Department of Energy
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18 DEC 2002

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Mr. Steve Zappe, WIPP Project Leader
Hazardous Waste Bureau
New Mexico Environment Department
2605 E. Rodeo Park Drive, Bldg. 1
Santa Fe, NM 87505

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

Dear Mr. Zappe:

The purpose of this letter is to submit to the New Mexico Environment Department (NMED) the subject report on the short-term stability of the 12-foot long explosion isolation wall proposed in the Class1* permit modification request (PMR) submitted to NMED on November 25, 2002. This is provided in response to questions raised in a meeting held November 15, 2002 on the expected performance of this wall for a performance period expected to be no more than 5 years.

The Department of Energy (DOE) submitted the Class 1* PMR to NMED to extend closure of Panel 1. The purpose of the extended time frame is to provide sufficient time for regulatory and public review of the Class 3 PMR to the Panel Closure System (PCS) Design. During the interim, DOE proposes to install a 12-foot long explosion isolation wall that is one component of the approved PCS design in the current Hazardous Waste Facility Permit issued by NMED in October 1999. Installation of the 12-foot long explosion isolation wall does not preclude the ultimate construction of either the approved "Option D" design or the revised WIPP Panel Closure (WPC) system proposed in the Class 3 PMR.

The purpose of installing the 12-foot long explosion isolation wall is to protect human health and the environment until NMED issues a decision on the PCS design modification. During the interim period the 12-foot wall will:

- Prevent access into Panel 1
- Restrict the release of VOCs or other gases from the panel into the underground atmosphere
- Provide protection from a postulated methane explosion in the event generation of such gases does occur.

This Report demonstrates that the 12-foot long explosion isolation wall is capable of performing its required function for a period of at least five years. The wall design is evaluated against a combination of both natural creep-induced loads and a postulated

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methane explosion. Although the wall can withstand the postulated explosion, it is most unlikely that there will be sufficient methane to create explosive conditions during the 5 year period that may be necessary to complete the Class 3 PMR process. For example, methane gas generation was thoroughly considered in the Environmental Evaluation Group (EEG) Report Number 82, "Evaluation of Proposed Panel Closure Modifications at WIPP", December 2001, where it is stated that there will be an insufficient supply of methane to create explosive conditions for at least 15 years.

This report provides an engineering analysis of wall performance and in summary, the results of the modeling confirm that the 12-foot long explosion isolation wall will function as designed for this period even in the event of an explosion. This report also provides a brief review of EEG Report Number 82.

If you have any questions regarding this report, please contact me at (505) 234-7462 or page me at (505) 481-9034.

Sincerely,

H. L. Plum
RCRA Compliance Manager

Enclosure

cc: w/enclosure
J. Bearzi, NMED

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

Mine Engineering
Repository Development Project
Westinghouse TRU Solutions LLC

December 18, 2002

Revision 0

Table of Contents

List of Figures

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 at the WIPP is the closure of waste disposal panels. Each panel consists of air-intake and air-exhaust drifts, panel-access drifts, and seven rooms. 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 was contained in a report entitled "Detailed Design Report for an Operational Phase Panel-Closure System" (DOE, 1996). This report was attached to the Hazardous Waste Facility Permit (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 system (WPC) (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 it has been 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. Since waste disposal operations in Panel One will finish between mid-February to mid-March 2003, a Class 1* PMR was submitted requesting an extension of time to perform closure of Panel One while NMED acts upon the Class 3 PMR. In the Class 1* PMR, it is 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.

This report provides a structural analysis of the stability for a period of 5 years of the 12 foot long explosion isolation walls to be emplaced in Panel One. These walls will be built to the configuration in the current HWFP using the mortared 5000 psi concrete block specifications from the WPC design. This analysis is intended to be a reasonable and realistic assessment of actual performance during this period.

2 Stress Analysis

The purpose of the stress analysis was 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.

Detailed two-dimensional axisymmetric representations of the explosion isolation wall were developed using the FLAC (Itasca, 2000) computer code. For consistency, the properties used in these models are those presented in Appendix C of the WPC report.

FLAC has been used since 1991 to model underground excavations at the WIPP. FLAC is a two-dimensional explicit finite difference code that simulates the behavior of rock and soil-like structures. The WIPP Reference Creep Law is built into the code and has been verified against the WIPP Second Benchmark Problem (Kreig, 1984). The following section describes the geometry and boundary conditions of the model used in the FLAC analysis.

