Planned Change Request

Waste Isolation Pilot Plant
Repository Reconfiguration

DOE/CBFO 11-3478
Revision 0

United States Department of Energy
Waste Isolation Pilot Plant

Carlsbad Field Office
Carlsbad, New Mexico

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Summary

The U.S. Department of Energy (DOE) is proposing a change to the configuration of the repository at the Waste Isolation Pilot Plant (WIPP). The proposed configuration will relocate Panels 9 and 10 from the main north-south access drifts to south of the existing Panels 4 and 5. The DOE requests this change based on the following observations:

- Convergence rates in the Panel 9 and Panel 10 access drifts W-30 and E-140, in the southernmost part of the main north-south access drifts, are observed to be 1.5 to 5 inches per year (in/yr). These high convergence rates are caused by two factors: (1) the main access drifts have been open for 6 to 30 years and, as the result, the salt has become extensively fractured at some locations; and (2) the excavations for Panels 3, 4, 5, and 6 are directly adjacent to Panel 9, resulting in a higher local extraction ratio that increases the convergence rates in the main north-south access drifts.

- The main north-south access drifts must be widened to 33 feet (ft) in order to provide clearance for remote-handled transuranic (RH TRU) waste containers that are emplaced in the walls of the drifts. This widening will significantly change the cross-section of the main north-south access drifts, which are currently 15 to 25 ft wide.

- Widening the access drifts has shown an increase in convergence rates as high as 367%, based on observations from a drift that was widened within the footprint for Panel 10.

- The resulting increase in convergence rates and local fracturing in the widened drifts represents a concern for worker safety and will require more intensive maintenance involving roof bolts and chain link fencing and possibly more aggressive ground support measures, such as steel sets.

- The use of lead shielded containers does not eliminate the need to relocate Panels 9 and 10. An evaluation of RH TRU waste streams was performed in support of the Lead Shielded Container Planned Change Request (PCR). This evaluation indicated that based on the inventory information available at the time, 1,922 cubic meters (m^3) of RH TRU waste could be shipped in lead shielded containers (Crawford and Taggart, 2007). However, shielded containers will only be used to improve shipping efficiency and emplacement economy for those RH waste streams that do not require the additional protection afforded by the more robust shielding of the RH-TRU 72B shipping package and the standard Facility Cask. Disposal of RH canisters shipped in RH-TRU 72B

packages and emplaced in horizontal boreholes in the ribs of future disposal rooms must continue whether Panels 9 & 10 are relocated or not.

In summary, relocating Panels 9 and 10 to south of the existing Panels 4 and 5 will enhance worker safety and reduce maintenance requirements by providing a more stable geotechnical environment for the last two waste emplacement panels in the repository.

1.0 Introduction

The current repository design configuration includes eight mined panels for waste disposal and includes the main north-south access drifts for two additional waste panels (9 and 10). However, much of this area has been open for more than 25 years, and as such has experienced creep closure and requires continuing ground support maintenance. The main north-south access drifts would also require additional mining to accommodate RH TRU waste emplacement in canisters. A geotechnical assessment of these openings, and the likely ground support needs if they are enlarged to take waste, has indicated that worker safety will be enhanced and maintenance requirements will be reduced by using newly mined panels instead of the existing area designated a Panels 9 and 10 (DOE 2011). Therefore, it is DOE's intention to replace Panels 9 and 10 with two newly mined waste disposal panels, designated as Panels 9A and 10A, to the south of the existing Panels 4 and 5 respectively. A performance assessment (PA) Panel Closure Redesign and Repository Reconfiguration PA (PC3R PA) has been performed to evaluate the effects of the proposed change. The results of the PA show that this change will have only a very minor effect on total normalized releases from the repository, and that the WIPP will remain in compliance with the containment requirements in 40 CFR Part 191 (EPA 1993).

2.0 Background

The original design of the WIPP repository has eight waste disposal panels, with four panels on each side of the four main north-south access drifts (see Figure 1). The waste panels are separated from each other and the main access drifts by pillars that are nominally 61 m (200 ft) wide. The pillars between rooms are 30 m (100 ft) wide. Each waste panel has seven rooms, each of which has nominal dimensions of 91 m (300 ft) long, 10.1 m (33 ft) wide, and 4.0 m (13 ft) high.

