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Sandia National Laboratories
Waste Isolation Pilot Plant

Reassessment of MONPAR Analysis for Use in the 2019 Compliance Recertification Application

Revision 0

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1 Introduction

This report documents a reassessment of the 40 CFR §194.42 (U.S. EPA 1996) compliance certification analysis used to determine repository performance monitoring parameters. The Compliance Certification Application (CCA; U.S. DOE 1996) contains an analysis which was used to fulfill the regulatory requirement at 40 CFR §194.42. This analysis was documented in CCA Appendix MON, Attachment MONPAR (termed the MONPAR analysis). Information from the MONPAR analysis was used to determine what monitoring parameters should be included in a monitoring program to address Environmental Protection Agency (EPA) requirements. The Department of Energy (DOE) is required by the Land Withdrawal Act (U.S. Congress 1996) to demonstrate continued compliance with the EPA's disposal standards. DOE is developing the fourth Compliance Recertification Application (CRA-2019) to document WIPP's continue compliance with the EPA standards. A reassessment was made of MONPAR at the time of the second CRA (Wagner 2013) and was performed under SP 9-8 (Wagner 2017). Similarly, a reassessment is again needed for the fourth recertification application.

Reassessments of MONPAR are necessary to demonstrate continued compliance with the EPA's monitoring requirements at 40 CFR §194.42. Since the CCA, changes in activities and conditions have occurred within the WIPP project that could potentially impact the conclusions in the original MONPAR analysis. This reassessment report developed a list of potential elements that may impact the monitoring program and assesses them against the conclusions in the original MONPAR analysis (U.S. DOE 1996). This reassessment's objective is to determine one of three conclusions;

1. If the conclusions of the MONPAR Analysis remain valid and its conclusions continue to be adequate for inclusion in CRA;
2. If the conclusions of the MONPAR Analysis remain valid with minor modification; or
3. If the conclusions of the MONPAR Analysis are invalid and a new analysis is needed.

The results of the assessment outlined in the document determined that the original conclusions in MONPAR remain valid and its conclusions continue to be adequate for inclusion in the CRA-2019.

2 Assessment Approach

This analysis is performed under SP 9-8, *Monitoring Parameter Assessment per 40 CFR 194.42* (Wagner 2017). The objective of this reassessment is to determine the adequacy of continuing to use the CCA MONPAR analysis to meet the regulatory requirements of 40 CFR §194.42. The reassessment does this by assessing the impacts of changes that have occurred since the last recertification on the original MONPAR conclusions. The regulatory requirement for a monitoring analysis and the original MONPAR was reviewed to determine the processes and assumptions used to derive the MONPAR conclusions.

2.1 EPA Requirement for a MONPAR Analysis

The EPA requires the DOE to monitor repository performance as an assurance requirement. EPA's disposal standard 40 CFR §194.42 states (U.S. EPA 1996):

> (a) The Department shall conduct an analysis of the effects of disposal system parameters on the containment of waste in the disposal system and shall include the results of such analysis in any compliance application. The results of the analysis shall be used in developing plans for pre-closure and post-closure monitoring required pursuant to paragraphs (c) and (d) of this section. The disposal system parameters analyzed shall include, at a minimum:
>
> (1) Properties of backfilled material, including porosity, permeability, and degree of compaction and reconsolidation;
> (2) Stresses and extent of deformation of the surrounding roof, walls, and floor of the waste disposal room;
> (3) Initiation or displacement of major brittle deformation features in the roof or surrounding rock;
> (4) Ground water flow and other effects of human intrusion in the vicinity of the disposal system;
> (5) Brine quantity, flux, composition, and spatial distribution;
> (6) Gas quantity and composition; and
> (7) Temperature distribution.

