533098

Sandia National Laboratories
Waste Isolation Pilot Plant

MONPAR
Reassessment

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Sandia National Laboratories

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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ACRONYMS

CCA	Compliance Certification Application
CFR	Code of Federal Regulations
CH	contact-handled
CMP	Compliance Monitoring Program
COMP	Compliance Monitoring Parameter
CRA	Compliance Recertification Application
DBDSP	Delaware Basin Drilling Surveillance Program
DOE	U.S. Department of Energy
DRZ	disturbed rock zone
EDTA	ethylenediaminetetracetate
EPA	Environmental Protection Agency
ERMS	Electronic Record Management System
FEPs	features, events, and processes
FMT	Fracture-Matrix Transport
LWA	Land Withdrawal Act
MgO	magnesium oxide
PA	performance assessment
PAVT	performance assessment verification test
SNL	Sandia National Laboratories
TRU	transuranic
VOCs	volatile organic compounds
WIPP	Waste Isolation Pilot Plant
WUF	Waste Unit Factor
WWIS	WIPP Waste Information System

EXECUTIVE SUMMARY

As part of the Department of Energy's (DOE) Compliance Certification Application (CCA), an analysis was conducted to determine appropriate monitoring parameters for the pre- and post-closure time period for the Waste Isolation Pilot Plant (WIPP). This analysis was included in the CCA as Appendix MONPAR, and termed the "MONPAR Analysis." The MONPAR Analysis is responsive to 40 CFR §194.42 *Monitoring* and was found to be acceptable by the Environmental Protection Agency (EPA). As a result of the MONPAR Analysis, ten compliance monitoring parameters or "COMPs" were identified, and have been monitored as part of the WIPP Compliance Monitoring Program (CMP).

Pursuant to the WIPP Land Withdrawal Act (LWA), the WIPP must be recertified every five years. Each recertification is an opportunity to re-evaluate changes to the compliance baseline. These changes may be driven by specific petition to the EPA, unexpected events, or other sources. The totality of these changes must be appropriately incorporated in DOE's demonstration of continued compliance and submitted to the EPA for review, concurrence, and ultimately, recertification. The regulatory document to be submitted by the DOE is called the Compliance Recertification Application (CRA).

The purpose of this document is to address the impact of changes to the baseline on the MONPAR Analysis described earlier. The results of this assessment conclude that the original conclusions in MONPAR remain valid and that changes to the WIPP compliance baseline do not affect the conclusions and monitoring parameters identified in the MONPAR Analysis. The conclusions drawn in the original MONPAR Analysis remain unchanged. Therefore, no changes are necessary to the original monitoring parameters used in the CMP. Secondly, ongoing Culebra investigations may identify conditions that would suggest changes be made to the current monitoring program. Should this occur, a new MONPAR Analysis may be warranted.

1 INTRODUCTION

The United States Department of Energy (DOE) has developed the Waste Isolation Pilot Plant (WIPP) in southeastern New Mexico for the disposal of transuranic (TRU) wastes generated by defense programs. In May of 1998, the Environmental Protection Agency (EPA) certified that the WIPP would meet the disposal standards (EPA 1998) established in Title 40 Code of Federal Regulations (CFR) Part 191, Subparts B and C (EPA 1993), thereby allowing the WIPP to begin waste disposal operations. This certification was largely based on performance assessment (PA) calculations that were included in the DOE's Compliance Certification Application (CCA) (DOE 1996). These calculations demonstrate that the cumulative releases of radionuclides to the accessible environment will not exceed those allowed by the EPA standards at 40 CFR §191.13.

In addition to meeting EPA's release standards, the DOE is also required to comply with other aspects of the long-term disposal standards, including the Assurance Requirements of 40 CFR §191.14. The Assurance Requirements are intended to, *"provide the confidence needed for long-term compliance with the requirements of §191.13"* (EPA 1996). The EPA's Assurance Requirements:

1. Limit the assumed effectiveness of active institutional controls in performance assessment;
2. Require ***monitoring*** after disposal to detect substantial and detrimental deviations from expected performance;
3. Require the use of passive institutional controls;
4. Specify both natural and engineered barriers;
5. Discourage disposal sites within resource-rich areas[1]; and
6. Require provisions for waste removal.[2]

Complementary to the Assurance Requirements in §191.14, are EPA's compliance criteria. The EPA provides specific monitoring criteria at 40 CFR §194.42 *Monitoring*. As part of the CCA, the DOE submitted an analysis responsive to the criterion at §194.42. The results of this analysis were included as Attachment MONPAR to CCA Appendix MON. Attachment MONPAR identified ten pre-closure monitoring parameters that met the criteria at §194.42. Data for most of these parameters were already being collected as part of one or more of the numerous existing WIPP operational monitoring programs at the WIPP. Five of the ten pre-closure monitoring parameters will continue to be monitored during the post-closure period.

Since the CCA, changes have occurred within the WIPP project that could potentially impact the conclusions in the initial MONPAR Analysis. Therefore, this document presents a reassessment of the initial analysis results. This reassessment will revisit each component of the initial MONPAR analysis and determine if changes to the WIPP's compliance baseline since the original compliance application affect the conclusions drawn in the initial analysis. This analysis will determine if:

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[1] Unless the favorable characteristics of such places compensate for their greater likelihood of being disturbed in the future. Compliance with §191.13 (includes disturbed scenarios) demonstrates that the WIPP's favorable characteristics outweigh the increased likelihood of intrusion due to resources present.