After waste is emplaced in the eight panels, the current plan is to enlarge the main north-south and east-west access drifts between the eight panels and make them available for waste disposal, as described in the Compliance Certification Application (CCA) (DOE 1996). The CCA specified that the main access drifts, currently used as transport routes for transporting waste to the disposal panels, hauling mined salt to the Salt Shaft and for supplying and exhausting ventilation air, would eventually be filled with waste and subsequently be designated as waste Panels 9 and 10. The footprint for

Panels 9 and 10 encompasses the four main north-south access drifts: E-300, E-140, W-30 and W-170. The footprint is bounded at the north end by the S-1600 east-west cross drift and at the south end by the S-3650 cross drift, with Panel 9 consisting of the drifts at S-2750 to the south and Panel 10 those drifts between S-1600 and S-2520. The repository design for the CCA, including the drift nomenclature, is shown in Figure 1.

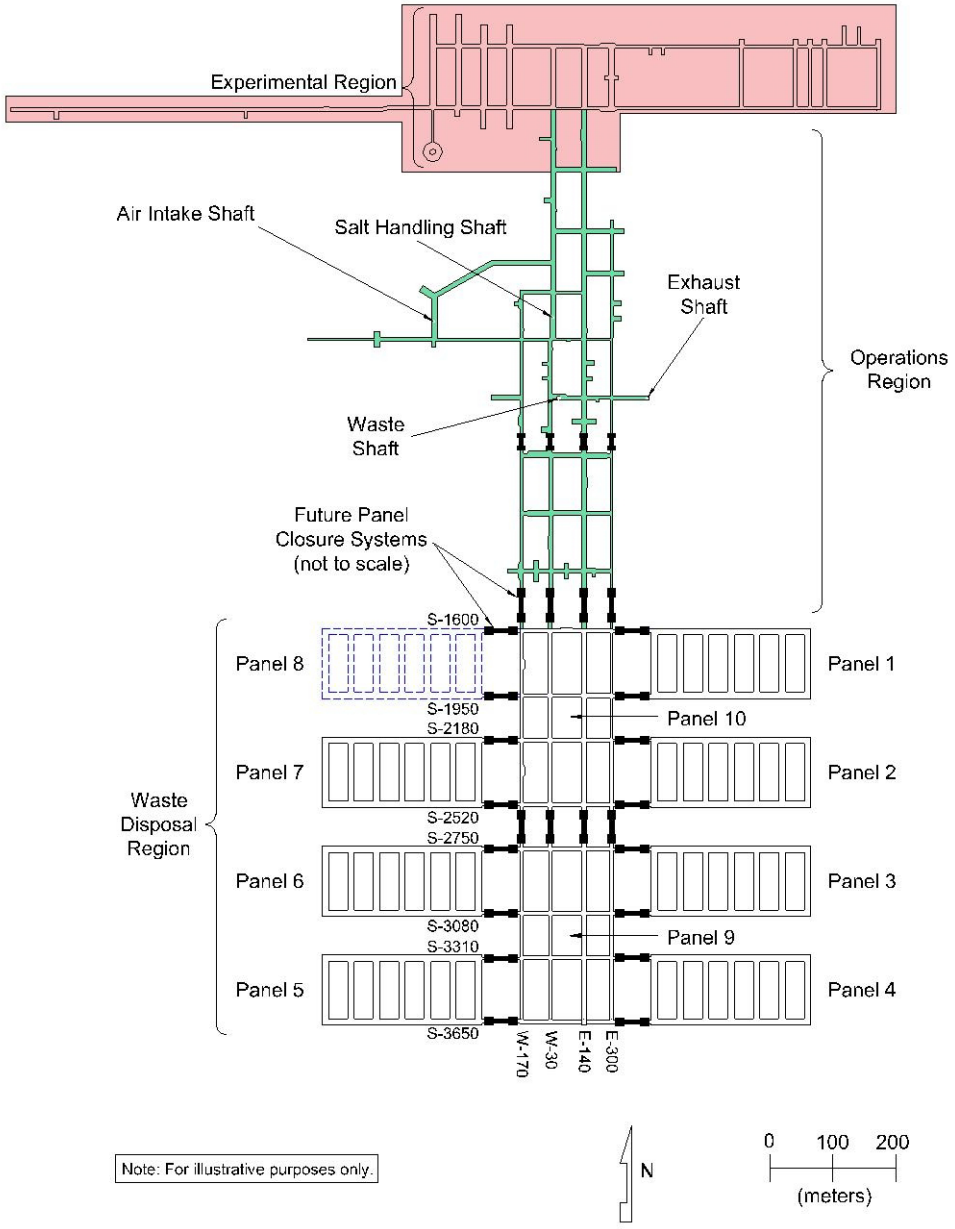

Figure 1. Plan view of currently approved repository design

Preliminary designs of the WIPP repository were developed in the early 1970s with validation efforts for the early designs starting in 1981 under the Site and Preliminary Design Validation (SPDV) program. The SPDV program was performed to further characterize the site, obtain geotechnical data, and to validate early WIPP site geology

and the preliminary repository design. Data obtained through the SPDV program and documented in the Design Validation Report (DOE 1986) helped confirm the design criteria and validate the basis being used for underground disposal room design.

One aspect of the repository is the visco-plastic (creep) properties of the rock salt formation in which it is located. When an opening such as a waste disposal room or access drift is excavated in a salt formation, the surrounding salt will creep in response to the imposed stress change, and the opening will close in time. In a bedded-salt formation, such as the host rock for the WIPP disposal system, this closure is also characterized by bed