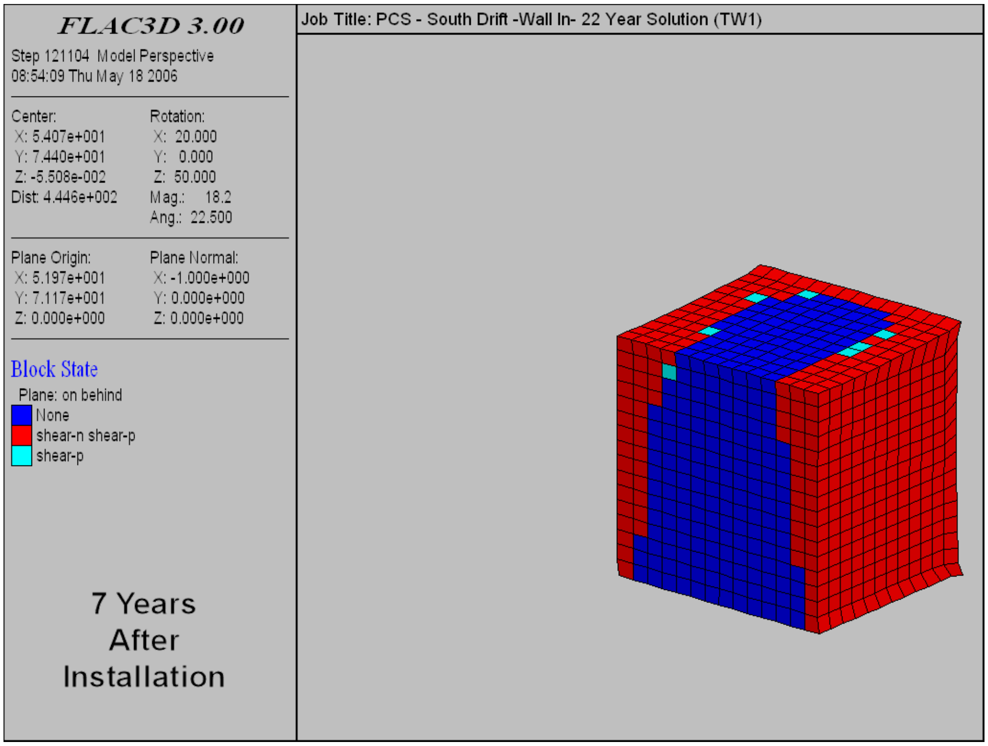


Figure 7. Shear failure in South 1950 wall seven years after installation.