[2] Waste removal is not anticipated, but must be technically feasible, per the EPA's disposal standards.

- The conclusions of the MONPAR Analysis remain valid;
- The conclusions of the MONPAR Analysis remain valid with minor modifications; or
- The conclusions of the MONPAR Analysis are invalid and a new analysis is warranted.[3]

2 RE-ANALYSIS METHODOLOGY

2.1 MONPAR Analysis for the Compliance Certification Application

The initial MONPAR Analysis conducted for the CCA was used to determine what monitoring parameters should be included in a monitoring program as required by the EPA Assurance Requirements at 40 CFR §191.14, and further detailed in the EPA Certification Criteria at 40 CFR §194.42. The objective of the CCA MONPAR Analysis was to identify significant disposal system parameters that could provide meaningful indications about the performance of the disposal system. "Significant disposal system parameters" are defined in 40 CFR § 194.42(c) as those that "affect the system's ability to contain waste or the ability to verify predictions about the future performance of the disposal system."

The following list summarizes regulatory guidance relating to post-closure monitoring:

- The disposal site shall be monitored after disposal to detect substantial and detrimental deviations from expected performance.
- The monitoring techniques used must not jeopardize waste isolation.
- Monitoring will continue as long as practicable and/or until no significant concerns are to be addressed.

Therefore, the results of the initial MONPAR Analysis concluded there were ten monitoring parameters that could provide meaningful data in the near term, five of which will be monitored beyond the closure of the WIPP. These parameters are listed below in Table 2.1.

[3] Should a new analysis be necessary, it will be outside the scope of the reassessment documented in this report. A new and separate analysis must meet the requirements of NP 9-1, "Analyses."

Table 2-1. Preclosure and Postclosure Monitored Parameters

Monitored Parameter	Preclosure	Postclosure
Change in Culebra groundwater composition	X	X
Change in Culebra groundwater flow	X	X
Probability of encountering a Castile brine reservoir	X	X
Drilling rate	X	X
Subsidence measurements	X	X
Waste activity (waste unit factor)	X	
Creep closure and stresses	X	
Extent of deformation	X	
Initiation of brittle deformation	X	
Displacement of deformation features	X	

Data from these ten monitoring parameters continue to be collected and are assessed by Sandia National Laboratories (SNL) annually in the Annual Compliance Monitoring Parameter (COMPs) Reports per AP-69 (SNL 2000a).

2.2 MONPAR Reassessment

The objective of this reassessment is to determine if the results of the CCA MONPAR Analysis continue to meet the regulatory requirements of 40 CFR §194.42, given the changes to the compliance baseline since the initial analysis. This analysis is conducted in accordance with Sandia National Laboratories Analysis Plan AP-109 (SNL 2003a), and will: 1) determine which changes should be considered in this reassessment, and then 2) determine the impact of these changes on the conclusions drawn in the CCA MONPAR Analysis. Changes from the following disposal system elements will be evaluated for any impacts to the CCA MONPAR Analysis:

- Monitoring Results
- Experimental Activities
- Performance Assessment Changes--Methodology/Parameters/Implementation
- WIPP Operational Changes

Once changes have been identified, components of the original MONPAR Analysis will be evaluated to determine if these changes impact the conclusions of the MONPAR Analysis. After these changes are evaluated against the recommendations of the MONPAR Analysis, one of the following conclusions will be made:

- The MONPAR Analysis is not impacted by changes and is adequate for the recertification application – the original analysis conclusions are unchanged;

- The MONPAR Analysis is not significantly impacted by the changes – (document the affected areas of the analysis and justify "insignificant" conclusion); or

- The MONPAR Analysis is significantly impacted such that the original conclusions are likely to be different upon completion of a new monitoring parameter analysis.

3 MONITORING RESULTS

Since WIPP's initial certification, the Compliance Monitoring Program (CMP) has been underway as specified in the DOE Monitoring Implementation Plan (MIP) (DOE 1999). Each year, the CMP data are compiled in the COMPs Report. Three such COMPs reports have been completed to date (SNL 2000b, SNL 2001a, SNL 2002a). These three reports describe each year's COMP data, and provide an assessment to determine if data are within performance assessment expectations. It should be noted that the Annual COMPs Report for 2003 is not yet available and therefore is not considered in this MONPAR Reassessment. The 2003 COMPs Report will be included in future reassessments of MONPAR results and monitoring parameters.

The following subsections break down the four main monitoring focus areas of the COMPs program, and describe any observed changes within each area.

3.1 Human Activities COMPs

The Delaware Basin Drilling Surveillance Program (DBDSP) collects data related to drilling activities within the vicinity of the WIPP. The data collected primarily support performance assessment (PA) activities for the WIPP, particularly as they relate to human intrusion scenarios. Of the many types of drilling data collected, two are identified as COMPs. They are:

- Drilling Rate
- Probability of Encountering a Castile Brine Reservoir

Since the CCA, the drilling rate has increase from 46.8 to 52.5 boreholes per square kilometer per 10,000 years. This change is primarily due to the manner in which the drilling rate is derived. Further explanation of this increase is provided in Section 7.5.3.