separations at the over- and underlying clay and anhydrite layers, and the resulting development of salt beams in the roof and floor which require constant monitoring and ground support maintenance to ensure continuing safe access. These deformations are accompanied by fracturing in the roof and floor. Beam deformation, room closure and fracturing increase with age of the opening. In the original WIPP repository planning, the rooms and pillars were designed to ensure that waste disposal could be carried out safely while a panel was being filled with waste, and no contact-handled (CH) TRU waste containers would breach due to creep closure. A nominal five-year timeframe was planned for mining, waste emplacement, and closure of a panel (DOE 1986).

After years of mining and waste disposal activities, geotechnical issues in the main access drifts and cross drifts have been identified. Portions of these access drifts which were initially mined six to 30 years ago. The ongoing ground movements are controlled and safe access is ensured through continuing maintenance. However, given the age of the main access drifts and the need to widen these drifts for emplacement of RH TRU waste, any additional excavation to enlarge these entries for waste disposal will cause an increase in ground movements that must be controlled. As a result, the DOE has evaluated the relocation of the waste destined for disposal in Panels 9 and 10 to an alternate location in the underground facility south of the existing Panels 4 and 5. Figure 2 shows the proposed reconfiguration, with 10 panels for waste emplacement and a central region without waste.

(Locations in the underground are identified with a coordinate system centered on the salt handling shaft. A drift that runs north and south that is located 300 ft east of the salt handling shaft is identified as E300. A location in drift E300 that is 90 ft south of the salt handling shaft is identified as E300/S90. For example the exhaust shaft is located at S400/E475; the waste handling shaft is located at S400/E25; the Panel 4 inlet is located at S3650/E140 and the exhaust entry is located at S3310/E140.)