2.1 Model Development

A detailed axisymmetric model was developed to investigate the behavior of the explosion isolation wall under creep loading and combined creep and explosion loading. The geometry of this model is shown in Figure 2-1. Since the Option D explosion isolation wall does not contain construction joints, none were used in this model. Concrete is modeled as a Mohr-Coulomb material with a tension cut-off. Three cases were run with different loadings as called for by the ACI Ultimate Strength Design Method (ACI 318-02):

$$1.4\,W$$

$$1.2\,W + 1.6\,E$$

$$0.9\,W + 1.6\,E$$

where W and E denote the dead load (far-field stress) and explosion load, respectively. All three cases used a strength reduction factor of 0.8. In addition to these three cases, a service load case was run with all loading and strength properties set to their nominal values. In all cases with an explosion load, the explosive force was applied instantaneously, equilibrium was reached, and then the force was removed.

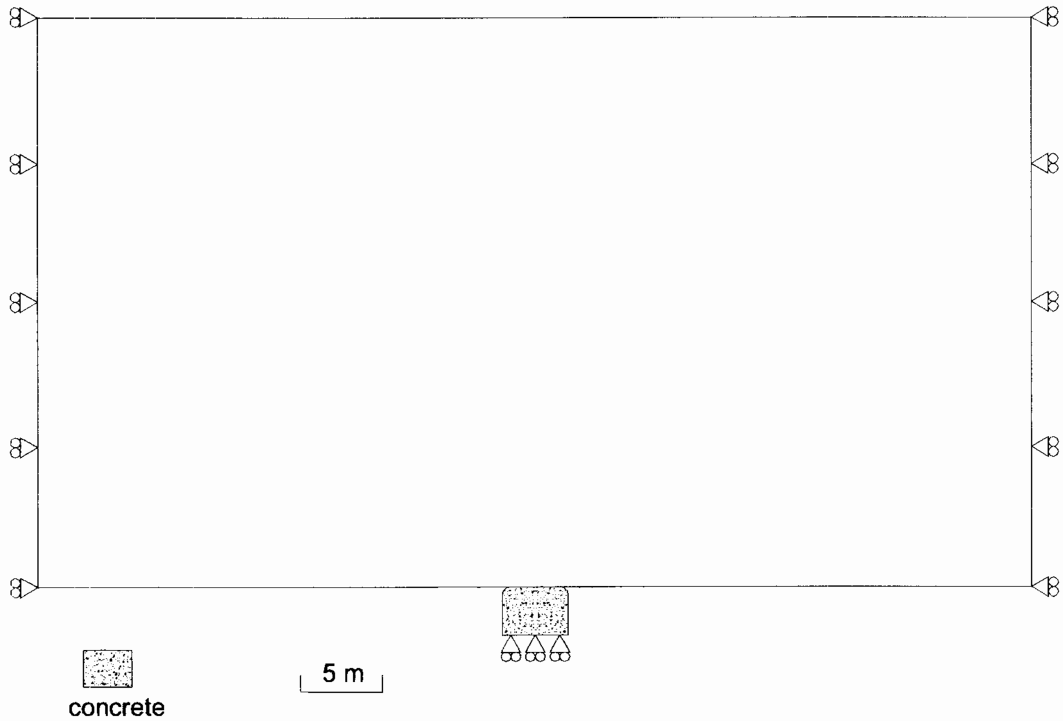

Figure 2-1 Creep Plus Explosion Model Geometry and Boundary Conditions.

2.2 Modeling Results

The results from the Ultimate Strength Design cases showed that while some failure occurs near the ends of the explosion isolation wall, the wall maintains a sizeable intact confined core in every case. Only the results from the service load case are presented here. Profiles of the stress in the wall caused by an explosion after five years of creep loading are shown in Figure 2-2 and Figure 2-3. The vertical (radial) loading is not significantly changed, while the axial loading is actually improved since the stress goes slightly compressive rather than tensile. Figure 2-4 and Figure 2-5 show contours of stress in the wall and in the rock during the explosion. Figure 2-6 shows the plasticity state in the wall five years after wall installation. This figure shows a limited tensile fracture zone near the ends of the wall. These figures show that the explosion isolation wall will perform its required function during this period.