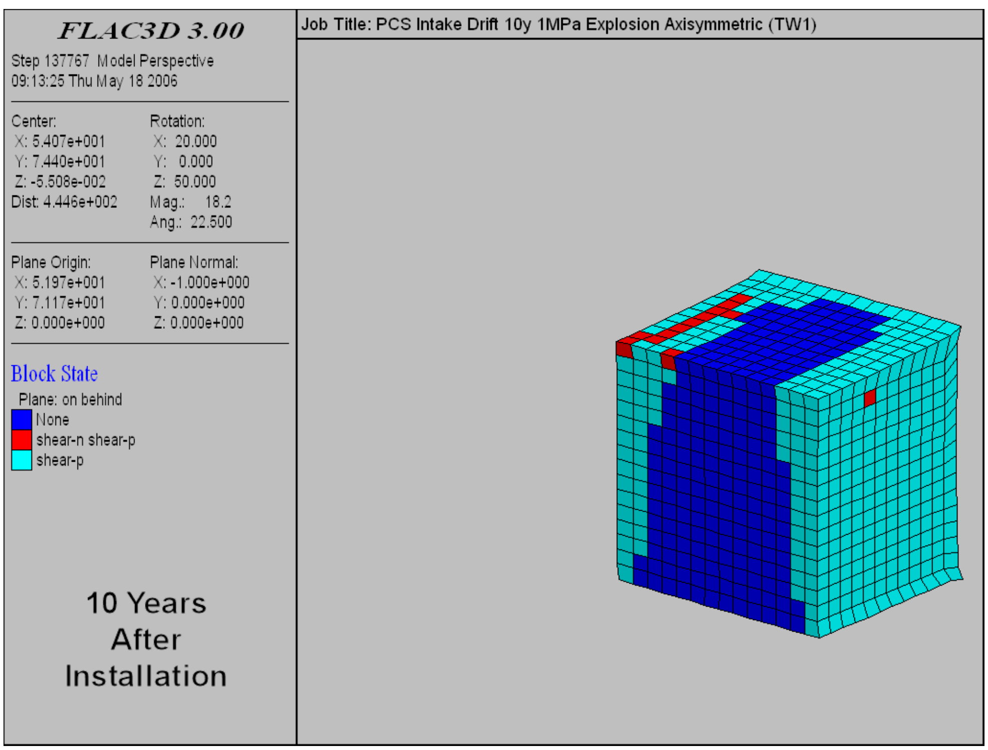


Figure 8. Shear failure in South 1950 wall with explosion at ten years after installation.

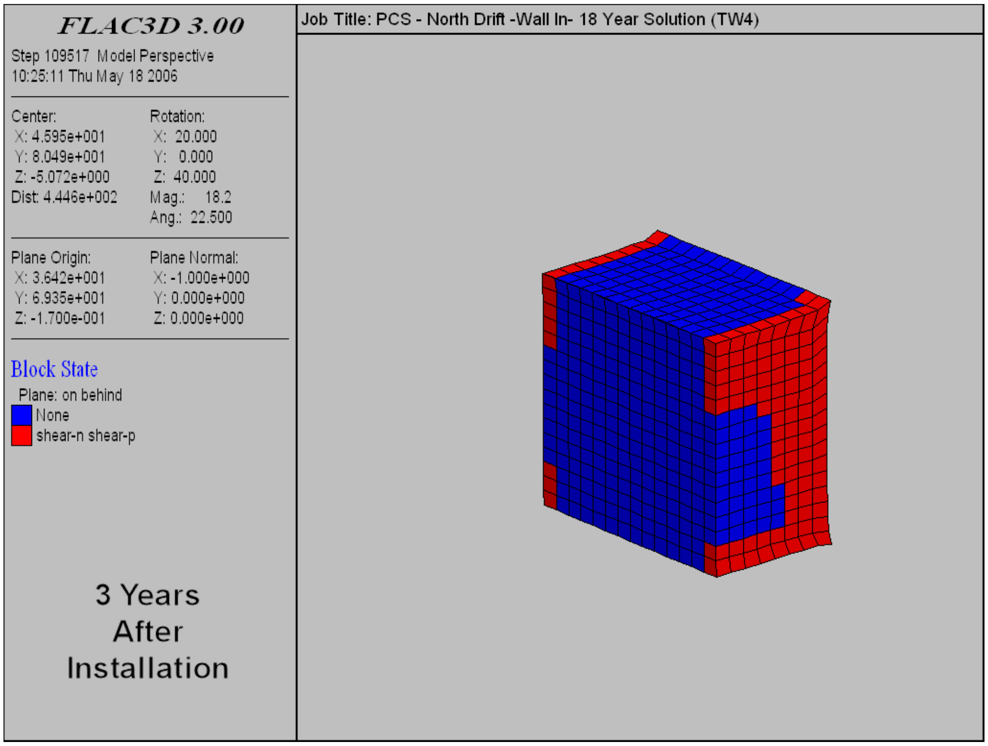


Figure 9. Shear failure in South 1600 wall three years after installation.