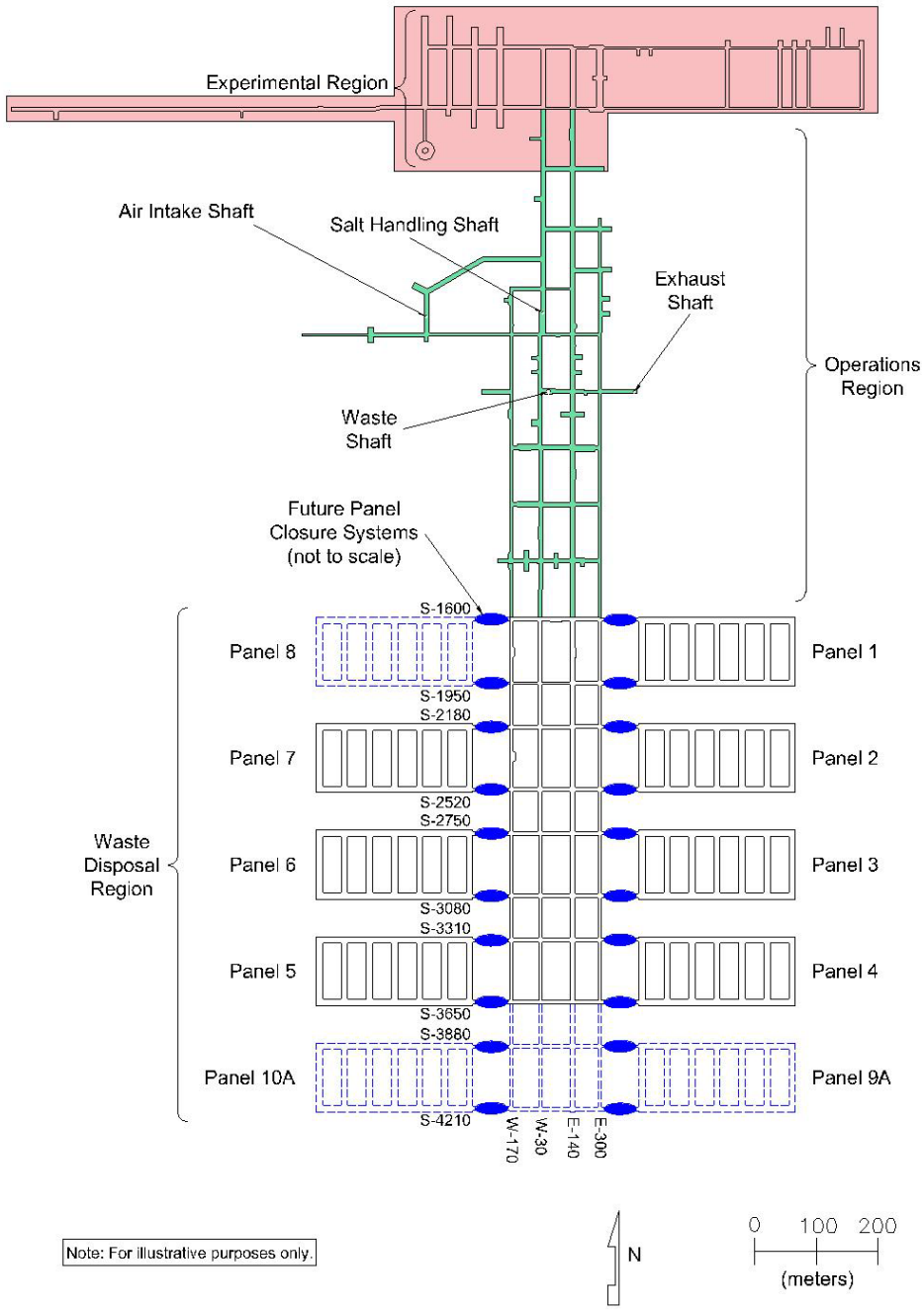

Figure 2. Plan view of the revised repository layout

The following sections discuss the recent geotechnical analysis and the potential impacts from the proposed reconfiguration of the repository on long-term performance.

3.0 Geotechnical Evaluation and Analyses

Geotechnical evaluations and analysis of historical and current ground conditions, as documented in the Geotechnical Analysis Report (GAR) (DOE 2011), indicate that convergence rates (the rate at which an opening closes after initial mining) and the

development of fractures are dependent on the age of the excavation and the proximity of nearby excavations. The age of the excavations in the area of the repository designated as Panels 9 and 10 varies from six to 30 years. (Convergence point data are obtained by measuring the change in distance between fixed points anchored into the rock across an opening, either from rib-to-rib or from roof-to-floor. The measurement end-points constitute a "chord.") The highest convergence rates and more closely spaced fractures occur in the older access drifts: the E-140 drift, followed by the W-170, W-30 and E-300 drifts, and particularly in the southernmost areas (Panel 9). This behavior is not only due to the age of the excavations but also to the effects of mining of Panels 3, 4, 5 and 6, which are adjacent to the access drifts at the southern end of the repository. Typically, as the dimensions of a drift are increased, the ground responds to the removal of natural support, displacing the ground stresses to the ribs, roof and floor. These effects can be substantial and are evident through increased convergence rates, roof beam dilation and floor heave. For example, the W-30 drift at Panel 10 was widened from 16 ft to 20 ft in stages from late 2007 through mid 2010. Measurements taken between mid 2010 and early 2011 in the W-30 drift at S-2275 indicated the convergence rates increased from 1.5 to 2 in/yr before increasing to 6 to 7 in/yr after widening (Figure 3). The higher than average convergence rate is typical when an opening is enlarged. It is anticipated that the rate will gradually decrease to a rate slightly higher than what has been observed previously at that location. Higher levels of effort are usually required in these areas in the form of scaling (removing loose rock), roof bolting and steel straps that are bolted to the roof to control loose rock that has started separating.