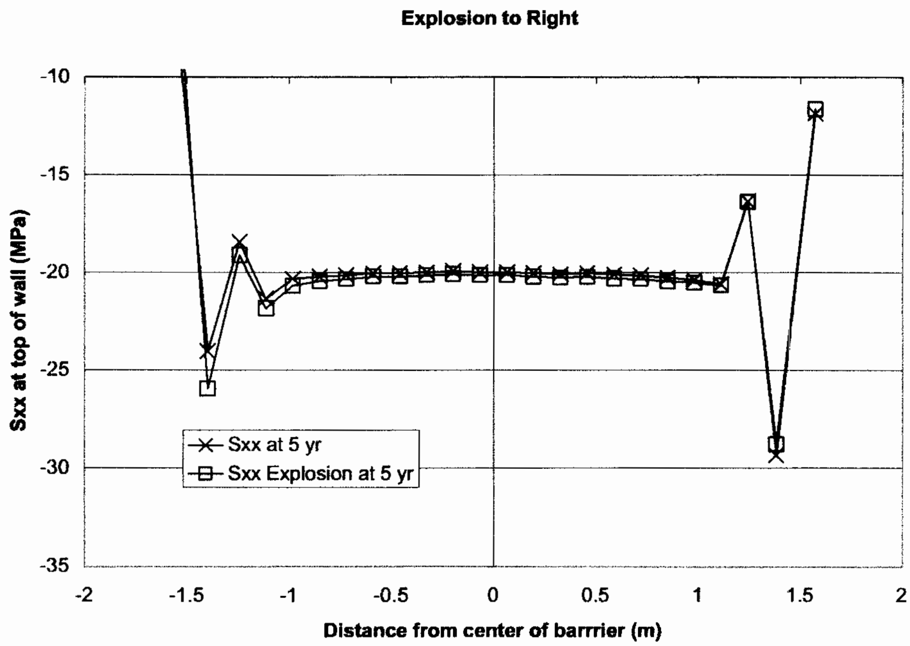

Figure 2-2 Vertical (Radial) Stress Profile at Top of Block Wall During an Explosion Occurring 5 Years after Emplacement

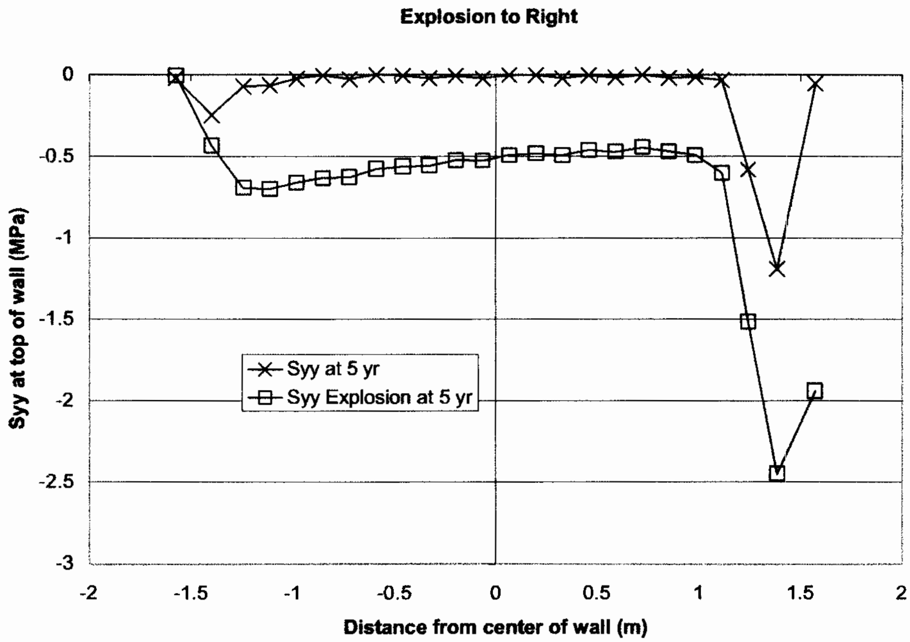

Figure 2-3 Horizontal (Axial) Stress Profile at Top of Block Wall During an Explosion Occurring 5 Years after Emplacement