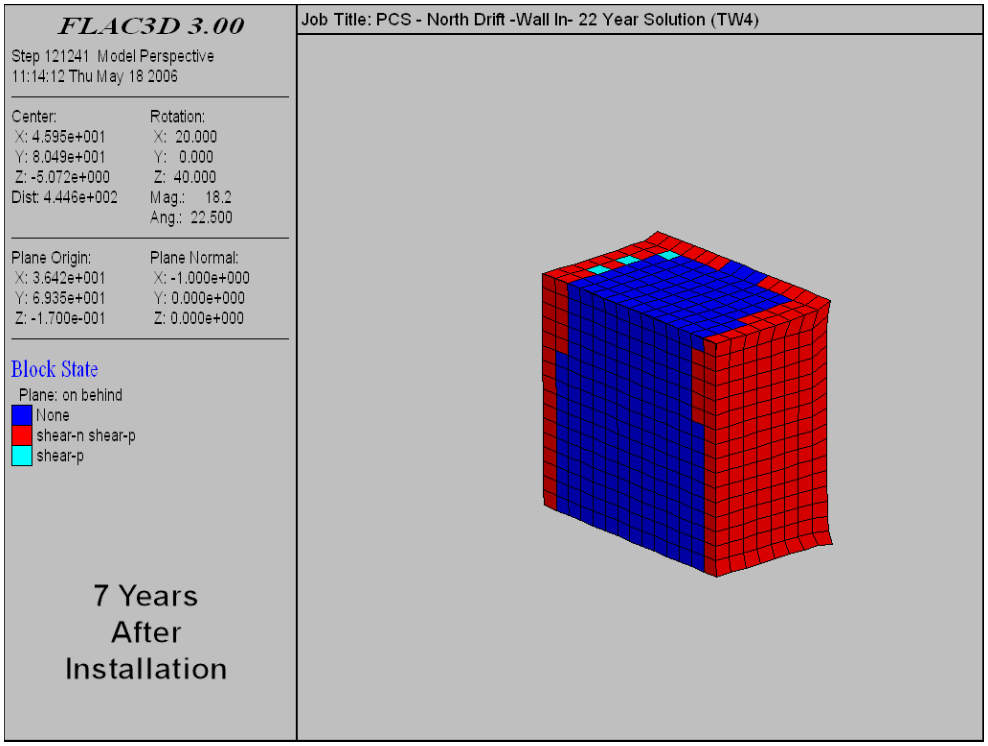


Figure 10. Shear failure in South 1600 wall seven years after installation.

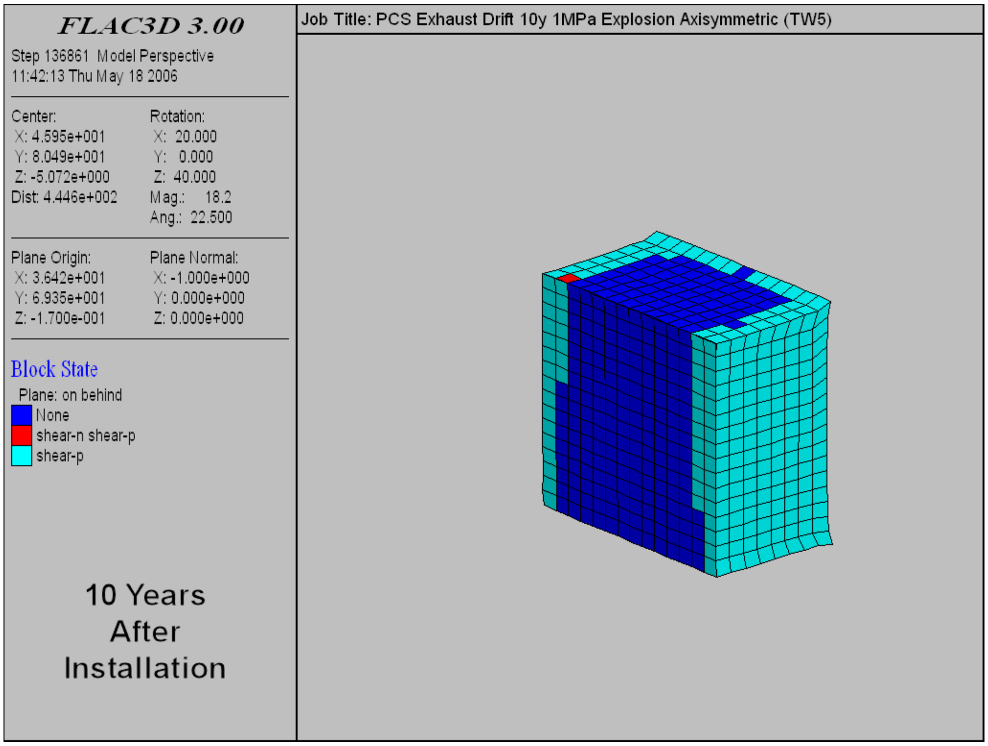


Figure 11. Shear failure in South 1600 wall with explosion at ten years after installation.