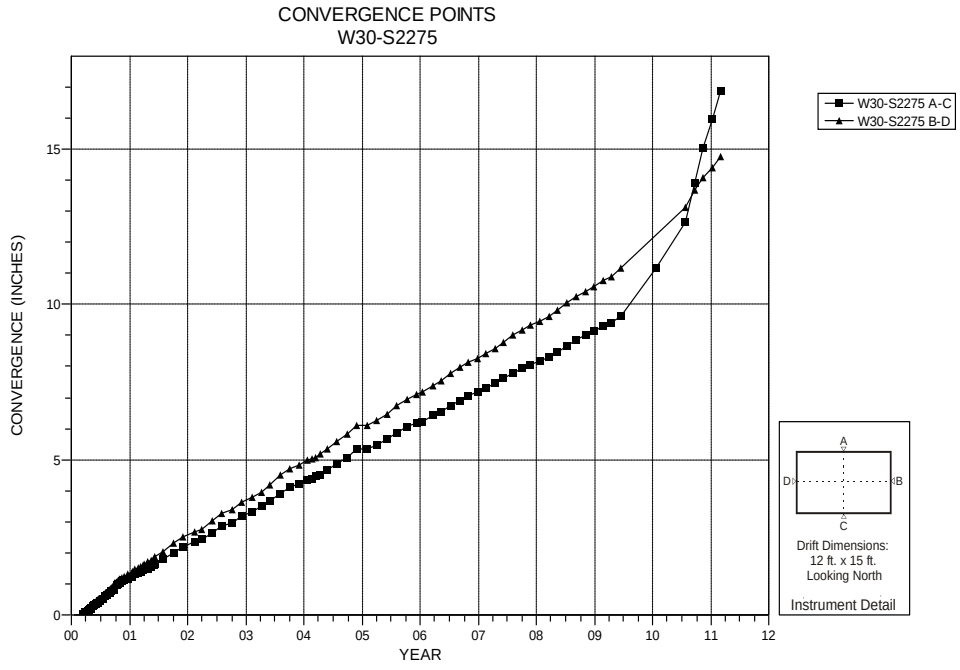

Figure 3 Convergence rate increase at W-30, S-2275 after drift was widened

The W-30 drift was initially mined to 13 ft high by 16 ft wide between February 1986 and December 2000. Additional mining completed in July 2010 enlarged this section to 15 ft high by 20 ft wide. After the final excavation, the convergence rates in W-30 Panel 9

range from 1.25 to 5 in/yr as indicated in Table 1. Table 1 show the average convergence rates (inches per year) from measurements taken from mid 2009 to mid 2010. The E-140 drift was initially mined to 8 ft high and 25 ft wide in 1983.

Table 1. Convergence Rates (inches per year) at W-30, Panel 9
(A-C indicates vertical measurement, B-D indicates horizontal measurement)

Location W-30, Panel 9 (Chord)	Convergence Rates (Inches per year) Data taken from July 2009 to June 2010
S2750 A-C	1.75
S2833 A-C	3.11
S2833 B-D	2.07
S2916 A-C	5.16
S2916 B-D	1.64
S2998 A-C	2.74
S2998 B-D	1.61
S3080 A-C	2.24
S3195 A-C	2.03
S3195 B-D	1.42
S3310 A-C	1.64
S3395 A-C	1.71
S3395 B-D	1.35
S3480 A-C	2.25
S3480 B-D	1.30
S3565-2 A-C	1.37
S3565 B-D	1.31
S3650-2 A-C	1.59

From late 2001 through early 2005, the E-140 drift was enlarged to 14 ft high by 25 ft wide and convergence rates in this area range from 2.5 to almost 5.5 in/yr as indicated in Table 2. Table 2 shows the average convergence rates (inches per year) from measurements taken from mid 2009 to mid 2010. (DOE 2011). The convergence in this area is to due to a combination of both widening and anhydrite stringers (geological features in this area of the repository) that have caused the roof beam to separate. Additional roof bolting has been done in this area to maintain safe conditions. Widening the access drifts in this area will further increase the convergence rates in Panel 9.