2.2 Original MONPAR Approach

The original MONPAR analysis is documented in CCA Appendix MON (U.S. DOE 1996). The MONPAR analysis looked for potentially significant parameters used in PA that could be used in pre-closure and post-closure monitoring programs. Significant 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 term parameter is used in 40 CFR Part 194 to describe properties and processes in the disposal system. While this use is somewhat inconsistent with the DOE's use of parameters in the mathematical modeling system, the DOE has considered PA parameters, properties, and processes in the MONPAR analysis to satisfy the criteria of 40 CFR § 194.42. The original MONPAR analysis looked at PA parameters, modeling assumptions and current monitoring programs at WIPP for possible inputs. These inputs were qualitatively assessed against EPA's definition of significance. The analysis also considered the possibility of monitoring the parameter at WIPP. The results of the analysis were used in the CCA to propose an operational monitoring program using 10 parameters (CCA Chapter 7; Appendix MON; U.S. DOE 1996)(Compliance Monitoring Parameters – COMPs). As a result of the MONPAR analysis, the following parameters have been monitored in the COMPs program and included in an annual report since 1999.

1. Drilling Rate
2. Probability of Encountering a Brine Reservoir

3. Waste Activity
4. Subsidence
5. Changes in Groundwater Flow
6. Change in Groundwater Composition
7. Creep Closure
8. Extent of Deformation
9. Initiation of Brittle Deformation
10. Displacement of Deformation Features

3 Assessment for CRA-2019

The objective of this current assessment is to determine if elements of the WIPP program that have changed since the last recertification affect the "parameters" used in the MONPAR analysis. Specifically, the PA work performed by SNL that captures the changes introduced since the CRA-2014 (U.S. DOE 2014) was reviewed to determine the impact on the original MONPAR analysis. The process first determines which changes could be considered in this reassessment, and then determines the impact of these changes on the conclusions drawn in the CCA MONPAR Analysis. Changes from the following disposal system elements were evaluated for any impacts to the CCA MONPAR analysis:

1. Monitoring Results
2. Experimental Activities
3. Performance Assessment Changes – Methodology/Parameters/Implementation
4. WIPP Operational Changes
5. Proposed changes to activities and conditions approved by the EPA

3.1 Monitoring Results

There have been five annual COMPs reports since the last reassessment. These include:

Wagner and Kuhlman 2013	COMPS 2013
Wagner and Kuhlman 2014	COMPS 2014
Wagner and Thomas 2016a	COMPS 2015
Wagner and Thomas 2017	COMPS 2016
Wagner and Hayes 2018	COMPS 2017

A review of the conclusions in these annual COMPs reports show:

- Results of the COMPs assessments concluded that there were no reportable conditions or events during their reporting periods.
- The WIPP underground fire and the unrelated release events occurred in early February of 2014. Since the underground was not accessed for a period after these events, not all activities of the WIPP geoscience program were performed during the COMPs reporting periods for 2015 to 2017. Similarly, no waste was emplaced after these incidences until January of 2017. No other COMP was impacted as a result of the

February 2014 events. The COMPs program has not identified unexpected conditions after resumption of the impacted programs.

The COMPs reports did not recommend changes to the monitoring parameters. As a result of this review, no issues were identified that effect the conclusion of the original MONPAR analysis.

3.2 Experimental Activities

3.2.1 SNL

WIPP-relevant experimental activities performed by Sandia National Laboratories (SNL) include hydrology investigations, Iron (Fe) and Lead (Pb) chemistry experiments, room closure and waste compaction analyses. The following sections describe these activities and their impacts on MONPAR conclusions.

3.2.1.1 Hydrology Investigations

The SNL hydrology program continues to investigate regional groundwater conditions to support flow and transport modeling in CRA performance assessments. These activities are described in the following Analysis Plans:

AP-150	Analysis Plan for the Analysis of Observed Water Level Fluctuations
AP-160	Analysis Plan for Hydrologic Data Report Development

These investigations are ongoing. The current COMPs include assessment of groundwater flow and composition. Data from groundwater well monitoring is used in these assessments and also in the ongoing hydrology investigations. Because the original COMPs assessments identified issues that initiated the current hydrology investigations, the original conclusion to monitor groundwater flow and composition have been validated. The hydrology studies have resulted in changes to the groundwater flow and transport models used in the CRA-2014 PA. Changes were made to the derivation and trigger value for the Change in Culebra Groundwater Flow COMP (Wagner and Thomas 2016b). These changes refined the COMP but did not change the monitoring parameter.