2.2 Assessment of Field Data

To assess the stability of existing concrete structures, ACI recommends regular observation and tracking of fractures on the surface of the structures. The location and aperture of all fractures on the wall should be noted. The ACI code states that any indication of shear displacement along the fractures should be noted as this is indicative of potential failure.

At an inspection held on May 22, 2006, the walls were found to have minor cracking at some corners and a few surficial spalls were also noted. These are most likely a result of differential loading caused by a non-perfect initial contact and would be expected to stabilize quickly after the initial cracking occurred. Otherwise, the walls show no signs of bulging or spalling away from the edges. On the basis of direct observations, the walls appear to be in near pristine condition with no signs of failure.

Closure data from radial convergence (RC) points near the wall indicate that the walls are in a state of equilibrium with the rock. After a settling in period of a few months (during which the edge cracks probably formed as the block to rock interface was established), rock displacement rates near the wall have remained steady since wall installation. These steady convergence rates (i.e. the lack of variation or trend toward increasing convergence) indicate that there is little if any change in the load that is borne by the wall as opposed to the rock pillars, which again is an indication that there has been no wall failure to date. Figures 12 to 15 show closure data from the field compared to FLAC3D model results.

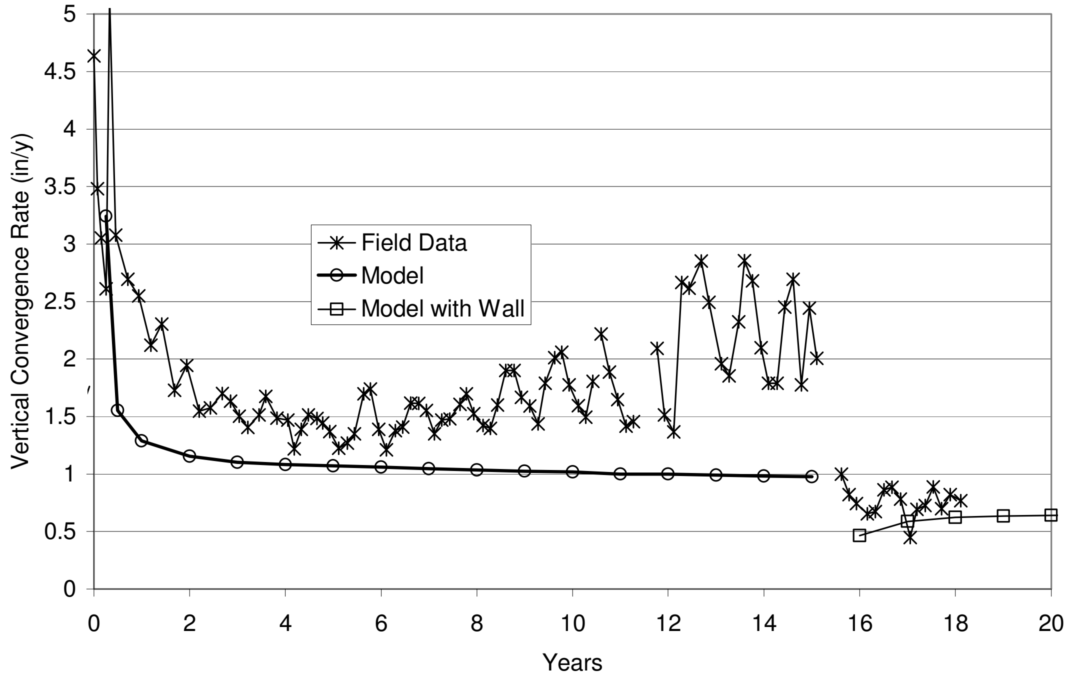


Figure 12. Field and model vertical convergence from RC 5' west of S1950 wall

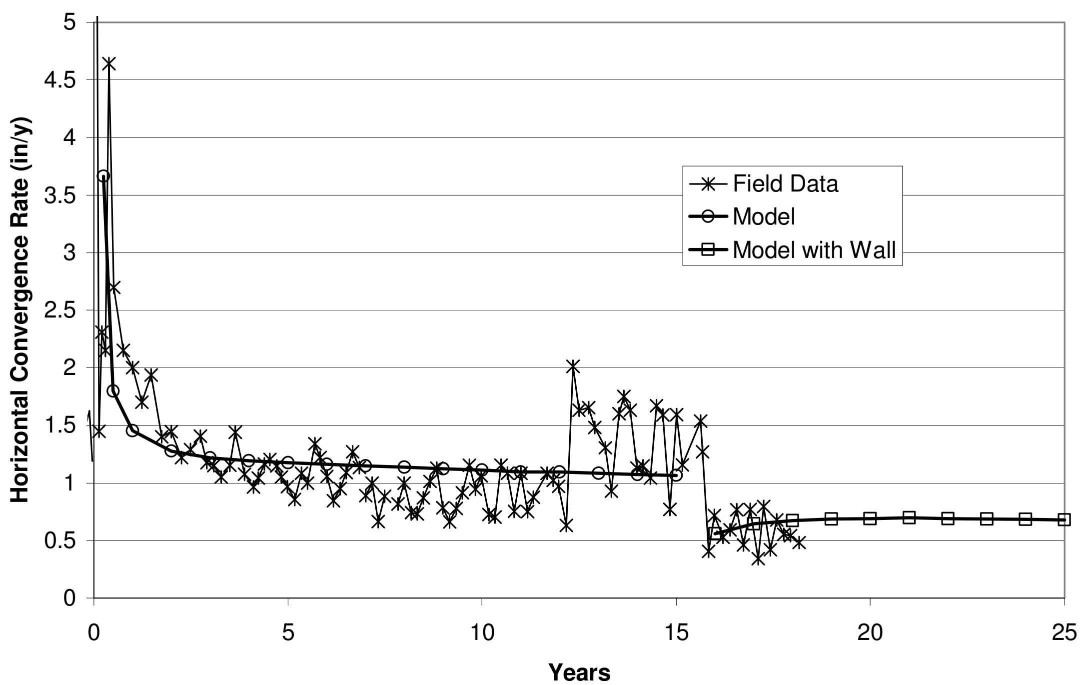


Figure 13. Field and model horizontal convergence from RC 5' west of S1950 wall.