Table 1. Convergence Rates (inches per year) at E-140, Panel 9
(A-C indicates vertical measurement, B-D indicates horizontal measurement)

Location E-140, Panel 9 (Chord)	Convergence Rates (Inches per year) Data taken from July 2009 to June 2010
S2634 A-C	5.42
S2634 B-D	2.02
S2750-2 A-C	2.37
S2833-3 A-C	4.04

S2833 B-D	1.79
S2915-3 A-C	3.50
S2915 B-D	1.94
S2998-3 A-C	3.43
S2998 B-D	1.74
S3080-2 A-C	2.58
S3195-2 A-C	3.47
S3195 B-D	1.66
S3295-2 A-C	2.15
S3325 A-C	2.01
S3395-2 A-C	3.47
S3395 B-D	1.55
S3480-2 A-C	3.59
S3480 A-C	1.60
S3565-2 A-C	2.61
S3565 B-D	1.55
S3650-2 A-C	1.74

As the repository ages, the condition of the host rock locally around the excavations degrades. Ground support systems need to be installed and additional mining and scaling performed to maintain safe access. If the south access drifts are enlarged for disposal of CH TRU and RH TRU waste, the response to the removal of pillar volume and to the increase in roof span will be an increase in convergence rates by a factor of 3.6 or more, based on *in situ* observations. In another example that demonstrates the response to enlarging an access drift, Figure 4 shows the convergence rates for an access drift that was widened from 16 ft to 20 ft. The measurements were taken in an area located within the footprint for Panel 10, near the intersection of W-30 and S-2067. Figure 4 demonstrates that the vertical convergence rate increases from less than 1 in/yr before widening to approximately 3.5 in/yr after widening. Given these observed geotechnical responses, DOE recommends that the main north-south access drifts should not be enlarged, and that Panels 9 and 10 should be relocated to south of Panels 4 and 5 (i.e., south of S-3650), as shown in Figure 2.

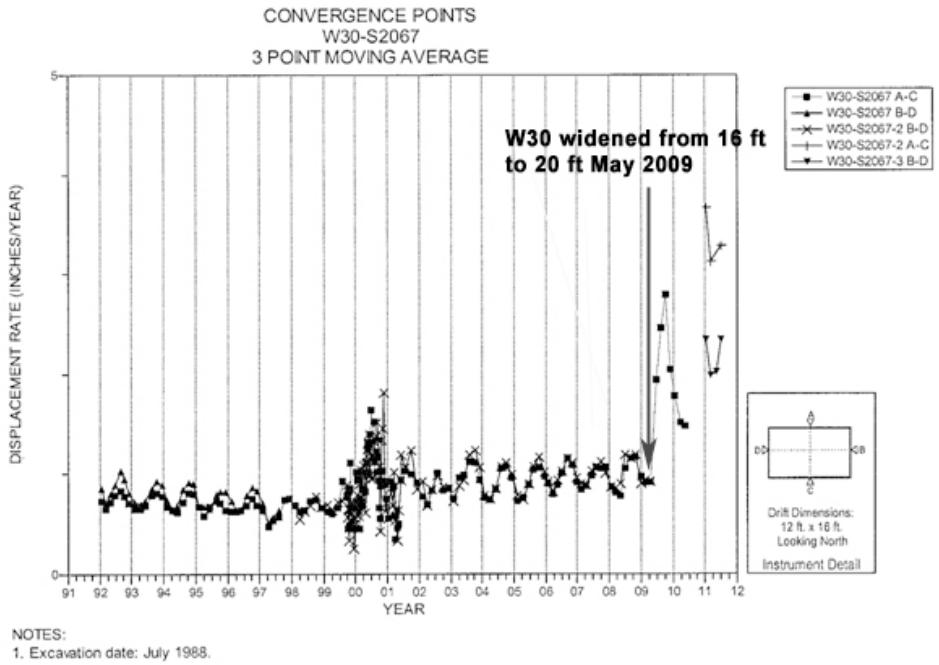

Figure 4. Comparison of vertical and horizontal convergence rates before and after widening the access drift near W-30 and S-2067 (within footprint of Panel 10)

Additional geotechnical data for convergence rates of the access drifts are documented and discussed in the 2011 GAR.