The probability of encountering a Castille brine reservoir is also one of the two human activities COMPs. Since the CCA, five brine encounters within the vicinity of WIPP have been informally reported, although no record of these events can be found in the drilling reports. Even if these purported brine encounters are real, they do not represent a marked change in the frequency of brine encounters within the region. In the CCA PA, a probability of brine encounter was set at 0.08. In their Performance Assessment Verification Test, (PAVT), EPA specified a range of 0.01 to 0.6, effectively bounding the uncertainty of this parameter. Therefore, even significant changes in reported brine encounters will fall within the frequency sampled in PA.

In addition to collecting data for these two COMPs, the DBDSP collects other information regarding current drilling practices within the Delaware Basin. No significant changes have been identified related to drilling operations, plugging operations, recovery techniques, or exploration techniques.

3.2 Geotechnical COMPs

The Geotechnical Monitoring Program collects data supporting five COMPs. These are:

- Creep Closure
- Extent of Deformation
- Initiation of Brittle Deformation
- Displacement of Deformation Features
- Subsidence

The Geotechnical COMPs can be derived from or related to the repository's operational safety monitoring program, which is performed to ensure worker and mine safety. By nature, changes in geotechnical conditions evolve slowly. Because pertinent data from the underground reflect slowly evolving conditions, relationships that correlate to geotechnical COMPs also evolve slowly. Nonetheless, monitoring underground response allows continuing assessment of conceptual geotechnical models that support WIPP's certification basis. To date, creep rates, subsidence, and DRZ-related processes are occurring as expected and have had no impact on performance.

3.3 Hydrogeological COMPs

The Hydrogeologic monitoring program collects data specifically targeted at the following COMPs:

- Changes in Culebra groundwater composition
- Changes in Culebra groundwater flow

Monitoring Culebra groundwater was identified in the CCA MONPAR Analysis and has proven to be an important element of the WIPP operational monitoring program. The program continues to monitor Culebra groundwater. To date, Culebra groundwater levels have been gradually increasing for several years. These increases have prompted additional groundwater investigations and include additional well drilling, monitoring, and analyses. These additional activities continue to monitoring more closely changes in groundwater flow and composition, including other units within the Rustler. To date, however, the most recent Annual COMPs Assessment (SNL 2002a) does not indicate that a change in monitoring parameters is warranted at this time.

3.4 Waste Activity

In the CCA, the DOE identified 10 radionuclides that were important to WIPP performance. Therefore, the MONPAR Analysis identified Waste Activity as a suitable COMP. Waste Activity is used to calculate EPA's Waste Unit Factor (WUF). The WUF is then used to determine allowable releases to the environment per EPA's release standards of 40 CFR

§191.13. Activity for the following radionuclides is tracked and stored in the WIPP Waste Information System (WWIS).

Am^{241}
Pu^{238}
Pu^{239}
Pu^{240}
Pu^{242}
U^{233}
U^{234}
U^{238}
Sr^{90}
Cs^{137}

According to the Annual COMPs reports, there are no reportable issues associated with this COMP. Waste Activity continues to be tracked in the WWIS.

4 EXPERIMENTAL ACTIVITIES

Since the certification of the WIPP, the Project has continued certain experimental activities in order to defend and support key assumptions used in PA. Additionally, some experiments have been geared towards increasing confidence or removing conservatism in PA assumptions. Such experiments relate to microbial gas generation, cementitious material degradation, actinide chemistry, MgO reaction kinetics, hydrologic model development, and DRZ investigations. These experiments are listed and tracked in the "Sandia National Laboratories Technical Baseline Reports" (SNL 2001b, SNL 2001c, SNL 2002b, SNL 2002c, SNL 2003b).

Of these experimental activities, the effects of organic ligands on actinide chemistry have been incorporated into performance assessment. The CRA calculations include the effects of organic ligands (acetate, citrate, EDTA [ethylenediaminetetraacetate], and oxalate) on actinide solubilities in the Fracture-Matrix Transport calculations (FMT)(Brush and Xiong 2003). The FMT database includes all of the results of experimental studies (Choppin et al. 2001) required to predict the complexation of dissolved An(III), An(IV), and An(V) species by acetate, citrate, EDTA, and oxalate (Giambalvo 2002a and 2002b).

5 PERFORMANCE ASSESSMENT CHANGES

The performance assessment baseline includes all components of the performance assessment methodology: Features, events, and processes (FEPs), conceptual models, numerical models, computer codes, parameter selection, parameter distribution and range, and modeling assumptions. Since the CCA, changes have occurred to this baseline. Some changes are due to EPA mandate to vary parameter values and/or type, while other changes are due to disposal system changes, model development, or new information such as updated waste inventory data. The following table identifies changes within the PA framework.