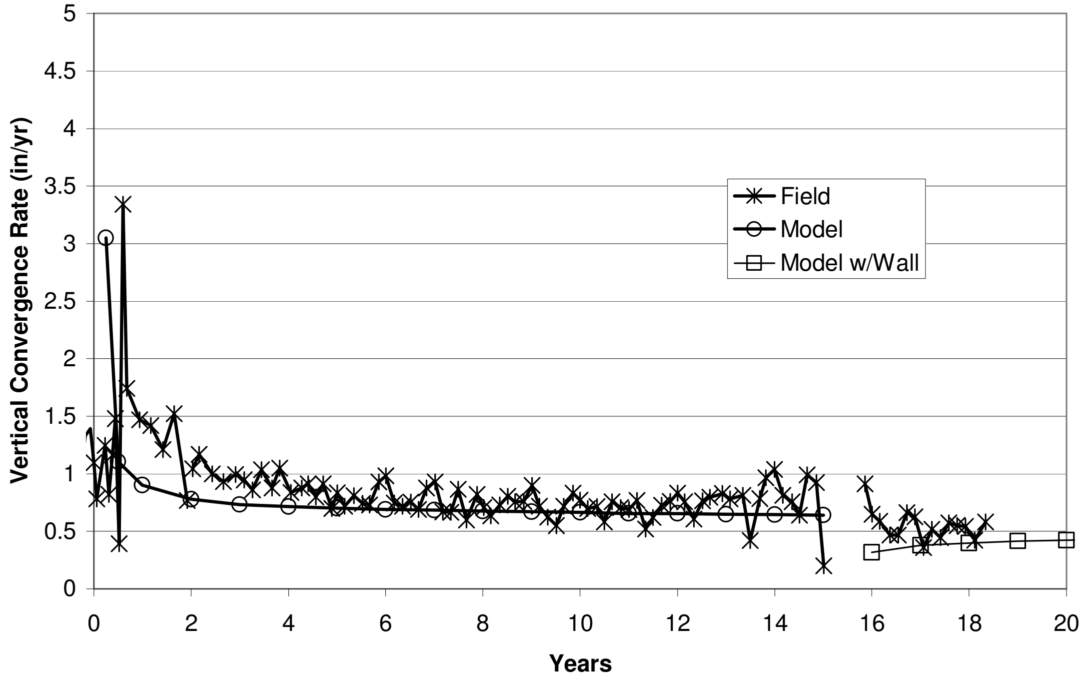


Figure 14. Field and model vertical convergence from RC 5’ west of S1600 wall.

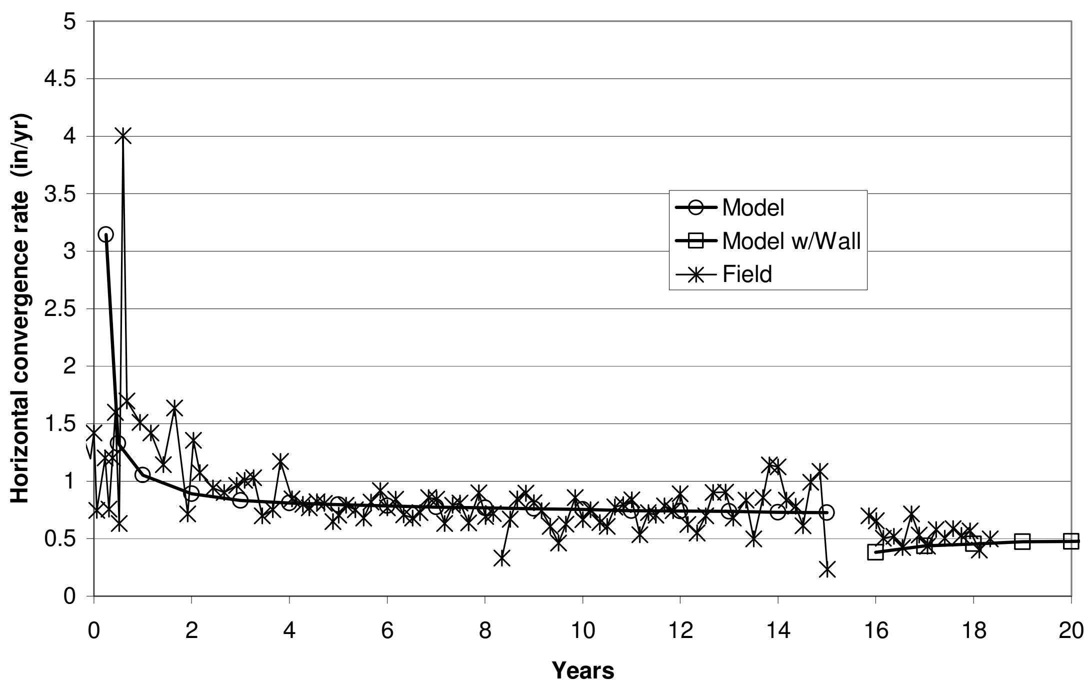


Figure 15. Field and model horizontal convergence from RC 5’ west of S1600 wall.

The fracture and closure field data indicate that the wall currently is stable. After three years there is only superficial damage. This indicates that the wall is meeting or exceeding its designed performance. The model results for the wall state at three years after installation are very similar to the field performance, only showing superficial damage at that time. The current field performance of the wall supports the conclusion from the model results that the wall will remain stable for at least ten years total. However, the field data should be regularly reassessed to ascertain that this remains true.