4.0 Impact on Long-Term Performance Assessment

The impact of the proposed repository reconfiguration on long-term repository performance has been evaluated with a PA that represents the relocation of Panels 9 and 10. The locations of Panels 9A and 10A are illustrated in Figure 2. Since the PCR for the repository reconfiguration and the PCR for the panel closure redesign are being prepared simultaneously, DOE has performed a combined PA for both changes. This PA, which is called the Panel Closure Redesign and Repository Reconfiguration PA (PC3R PA) Camphouse et al. 2011, demonstrates that the combined changes from repository reconfiguration and panel closure redesign result in predicted total mean normalized releases that are very similar to the predicted total mean normalized releases for the Performance Assessment Baseline Calculation-2009 (PABC-2009), which is the current PA baseline. The key technical results from the PC3R PA are presented here, with a more complete discussion in the PC3R PA Summary report (Camphouse et al. 2011).

For the PC3R PA, the “Option D” panel closure design for the PABC-2009 is replaced with 100 ft of run-of-mine salt emplaced against a “significant barrier” on the waste disposal side. With Panels 9 and 10 relocated to the south end of the repository, there is an open central area with panel closures installed only at the end of waste-filled panels, as shown in Figure 2. The time-dependent hydrologic properties of the run-of-mine salt are defined in Camphouse et al. 2011. The results for the PC3R PA show that the

revised panel closure design with an open central area will produce small differences from the PABC-2009, as shown in Figure 5. The primary cause of these small differences is the time required for the run-of-mine salt to reconsolidate combined with the open central area, resulting in reduced repository pressure in the waste emplacement panels (Camphouse et al. 2011).

Figure 5 presents the predicted total mean normalized releases for the PC3R PA and the PABC-2009. The results in Figure 5 demonstrate that the differences in predicted total mean normalized releases for the PC3R PA and PABC-2009 are relatively minor throughout the probability range of 0.001 to 1 and essentially equal for probabilities between 0.01 and 1. The numerical values in Table 3 (Camphouse et al. 2011, Table 11) also demonstrate that the statistics for the distribution of complementary cumulative distribution functions (CCDFs) about the mean are similar for the PC3R PA and for the PABC-2009. It follows that the mean values and the distributions of total normalized releases for the combined changes from repository reconfiguration and panel closure redesign are very similar to the corresponding parameters for the PABC-2009. In addition, the mean total normalized release from the PC3R PA is 0.89 at a probability of 0.001 (see Table 3), and therefore the potential releases for the PC3R are less than those calculated for the PABC-2009.

Table 3. PC3R PA and PABC-2009 Statistics on the Overall Mean for Total Normalized Releases in EPA Units at Probabilities of 0.1 and 0.001

Probability	Analysis	Mean Total Release	90th Percentile	Lower 95% CL	Upper 95% CL	Release Limit
0.1	PC3R PA	0.09	0.16	0.09	0.10	1
	PABC-2009	0.09	0.16	0.09	0.10	1
0.001	PC3R PA	0.89	1.00	0.34	1.41	10
	PABC-2009	1.10	1.00	0.37	1.77	10

A complete analysis of the parameter values for the PC3R PA and of the contributions of Cuttings/Cavings, Direct Brine Release, Spallings, and Transport in the Culebra to total normalized releases for the PC3R PA is presented in Camphouse et al. 2011. These details are not repeated here because the total normalized releases are very similar for the PC3R PA and the PABC-2009, and because the repository remains in compliance with the containment requirements in 40 CFR Part 191.