Table 5.1: PA Changes Since the CCA

WIPP PA Change	Source of Change
Credit for Passive Institutional Controls	PAVT
K_d (chemical retardation coefficient)	PAVT
Probability of Encountering a Brine Reservoir	PAVT
Brine Reservoir Rock Compressibility	PAVT
Brine Reservoir Porosity	PAVT
Drill String Angular Velocity	PAVT
Waste Permeability	PAVT
Inundated Steel Corrosion Rate	PAVT
Long-term Borehole Permeability	PAVT
Borehole Plug Permeability	PAVT
DRZ Permeability	PAVT
Actinide Solubility	PAVT
Waste Shear Strength and Erodability	New Spallings Model
Waste Activity (used for WUF)	CRA Appendix TRU Waste
Borehole Plugs Configuration Probability	Appendix PA, Attachment MASS
Inventory Update	CRA Appendix TRU Waste
Waste tensile strength	Revised Spallings Model
Mud pump rate	Revised Spallings Model
Drill penetration rate	Revised Spallings Model
Gravity correction factor	Revised Spallings Model
Strength correction factor	Revised Spallings Model
Inclusion of Organic Ligands in PA	FEPs Reassessment and Experimental Activities
Revised Salado Flow Model (Shaft simplications)	Incorporation of EPA-mandated Option D panel closure system

Most changes to the PA system are a result of the EPA's PAVT. The DOE migrated the PA baseline in 2002, effectively adopting EPA's PAVT parameter values (SNL 2002d).

The representation of spalling in PA changed during the WIPP certification process as a result of peer review conclusion. Since the CCA, a new spallings model has been developed. Some of the parameters used in the MONPAR analysis are related to the original spallings model. The new CRA spallings model does not use the same parameter set as used in the CCA. Specifically, the gravity correction factor and the strength correction factor for spallings are no longer used in performance assessment. Two additional parameters have been added: mud pump rate and drill penetration rate.

Changes to the waste inventory are discussed in Section 3.4 of this report, and listed here for completeness. Changes in waste activity and the WUF are represented in performance assessment modeling.

The inclusion of organic ligands in performance assessment has been discussed in Section 4, Experimental Activities.

The Salado Flow Model has also changed and results in a different representation of panel closures in performance assessment. The CRA performance assessment specifically models the option D panel closure design (see Chapter 6, Section 6.4.3 and DOE [1996: Appendix PCS]).

6 OPERATIONAL CHANGES

The following operational changes have occurred since the original certification of the WIPP.

Table 6.1: Operational Changes at WIPP Since Certification

WIPP Project Change	Source of Change
Operational Changes	
Raise Disposal Horizon to Clay Seam G	Operational mine stability concerns
MgO mini-sack elimination	EPA approval of DOE request
MgO supplier change	EPA approval of DOE request
Option D Panel Closure	Final Certification Ruling

The following subsections provide descriptions of these operational changes.

6.1 Elevated Repository Horizon

The Carlsbad Field Office proposed to raise the repository horizon in Panels 3, 4, 5, 6, and 9 by approximately two meters so that the roof is at clay seam G. Positioning the roof at clay seam G will result in a more stable roof configuration and improve repository ground control. Raising the horizon will reduce the rate of roof-beam deformation and slow the development of fractures, thus reducing risks during mining and waste handling in the underground. With this change, less maintenance will be required to assure optimum ground conditions.

EPA concurred with the request to elevate the repository horizon in a letter dated August 11, 2000 where they state, " … that (this change) will enhance operational safety without significantly affecting the long-term performance of the facility." (EPA 2000)

6.2 Magnesium Oxide Changes

Magnesium oxide (MgO) mini sacks have been eliminated to optimize worker safety in waste-emplacement operations and to minimize the potential for occupational radiation exposures to waste operations personnel. The EPA granted approval for the elimination of mini sacks in January 2001 (EPA 2001a). Their elimination has resulted in a reduction in the total mass of MgO emplaced in the WIPP underground by about 15 percent. Analyses indicate that the quantity of MgO originally proposed to be emplaced is 3.7 times more than that required to sequester the entire possible inventory of carbon dioxide (CO_2) in the underground. With the elimination of MgO mini sacks, there will still be a 3.2 fold excess of MgO in the repository.

In 2000, MgO became unavailable from the original supplier. Accordingly, it was necessary to select a new supplier of the MgO. EPA formally approved this change in July of 2001 (EPA 2001b).

6.3 Option D Panel Closure

In their final certification ruling (EPA 1998), the EPA specified that the Option D panel closure design be implemented in the WIPP. This design was considered the most robust and substantial of the options identified in the CCA. The PA conducted for the CCA did not explicitly represent this robust closure system, but instead included a more generic representation in PA. For the CRA, the Option D panel closure will be explicitly represented.

7 EFFECT OF CHANGES ON POTENTIALLY SIGNIFICANT PARAMETERS

7.1 Identification of Potentially Significant Parameters

The previous sections have identified relevant disposal system changes. This section will determine if these changes affect disposal system parameters identified in the initial MONPAR Analysis. The parameters listed in this section were included in the MONPAR Analysis because they met one or more of the following criteria:

- The parameter represents one or more important aspects of the process or model
- The parameter represents subjective uncertainty (such as spatial variability in a physical property or process used in modeling results of repository performance)
- The parameter represents stochastic uncertainty (such as drilling rate for consideration of human intrusions)
- The parameter represented subjective or stochastic uncertainty in previous preliminary performance assessment calculations (such as the diameter of the drill bit in the intrusion borehole)
- The parameter proved to be moderately- to highly- sensitive in previous preliminary performance assessment calculations (for example, SNL 1992)

The following table presents disposal system parameters identified in the MONPAR Analysis:

Table 7.1: Potentially Significant Disposal System Parameters

NATURAL PARAMETERS	
Impure halite effective porosity	Culebra diffusional porosity
Impure halite permeability	Culebra longitudinal dispersivity
Impure halite pore compressibility	Climate change index
Impure halite far-field pore pressure	Culebra groundwater quantity
Anhydrite permeability	Culebra groundwater flux
Anhydrite pore compressibility	Culebra groundwater spatial distribution
Anhydrite two-phase flow model choice	Culebra groundwater composition
Salado pore shape	Castile brine volume in reservoir
Salado residual brine saturation	Castile brine reservoir volume selection index
Salado residual gas saturation	Castile brine reservoir pressure
Salado brine quantity	Castile brine reservoir permeability
Salado brine flux	Castile brine reservoir rock compressibility
Salado brine spatial distribution	Castile brine composition
Salado brine composition	Castile brine flux
Culebra transmissivity	Castile brine spatial distribution
Culebra advective porosity	Natural temperature distribution
Culebra fracture spacing	
WASTE AND REPOSITORY PARAMETERS	
Closure rates and stresses	Probability factor for types of microbial degradation
Extent of deformation	Gas quantity
Initiation of brittle deformation	Gas composition
Displacement of major deformation features	Choice of oxidation state distribution
DRZ permeability	Solubility of nine radionuclides in Salado brine
DRZ effective porosity	Solubility of nine radionuclides in Castile brine
DRZ brine flux	Humic colloid concentration in Salado brine
DRZ brine quantity	Humic colloid concentration in Castile brine
Waste area residual gas saturation	Clay shaft seal member permeability
Waste area residual brine saturation	Concrete shaft seal member permeability
Brine wicking	Asphalt shaft seal member permeability
Waste area permeability	Shaft DRZ permeability
Backfill porosity	Crushed salt seal component permeability (permeability selection index)
Backfill permeability	Seal residual gas saturation
Degree of backfill compaction	Seal residual brine saturation
Backfill reconsolidation	Seal pore shape
Inundated steel corrosion rate with CO_2	Waste- and repository-induced temperature distribution
Inundated steel corrosion rate without CO_2	Salado Kds for dissolved radionuclides
Inundated microbial degradation rate	Culebra Kds for six dissolved radionuclides
Humid microbial degradation rate	Salado Kds for colloidal radionuclides
B -factor for microbial degradation process	
HUMAN INITIATED PARAMETERS	
Drilling rate	Borehole permeability
Waste particle diameter	Borehole plugging pattern (probability index)
Effective shear resistance to erosion	Change in Salado brine flow
Gravity correction factor for spalling	Change in Culebra groundwater flow
Strength correction factor for spalling	Probability that mining will occur
Time between intrusion	Mining index for adjusting Culebra transmissivity
Borehole location	Waste activity
Probability of encountering a Castile brine reservoir	Waste tensile strength
Borehole diameter	

7.2 Parameters Related to Changes Since the CCA

The next step compares the changes identified in Sections 3 through 6 of this report against the disposal system parameters identified in Table 7-1 above. Doing so identifies those disposal system parameters that are related to the changes that have occurred within the WIPP disposal system since the CCA. This comparison results in parameters identified below in Table 7.2.

Table 7.2: Parameters Related to Changes Since the CCA

Parameter	Source or Related Change
Culebra transmissivity	Culebra Monitoring Data/Recalculation of T-fields
Culebra groundwater quantity	Culebra Monitoring Data/Recalculation of T-fields
Culebra groundwater flux	Culebra Monitoring Data/Recalculation of T-fields
Culebra groundwater spatial distribution	Culebra Monitoring Data/Recalculation of T-fields
Castile brine reservoir rock compressibility	PAVT
DRZ permeability	PAVT
Inundated steel corrosion rate with CO2	PAVT
Inundated steel corrosion rate without CO2	PAVT
Choice of oxidation state distribution	PAVT
Solubility of nine radionuclides in Salado brine	PAVT
Solubility of nine radionuclides in Castile brine	PAVT
Clay shaft seal member permeability	Salado Flow Conceptual Model Change
Concrete shaft seal member permeability	Salado Flow Conceptual Model Change
Asphalt shaft seal member permeability	Salado Flow Conceptual Model Change
Drilling rate	DBDSP Monitoring Data
Effective shear resistance to erosion	Spallings Model Change
Probability of encountering a Castile brine reservoir	PAVT
Borehole permeability	PAVT
Borehole plugging pattern (probability index)	DBSP Monitoring Data
Change in Culebra groundwater flow	Culebra Monitoring Data/Recalculation of T-fields
Waste activity (used for WUF)	Waste Inventory Update

7.3 Measurable Parameters

The next step in determining the effects of changes to the MONPAR Analysis is to compare those parameters related to changes identified in Table 7.2 above to those parameters identified in the MONPAR Analysis as being measurable or amenable to monitoring. Those parameters are listed below in Table 7.3.