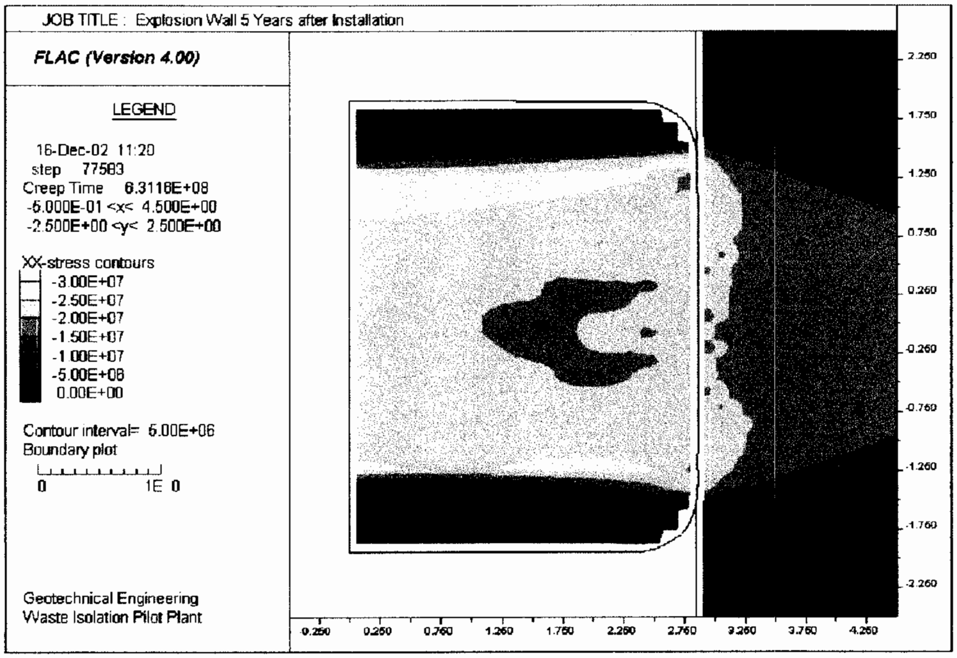

Figure 2-4 Vertical (Radial) Stress Contours in Block Wall During an Explosion Occurring 5 Years after Emplacement

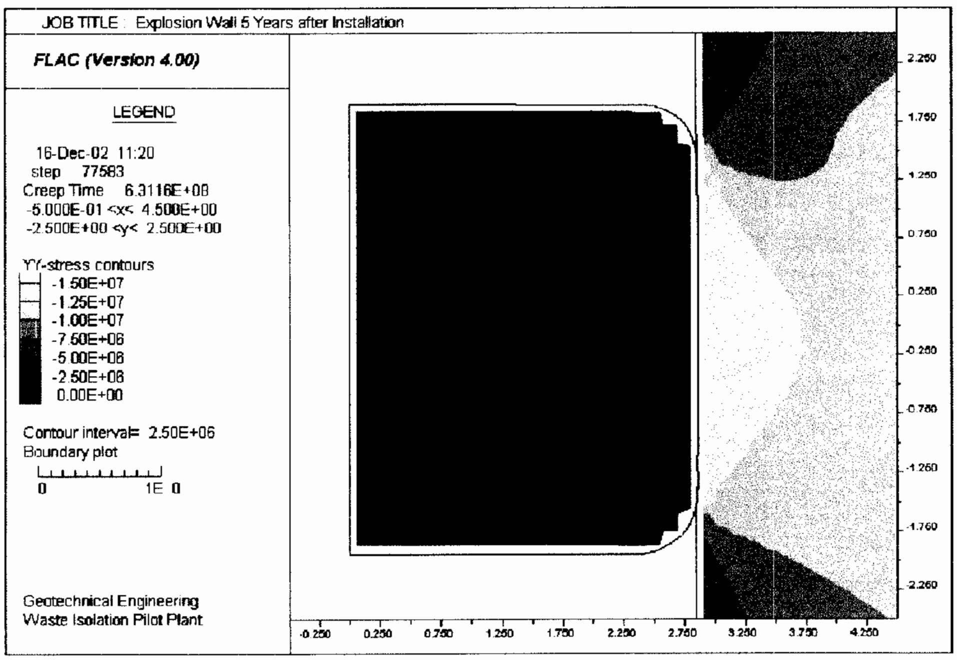

Figure 2-5 Horizontal (Axial) Stress Contours in Block Wall During an Explosion Occurring 5 Years after Emplacement