Monitoring Culebra groundwater levels continues. Data since 2006 show stable to declining water levels in the context of the end of the long-term rises observed in most wells (which approximately ended in 2008). The latest assessment of Culebra water level changes and the impacts of groundwater pumping and precipitation is found in Kuhlman and Corbet 2017. No new hydrological data was used in the CRA-2014, the same T-field information from the CRA-2009 PABC was used. As such, recent groundwater investigations have not impacted the groundwater COMPs and no recommendations have been made to change the compliance monitoring program.

3.2.1.2 Chemical Conditions Experiments

The SNL experimental programs continue to investigate the long-term chemical conditions expected after repository closure. These activities are described in the following analysis plans.

AP-167	Analysis Plan for the Evaluation of Humic-Actinide Complexation for WIPP Conditions
AP-172	Analysis Plan for Experimental Investigations of Absence or Presence of Mineral Fragments Colloids in the GWB and ERDA-6 Brines Under the WIPP Relevant Conditions at Sandia National Laboratories Carlsbad Facility
AP-176	Analysis Plan for the Development of a Self-Consistent Extension of the WIPP Geomechanical Thermodynamic Database that Includes Aqueous Ferrous Iron Chemistry

The impacts of Fe, Colloids and Mineral Fragments in PA are addressed through chemical condition assumptions and specific parameters. With respect to chemical conditions in the repository, the original MONPAR stated,

> *"The closed repository will not achieve the long-term chemical conditions (brine composition, dissolved actinide concentrations, or colloidal actinide concentrations) used in performance assessment during the operational or active control periods. Therefore, monitoring the [repository] chemical conditions will not provide relevant information or verify assumptions used in performance assessment. Chemical conditions in the repository cannot be monitored after decommissioning without jeopardizing repository integrity. Thus these parameters will not be monitored during the operational period nor during the post-closure periods…. ".*

There are Colloid and Fe-related parameters in PA that were changed in the CRA-2014 as a result of the experimental programs. However, these changes are refinements to the parameters and have not impacted the original conclusions in the MONPAR analysis because these experimentally derived conditions cannot be explicitly monitored in the repository.

3.2.1.3 Room Closure and Geomechanical Studies

The SNL experimental programs continue to investigate the long-term behavior of salt creep and room closure at WIPP. These activities are described in the analysis plan:

AP-178	Reconsideration of the WIPP Geomechanical Model for Room Closure

Current monitoring in CMP include techniques that monitor creep closure in the WIPP. These include closure rates in the drifts and waste rooms, fracture and observation borehole monitoring. Analyses of past and future monitoring and experimental results from this analysis plan may lead to changes to the current CMP. However, these room closure analyses have not progressed to a point where such changes can be identified. No analysis reports have been completed prior to the CRA-2019 cutoff date of December 31, 2018.

3.2.1.4 Waste Compaction Studies

The SNL experimental programs also investigates the expected long-term behavior of emplaced waste. These activities are described in analysis plan:

AP-180 Analysis Plan for the Development of a Model for the Compaction Behavior of Emplaced WIPP Waste

These studies use surrogate waste intended to represent degraded waste in the repository hundreds to thousands of years after closure. These studies do not impact the MONPAR conclusions for the same reasons discussed in Section 3.2.1.2 in that these experimentally derived conditions cannot be monitored in the repository.

3.2.2 LANL

WIPP-relevant actinide/brine chemistry and microbial experiments continue to be performed by the Los Alamos Actinide Chemistry and Repository Science Program (ACRSP) team. These research programs are briefly described in the following sections along with their potential impacts on MONPAR and expected input to PA.