3 Monitoring

Until such time as final closures are installed, the walls should be regularly inspected and re-evaluated by a professional engineer. This can be incorporated into the Geotechnical Engineering monitoring programs using existing procedures for fracture mapping and RC reading. Reporting of the inspections can also be incorporated into existing periodical Geotechnical Engineering reports such as the "Geotechnical Analysis Report."

4 Conclusions

This report assesses performance to date and the likely future performance of the explosion isolation walls for Panel 1 over a period of up to ten years using the ACI guidance for assessing the stability of existing concrete structures. The explosion isolation walls currently installed in Panel 1 continue to perform their design function and are expected to remain stable and perform their intended functions for at least ten years total (seven additional years). Because wall conditions may vary from the model results in the future due to unforeseen circumstances, as well as to provide a margin of safety, the wall should be re-evaluated within three years --- sooner if field performance varies from the past. The three year period is based on the performance of the wall over the last three years. The wall is therefore accepted through this assessment as competent at this time only for three more years, at which point it will be re-evaluated. Future evaluations will likely further extend the life of the wall. This is based on numerical analyses using the as-built conditions and on field measurements and observations.

5 References

American Concrete Institute (ACI), 2002, "Building Code Requirements for Structural Concrete and Commentaries," ACI 318-02, American Concrete Institute, Farmington Hills, Michigan.

Itasca Consulting Group, Inc. (Itasca), 2003, "FLAC3D User's Guide," Itasca Consulting Group, Inc., Minneapolis, Minnesota.

Itasca Consulting Group, Inc. (Itasca), 2000, "FLAC User's Manual, "Itasca Consulting Group, Inc., Minneapolis, Minnesota.

U.S. Department of Energy, 1996, "Detailed Design Report for an Operational Phase Panel-Closure System," DOE/WIPP 96-2150.

U.S. Department of Energy, 2002, "Design Report for a Revised Panel Closure System at the Waste Isolation Pilot Plant," Report Prepared for Westinghouse TRU Solutions, LLC by RockSol Consulting Group, Inc. under Purchase Order Number 3164.

Attachment D

Memo on Early Generation of Methane and Hydrogen in Filled Panels at WIPP

Golder Associates Inc.

44 Union Boulevard, Suite 300
Lakewood, CO USA 80228
Telephone (303) 980-0540
Fax (303) 985-2080

November 30, 2006 Our Ref: 063-2213

Washington TRU Solutions LLC
P.O. Box 2078
4021 National Parks Highway
Carlsbad, NM 88221

Attention: Mr. Rick Chavez

RE: EARLY TIME GENERATION OF METHANE AND HYDROGEN IN FILLED PANELS AT THE WIPP

Dear Mr.Chavez:

This letter addresses expected maximum generation rates for methane and hydrogen in filled panels at the WIPP in response to some stakeholder concerns conveyed by the New Mexico Environment Department (NMED) during the November 22, 2006 conference call. Specifically it addresses the expected maximum concentrations of these gases five years after waste disposal in a panel is complete and ventilation to the panel is stopped. The generation rates and concentrations discussed here are taken from the existing application, supplemented as appropriate by additional publically available information.

Methane Concentrations

Analyses included in Appendix I1 of the WIPP Resource Conservation and Recovery Act Part B Permit Application, and in Appendix PCS of the 1996 Compliance Certification Application, show the potential build up of methane in the closed panels for gas generation rates of 0.01 and 0.1 moles per drum per year, assuming that 70% of the gas generated by microbial degradation is methane. Based on these calculations the concentration of methane for the 0.1 mole per drum per year generation rate will only reach 1% after 5 years, or 20% of the lower explosion limit (LEL) for methane in an atmospheric oxygen environment.