Table 7.3: Parameters Related to Measurable Disposal System Properties

Parameter	Significance to Containment	Significance to Verification
SALADO PHYSICAL PARAMETERS		
Creep closure and stresses	LOW	LOW
Extent of deformation	LOW	LOW
Initiation of brittle deformation	LOW	LOW
Displacement of major deformation features	LOW	LOW
Natural temperature distribution	LOW	LOW
Creep closure and stresses	LOW	LOW
Extent of deformation	LOW	LOW
Initiation of brittle deformation	LOW	LOW
Displacement of major deformation features	LOW	LOW
Natural temperature distribution	LOW	LOW
SALADO HYDROLOGICAL PARAMETERS		
Impure halite pore compressibility	LOW	LOW
Impure halite far-field pore pressure	MEDIUM	MEDIUM
Salado pore shape	MEDIUM	MEDIUM
Impure halite effective porosity	MEDIUM	MEDIUM
Impure halite permeability	MEDIUM	MEDIUM
Anhydrite permeability	HIGH	HIGH
Anhydrite pore compressibility	MEDIUM	MEDIUM
Salado residual brine saturation	MEDIUM	MEDIUM
Salado residual gas saturation	MEDIUM	MEDIUM
Salado brine quantity	LOW	LOW
Salado brine flux	MEDIUM	MEDIUM
Salado brine spatial distribution	LOW	LOW
Salado brine composition	HIGH	HIGH
Salado K_ds for dissolved radionuclides	LOW	LOW
Salado K_ds for colloidal radionuclides	LOW	LOW
Salado change in groundwater brine	LOW	LOW
Natural temperature distribution	LOW	LOW
DRZ permeability	MEDIUM	MEDIUM
DRZ effective porosity	MEDIUM	MEDIUM
DRZ brine flux	MEDIUM	MEDIUM
DRZ brine quantity and spatial distribution	LOW	LOW
NON-SALADO HYDROLOGICAL PROPERTIES		
Culebra transmissivity	MEDIUM	MEDIUM
Culebra advective porosity	MEDIUM	MEDIUM
Culebra fracture spacing	HIGH	HIGH

Parameter	Significance to Containment	Significance to Verification
Culebra diffusional porosity	MEDIUM	MEDIUM
Culebra longitudinal dispersivity	LOW	LOW
Culebra groundwater quantity	LOW	LOW
Culebra groundwater flux	MEDIUM	MEDIUM
Culebra groundwater spatial distribution	LOW	LOW
Culebra groundwater composition	LOW	LOW
Castile brine reservoir pressure	HIGH	HIGH
Castile brine reservoir permeability	HIGH	HIGH
Castile brine reservoir rock compressibility	HIGH	HIGH
Castile brine reservoir brine volume	HIGH	HIGH
Castile brine flux	HIGH	HIGH
Castile brine spatial distribution	HIGH	HIGH
Castile brine composition	MEDIUM	MEDIUM
Natural temperature distribution	LOW	LOW
Culebra Kds for six dissolved radionuclides	HIGH	HIGH
Culebra Kds for humic and actinide-intrinsic colloidal Radionuclides	MEDIUM	MEDIUM
Effective decay constant for microbes	MEDIUM	MEDIUM
Culebra change in groundwater flow	MEDIUM	MEDIUM
	WASTE RELATED PARAMETERS	
Waste area residual gas saturation	MEDIUM	MEDIUM
Waste area residual brine saturation	MEDIUM	MEDIUM
Waste area permeability	MEDIUM	MEDIUM
Brine wicking	MEDIUM	MEDIUM
Inundated steel corrosion rate with CO_2	LOW	LOW
Inundated steel corrosion rate without CO_2	MEDIUM	MEDIUM
Inundated microbial degradation rate	LOW	LOW
Humid microbial degradation rate	LOW	LOW
Gas quantity	MEDIUM	MEDIUM
Gas composition	LOW	LOW
Choice of oxidation state distribution	HIGH	HIGH
Solubility of nine radionuclides		

Parameter	Significance to Containment	Significance to Verification
in Salado brine	HIGH	HIGH
Solubility of nine radionuclides in Castile brine	HIGH	HIGH
Humic colloid concentrations in Salado brine	HIGH	HIGH
Humic colloid concentrations in Castile brine	HIGH	HIGH
Waste particle diameter	HIGH	HIGH
Effective shear resistance to erosion	MEDIUM	MEDIUM
Waste activity (used for WUF)	HIGH	HIGH
Waste tensile strength*	HIGH*	HIGH*
Gravity factor for spalling	MEDIUM	MEDIUM
Strength factor for spalling	LOW	LOW
HUMAN ACTIVITY- RELATED PARAMETERS		
Drilling rate	HIGH	HIGH
Probability of encountering a Castile brine reservoir	MEDIUM	MEDIUM
Borehole plugging pattern (probability index)	LOW	LOW
Mud pump rate**	LOW**	LOW**
Drill penetration rate**	LOW**	LOW**
ENGINEERED BARRIER PROPERTIES		
Shaft DRZ permeability	MEDIUM	MEDIUM
Backfill porosity	LOW	LOW
Backfill permeability	LOW	LOW
Degree of backfill compaction	LOW	LOW
Backfill reconsolidation	LOW	LOW
Clay seal member permeability	MEDIUM	MEDIUM
Concrete seal member permeability	MEDIUM	MEDIUM
Asphalt seal member permeability	MEDIUM	MEDIUM
Seal residual gas saturation	LOW	LOW
Seal residual brine saturation	LOW	LOW
Seal pore shape	LOW	LOW
Long-term borehole permeability	HIGH	HIGH

* Spallings model development has resulted in a change in this parameter value.
** Spallings model development has resulted in the addition of this new parameter.

7.4 Measurable Parameters Related to Changes Since the CCA

Next, this reassessment identifies those parameters related to changes listed in Table 7.2 with those parameters having characteristics suitable to monitoring listed in Table 7.3. Table 7.4 lists the results of this intersection.