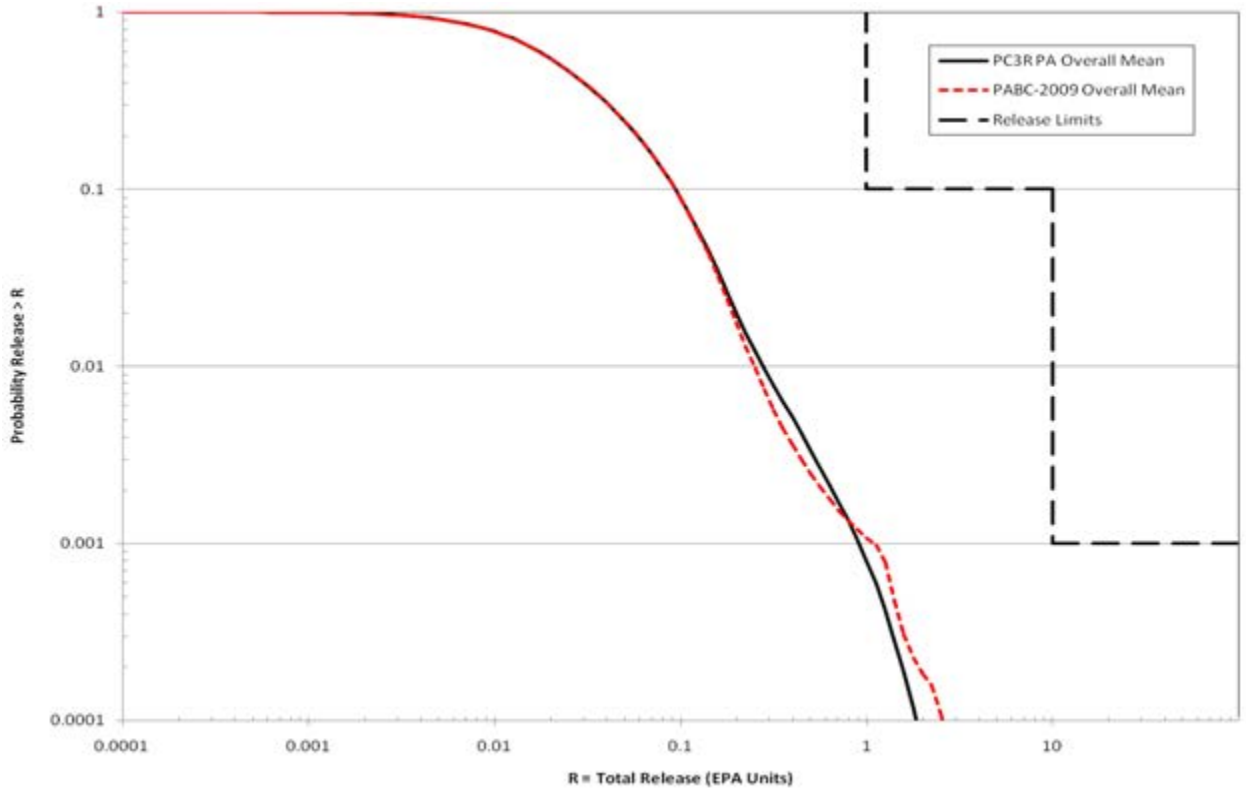

Figure 5 Overall mean CCDFs for total normalized releases for the PC3R PA and for PABC-2009

5.0 Conclusion

The DOE is proposing a change to the configuration of the repository at the WIPP. The current configuration will use the main north-south access drifts, suitably enlarged, as Panels 9 and 10 for waste disposal. However, the main north-south access drifts have been open for about 25 years, and a geotechnical assessment of these openings indicates that relocating Panels 9 and 10 to south of the existing Panels 4 and 5 will enhance worker safety and reduce maintenance requirements. Therefore, it is DOE's intention to replace Panels 9 and 10 with two new waste disposal panels, designated as Panels 9A and 10A, to the south of Panels 4 and 5.

A PA has been performed to evaluate the effects of the proposed change on long-term performance of the repository (Camphouse et al. 2011). Since the PCR for the repository reconfiguration and the PCR for the panel closure redesign are being prepared simultaneously, DOE has performed a combined PA for both changes. This PA, called the PC3R PA, demonstrates that the mean total normalized releases from the PC3R PA are only slightly different from the PABC-2009 throughout the probability range of 0.001 to 1, and almost equal for probabilities between 0.01 and 1. In addition, the mean total normalized release for the PC3R PA is 0.89 at a probability of 0.001, and therefore below the EPA's release limit. The WIPP will therefore remain in compliance with the containment requirements in 40 CFR Part 191 for the combined changes from repository reconfiguration and panel closure redesign.

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