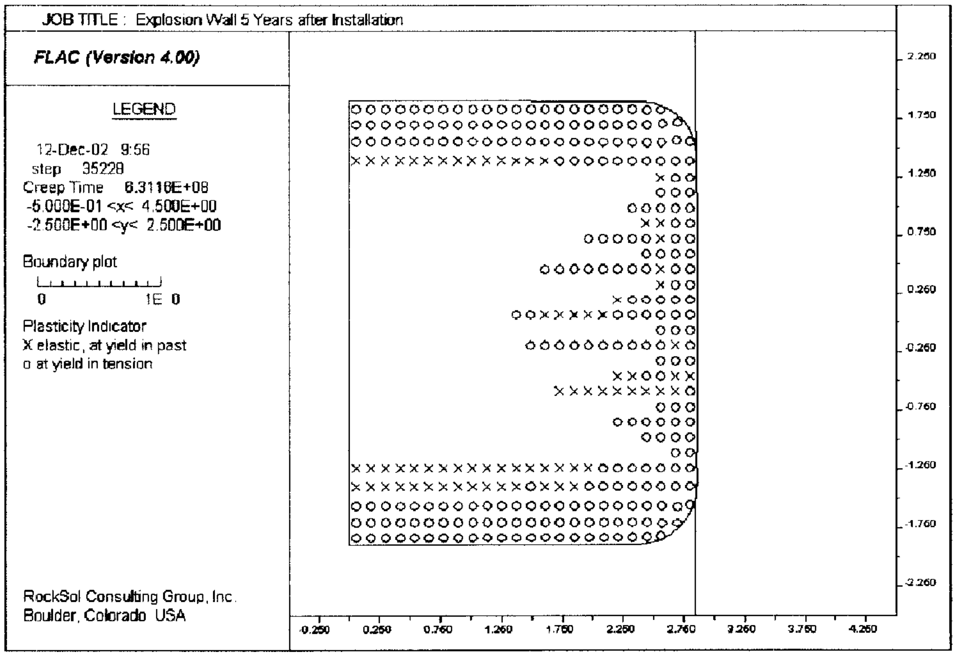

Figure 2-6 Plasticity State in Block Wall at 5 Years

2.3 Review of EEG-82

The Environmental Evaluation Group issued their report EEG-82, "Evaluation of Proposed Panel Closure Modifications at WIPP", (Allen, et al, 2001) following DOE submission of seven proposed panel closure modifications to EPA. The EEG-82 report reviews those modifications and some of the contents of this report are pertinent to this assessment.

EEG-82 notes that "…the design basis 480 psi methane explosion … cannot occur prior to (at least) 15 years after panel closure." This agrees with the conclusions of other design reports, hence an evaluation considering a postulated methane explosion is conservative.

The use of a reduced masonry compressive strength, as in the EEG-82 design calculations, is an appropriate and conservative approach for design purposes but in an assessment of likely actual behavior, the likely actual compressive strength can be used instead.

In EEG-82 the effects of lateral loading due to creep of the surrounding rock salt are not considered. Creep closure and the loads it gradually exerts on the wall have an important effect on the wall behavior and the effects of this loading vary in amount and importance.

Neglecting them for design generally produces a conservative estimate acceptable for that purpose. However, neglecting them when attempting to predict likely actual behavior will not produce a reasonable and realistic assessment.

In the design calculations in EEG-82, the stress analysis for the wall under methane explosion is performed based on a beam analogy. The use of FLAC for design calculations at WIPP is verified and validated using actual in situ measurements. Beam analysis is at best an approximation and validated models such as FLAC are more likely to reasonably predict actual performance.

3 Conclusions

This report assesses the likely actual performance of the explosion isolation wall for Panel One over a period of up to five years. The structural analysis investigated the stability of the explosion isolation wall to sustain a dead load from salt creep along with live loads due to a postulated methane gas explosion. The analysis shows that structural failure on the ends of the wall may occur, but that the central portion of the wall will sustain load under confinement from the surrounding salt. The explosion isolation wall will perform its intended function for this period.

4 References

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