Table 7.4: Parameters Related to Measurable Disposal System Properties Also Related to Changes Since the CCA

Parameter	Significance to Containment	Significance to Verification
SALADO PHYSICAL PARAMETERS		
None		
SALADO HYDROLOGICAL PARAMETERS		
DRZ permeability	MEDIUM	MEDIUM
NON-SALADO HYDROLOGICAL PROPERTIES		
Culebra transmissivity	MEDIUM	MEDIUM
Culebra advective porosity	MEDIUM	MEDIUM
Culebra fracture spacing	HIGH	HIGH
Culebra diffusional porosity	MEDIUM	MEDIUM
Culebra longitudinal dispersivity	LOW	LOW
Culebra groundwater quantity	LOW	LOW
Culebra groundwater flux	MEDIUM	MEDIUM
Culebra groundwater spatial distribution	LOW	LOW
Culebra groundwater composition	LOW	LOW
Castile brine reservoir rock compressibility	HIGH	HIGH
Culebra change in groundwater flow	MEDIUM	MEDIUM
WASTE RELATED PARAMETERS		
Inundated steel corrosion rate with CO_2	LOW	LOW
Inundated steel corrosion rate without CO_2	MEDIUM	MEDIUM
Choice of oxidation state distribution	HIGH	HIGH
Solubility of nine radionuclides in Salado brine	HIGH	HIGH
Solubility of nine radionuclides in Castile brine	HIGH	HIGH
Effective shear resistance to erosion	MEDIUM	MEDIUM
Waste activity (used for WUF)	HIGH	HIGH
Waste tensile strength *	HIGH*	HIGH*
HUMAN ACTIVITY- RELATED PARAMETERS		
Drilling rate	HIGH	HIGH
Probability of encountering a Castile brine reservoir	MEDIUM	MEDIUM
Borehole plugging pattern (probability index)	LOW	LOW
Mud pump rate**	LOW**	LOW**
Drill penetration rate**	LOW**	LOW**
ENGINEERED BARRIER PROPERTIES		
Clay seal member permeability	MEDIUM	MEDIUM
Concrete seal member permeability	MEDIUM	MEDIUM
Asphalt seal member		

Parameter	Significance to Containment	Significance to Verification
permeability	MEDIUM	MEDIUM
Long-term borehole permeability	HIGH	HIGH

* Spallings model development has resulted in a change in this parameter value.
** Spallings model development has resulted in the addition of this new parameter.

7.5 Parameters Related to Compliance Monitoring Parameters

Any of the parameters listed in Table 7.4 that are also related to the ten COMPs will be evaluated further. The ten COMPs were listed previously in Table 2.1. Those parameters that are listed in both Table 2.1 and in Table 7.4 are listed below.

- Change in Culebra groundwater flow
- Probability of encountering a Castile brine reservoir
- Drilling rate
- Waste activity

The remainder of this reassessment will evaluate the impact that changes to these four parameters have on the conclusions of the MONPAR Analysis.

7.5.1 Change in Culebra Groundwater Flow

As stated in Section 3.3, Culebra water levels have been rising for several years. These monitoring results have prompted additional groundwater investigations. These investigations are ongoing and involve additional well drilling and hydrological testing. Culebra groundwater monitoring was derived from the MONPAR Analysis and has proven to be an important element of the WIPP operational monitoring program. The program continues to monitor Culebra groundwater to ensure that changes to important activities and conditions related to WIPP long-term performance are identified and addressed. Future results of the ongoing investigations may necessitate changes to the monitoring program however the current monitoring parameters have not changed.

Culebra monitoring as part of the COMPs program has identified increasing water levels and has consequently prompted additional groundwater investigations. These investigations confirm the selection of Culebra groundwater composition as a valid monitoring parameter and upholds the conclusions presented in the MONPAR Analysis. Changes in groundwater flow do not affect the conclusions drawn in the MONPAR Analysis.

7.5.2 Probability of Encountering a Castile Brine Reservoir

The probability of encountering a Castile brine reservoir has changed due to the EPA's PAVT. In the CCA, the DOE used a probability value of 0.08 based the value on a geostatistical study (Powers et al. 1996). In EPA's PAVT, the parameter PBRINE was changed from a constant value of 0.08 to a uniform distribution ranging from 0.01 to 0.60. This change was of little consequence to overall releases.

While the DBDSP continues to collect data for reported encounters with pressurized brine, it is very unlikely that a probability approaching that required by the EPA will ever be observed. Nonetheless, this parameter will continue to be monitored as part of the COMPs and the DBDSP. Furthermore, the change in this parameter does not affect the conclusions of the MONPAR Analysis.

7.5.3 Drilling Rate

As stated in Section 3.1, the drilling rate has increased since the CCA from 46.8 to 52.5 boreholes per square kilometer per 10,000 years. While the drilling rate has gradually increased during the past three years of compliance monitoring, the increase is not unexpected, nor is it unexplained. The increase is largely due to the prescribed manner in which the drilling rate is computed, whereas the previous 100 years drilling is used to arrive at a predicted rate. Understandably, the "rolling 100-year window" is very sparsely populated with incidences of drilling during the first 20-30 year period because the oil industry was in its very early stages of development, as was the Delaware Basin as a prospective oil reserve. Conversely, during recent years, drilling has been quite active in the Delaware Basin thereby adding many more wells into the 100-year total count than those that drop out of the early part of the 100-year time-period. Based on the data population of the 100-year time period, the drilling rate will continue to increase or will not fall below the rate used in the CCA for many years, perhaps beyond the closure of the WIPP. Nonetheless, this rate will continue to be monitored, as it is also an important PA parameter used in compliance calculations.