The 0.1 mole per drum per year rate is based on expected gas generation rates under inundated conditions where the rooms are filled with brine. It is not anticipated that these inundated conditions will exist in the first five years after shutting off ventilation to the panel, as evidenced by the lack of significant moisture in open rooms, or in rooms which have been shut-off from ventilation during panel filling. Expected generation rates under humid conditions are about one order of magnitude slower[1].

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[1] US Department of Energy, Carlsbad Field Office, "Compliance Recertification Application, Appendix PA, Attachment PAR," March 2004

Gas generated by microbial action is expected to contain at least as much inflammable CO_2 as methane. A series of gas generation experiments under simulated WIPP conditions have been carried out at Brookhaven National Laboratory. These experiments subjected simulated waste materials to microbial degradation under simulated WIPP conditions. Early time data showed that after 853 days the major gas generated was CO_2, and no methane was detected[2]. Later results showed that after 1228 days methane had still not been produced. Minor amounts of methane were detected in some samples after 2718 days[3].

Based on this experimental evidence, and the use of a high generation rate in the calculations included in Attachment I1 of the permit application, it is apparent that the calculated value of 1% methane concentration after 5 years is extremely conservative.

Hydrogen Concentrations

Recently WTS has evaluated the potential for hydrogen generation by radiolysis, based on an analysis of the Panel 3 inventory, and generation rates obtained from head-space hydrogen data from actual containers prior to shipping[4]. These lead to a conservative estimate for the potential rate of hydrogen generation by radiolysis, and by extension to the maximum potential hydrogen concentrations in an unventilated panel. Using these rates, which equate to about 0.397 litres of hydrogen per drum per year, leads to a maximum potential hydrogen concentration from radiolysis of about 0.75% after 3 years, or 1.2% after 5 years. This is about 25% of the LEL for hydrogen in an atmospheric oxygen concentration. Hydrogen can also be generated by anoxic corrosion of steel in the wastes and the drums. However it is anticipated that anoxic conditions will take some time to develop and hydrogen is not generated by oxic corrosion. It should also be noted that rapid corrosion requires inundated conditions which, as discussed above, are also not expected to occur within the first five years...

Data on hydrogen concentrations for actual WIPP waste have been obtained by a series of gas generation experiments conducted at Argonne National Laboratories – West[5]. These experiments were run under inundated conditions, and under anoxic conditions established by pressurizing the containers with nitrogen. After about 5 ½ years the hydrogen concentrations in the containers were, less than 1% with the exception of one container which did show a value of 4.2%. It should be emphasized that these experiments were run under both anoxic and inundated conditions, which are not expected in the first five years after shutting off the ventilation to a panel.

It therefore has been determined that even under the most conservative assumptions of generation rates, and neglecting any affects of diffusion, the hydrogen concentrations after 5 years will be less than 1%, or 25 % of the LEL.

---

[2] Francis, A.J., J.B. Gillow and M.R. Giles, "Microbial Gas Generation Under Expected WIPP Repository Conditions," SAND96-2582, March 1997.

[3] Gillow, J. and A. J. Francis, "Microbial Gas Generation under Expected WIPP Repository Conditions, Final Report, Rev 0", Draft Report, Brookhaven national Laboratory, October 6, 2003

[4] Washington TRU Solutions LLC, "Estimation of Hydrogen Generation rates from Radiolysis in WIPP Panels", letter report from M. Devarakonda (WTS) to Daryl Mercer (CBFO), July 26, 2006

[5] Felicione, F. S., K. P. Carney, C. C. Dwight, D. G. Cummings, and L. E. Foulkrod, "Gas-Generation Experiments For Long-Term Storage of TRU Wastes at WIPP," Waste Management '03 Conference, February 23-27, 2003, Tucson, AZ

Conclusions

Existing calculational data and actual experimental results indicate that even under the most conservative assumptions methane and hydrogen concentrations in a filled and unventilated panel will not exceed between 1% and 1.2% for methane and hydrogen, respectively, in more than five years. These values represent 20% and 30% of the individual LELs, respectively, and 50% of the combined LEL.

Sincerely,

GOLDER ASSOCIATES INC.

T. William Thompson, Ph.D.
Principal

cc: Steve Kouba, WRES