3.2.2.1 Actinide/Brine Chemistry Investigations

The overall goal of the actinide/brine chemistry research is to perform experiments that establish/confirm the solubility, speciation, oxidation state distribution, and colloidal contribution of actinides to the mobile actinide source term used in WIPP PA. This research has focused on actinide/analog solubility in simulated brine systems. Additionally, the redox effects of iron on multivalent actinides as well as more fundamental studies in simplified brine systems are being conducted. These studies, altogether, are designed to confirm the WIPP modeling approach and quantify the extent of conservatism in current predictions. The following Test Plans govern this research.

LCO-ACP-02 - Solubility/Stability of Uranium (VI) in WIPP Brines
LCO-ACP-03 - Solubility of Neodymium (III) in WIPP Brines
LCO-ACP-04 - Plutonium (VI) Reduction by Iron: Limited-Scope Confirmatory Study,
LCO-ACP-05 - Plutonium Speciation and Solubility in the WIPP
LCO-ACP-06 - Americium Solubility/Stability in WIPP Brine
LCO-ACP-07 - Effect of Acetate, Citrate, EDTA, Oxalate and Borate Ions on Neodymium Solubility in WIPP Brine
LCO-ACP-11 - WIPP Actinide-Relevant Brine Chemistry
LCO-ACP-22 – Actinide Sorption Under WIPP-Relevant Conditions

The original MONPAR recognized actinide solubilities as the key contributor to the mobile actinide source term used in PA for calculating release in DBR release and past sensitivity analysis have confirmed the importance of actinide solubility uncertainties on long-term repository performance (Kirchner 2008 & Kirchner 2013). Because the experimental program addresses the long-term conditions in the repository after closure, operational monitoring programs cannot be used to directly confirm PA solubility parameters. As stated in the original MONPAR and quoted in Section 3.2.1, the closed repository will not achieve the long-term chemical conditions modeled in performance assessment during the monitoring time period such that these conditions cannot be

monitored. Although the results from these studies are used to validate PA assumptions, they are not expected to impact the original MONPAR conclusions.

3.2.2.2 Microbial Investigations

Microbial processes can impact repository performance in that they degrade organic waste to generate gas and can impact the mobile actinide source term by forming biocolloids. Research to establish the indigenous microbial ecology and the potential impacts of microbial processes on gas generation under repository-relevant conditions and the oxidation-state distribution (bio-reduction or oxidation) and bio-association (sorption and uptake) or actinides is ongoing and continues. These are described in the following Test Plan:

LCO-ACP-12 - Microbial Interactions in the Waste Isolation Pilot Plant (WIPP)

Microbial degradation of cellulose, plastics and rubber waste materials is an important element in PA and impacts gas generation in both the unsaturated and post-saturation phase of the WIPP. Microbial impacts on the mobile actinide source term only impacts the longer-term post-saturation PA release calculations in DBR release scenarios. There are no significant changes to the original MONPAR conclusions from these studies.

3.3 Performance Assessment Changes

The CRA-2014 PA is the current compliance PA baseline. No new PA is planned for the CRA-2019 submittal such that there are no PA changes to assess.

3.4 Operational changes to activities and conditions approved by the EPA

For the period between the CRA-2014 and the CRA-2019, the most significant operational change at WIPP include a planned change notice for a new ventilation shaft and associated drifts. While the change is planned and activities to characterize the shaft have occurred, actual construction will not occur for some time. The preliminary designs of the shaft and drifts are similar to the existing mine workings and are not expected to be significantly different than the existing mine workings. The current geotechnical monitoring program will be applied to any new mine workings. Therefore no impact is expected to the current monitoring program or to the basis of the original MONPAR analysis.

4 Conclusion

A review of the original MONPAR results was made using SP 9-8. Based on the review of activities, conditions and experimental programs that occurred since the CRA-2014, this reassessment concludes that: the conclusions of the MONPAR Analysis remain valid and its conclusions continue to be adequate for inclusion in the CRA-2019.

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