The change in this rate does not invalidate or affect the conclusions in the MONPAR Analysis. To the contrary, and as is the case with Culebra groundwater monitoring, this increase in drilling rate confirms the selection of drilling rate as an important compliance monitoring parameter.

7.5.4 Waste Activity

The WUF is a function of projected disposal inventory as used in performance assessment, and is the primary driver for the Waste Activity COMP. Because disposal inventory is based on DOE system-wide estimates and projections, it is subject to change based on department goals, objectives, and policy. Therefore, changes in the inventory are expected, and cause a commensurate change in the WUF as used in performance assessment. As such, changes in the WUF do not affect the conclusions drawn in the MONPAR Analysis related to waste activity. To the contrary, fluctuations in projected inventory confirm the need to continue to monitor actual waste activity as disposed in the WIPP.

7.6 Evaluation of Other Changes

The representation of spalling in PA changed during the WIPP certification process as a result of peer review conclusion. Since the CCA, a new spallings model has been developed. Some of the parameters used in the MONPAR analysis are related to the original spallings model, although they are not related to any of the 10 selected COMPs. As stated in Section 5, the new CRA spallings model does not use the same parameter set and therefore some parameters in CCA Attachment MONPAR of Appendix MON are affected. Specifically, the gravity correction factor and the strength correction factor for spallings are no longer used in PA. Two additional parameters have been added: mud pump rate and drill penetration rate. These two new parameters rank as low for significance to containment and verification. The waste tensile strength parameter has been changed from medium to high significance. This parameter cannot be directly monitored since the properties of the waste in the repository do not evolve into the conditions that are modeled for several hundred years, therefore it does not meet the criteria for monitoring specified by the EPA. As such, it does not affect the conclusions drawn in the MONPAR analysis.

As stated in Section 5, the representation of panel closures in PA has changed since the 1996 PA. The CRA PA specifically models the Option D panel closure design (see Chapter 6, Section 6.4.3 and DOE [1996: Appendix PCS]). The materials used in the closure have not changed. With respect to the closures, the MONPAR analysis determined that the exothermic reactions of the concrete in the closures were not significant. The conclusions in the MONPAR analysis have not been impacted due to the change in panel closure representation because no other closure parameters were included in the analysis.

8 CONCLUSIONS

Changes to the WIPP compliance basis have occurred since the submittal of the CCA. These changes can originate from regulatory, experimental, operational, and monitoring program sources. For example, some changes evaluated in this report were due to EPA-mandated deviations to parameters, models, codes, and assumptions and are generally comprised within the PAVT and final certification ruling (EPA 1998). Other changes are due to specific requests made by the DOE to deviate from conditions as described in the CCA. These requests are typically of an operational nature. Finally, some changes originate from experimental program activities or from the compliance monitoring program itself. Changes from all of these sources have been identified and reviewed against the conclusions drawn in the original MONPAR Analysis. The primary purpose of the review was to determine if any of these changes impact the conclusions of the initial MONPAR Analysis. Some studies such as the hydrologic model development and Culebra investigations may provide information that would be useful if another MONPAR Analysis were conducted, but will likely serve to *reduce* monitoring efforts. It is not the intent of this reassessment to reduce or alter the current Compliance Monitoring Program. This reassessment is intended only to determine whether the initial MONPAR Analysis continues to be suitable for use in the CRA given the changes to the baseline since the CCA. A complete revision of the MONPAR Analysis would likely be considered a significant change to the certification basis and therefore inappropriate for inclusion in the CRA. Therefore, after identifying applicable changes to the WIPP compliance basis and considering any effects they may have on the conclusions drawn in the initial MONPAR Analysis, this reassessment concludes that the MONPAR Analysis is not impacted and is adequate for the recertification application – the original analysis conclusions are unchanged.

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536610

date: September 2, 2004

to: Memo of Record

from: G. Ross Kirkes, MS-1395 (6821) GRK

subject: Explanation of Deviation from Analysis Plan AP-109

The purpose of this memorandum is to provide an explanation to deviation from Sandia National Laboratories Carlsbad Programs Group Analysis Plan AP-109.

Description of Deviation

Section 2.2 of AP-109 states that, "A final report shall be completed by September 12, 2003." The subject report, "MONPAR Assessment" (ERMS# 533098) was completed per AP-109, but was not completed until December 5, 2003.

Explanation for Deviation

The schedule was impacted by an unexpected increase in work load of key personnel necessary to conduct the MONPAR Assessment. Additional activities supporting the Department of Energy's initiative to emplace supercompacted waste from the Idaho National Engineering and Environmental Laboratory required a reprioritization of work efforts related to the MONPAR Assessment. As such, the completion of the MONPAR Assessment was delayed.

Impact of Deviation

There is no impact to other work products or deliverables associated with this delay.

Copy to:

MS-1395	M. Chavez (6820)
MS-1395	Department 6821 Day File
MS-1395	D. Kessel (6821)

WIPP:1.2.4:PA:QA-L:Pkg 530162;attach to 533098