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SANDIA NATIONAL LABORATORIES
WASTE ISOLATION PILOT PLANT

AP-169
Revision 0

Analysis Plan for the Impact Assessment of an Additional WIPP Shaft

Task 4.4.1.2.1

Effective Date: September 17, 2014

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1 Introduction and Objectives

The Waste Isolation Pilot Plant (WIPP), located in southeastern New Mexico, has been developed by the U.S. Department of Energy (DOE) for the geologic (deep underground) disposal of transuranic (TRU) waste. Containment of TRU waste at the WIPP is regulated by the U.S. Environmental Protection Agency (EPA) according to the regulations set forth in Title 40 of the Code of Federal Regulations (CFR), Part 191. The DOE demonstrates compliance with the containment requirements according to the Certification Criteria in Title 40 CFR Part 194 by means of performance assessment (PA) calculations performed by Sandia National Laboratories (SNL). WIPP PA calculations estimate the probability and consequence of potential radionuclide releases from the repository to the accessible environment for a regulatory period of 10,000 years after facility closure. The models used in PA are maintained and updated with new information as part of an ongoing process. Improved information regarding important WIPP features, events, and processes typically results in refinements and modifications to PA models and the parameters used in them. Planned changes to the repository and/or the components therein also result in updates to WIPP PA models. WIPP PA models are used to support the repository recertification process that occurs at five-year intervals following the receipt of the first waste shipment at the site in 1999.

The recent radiological release event at the WIPP site has temporarily halted waste emplacement activities at the facility. A modified ventilation system is envisioned that will provide sufficient airflow necessary for the resumption of full-rate disposal operations in the future. A primary component of the modified ventilation system is an additional exhaust shaft in the north end of the repository. This analysis plan develops the approach used to quantify the impact of the additional shaft on long-term performance of the repository.

2 Approach

Repository shafts have been included in WIPP performance assessment as a feature of the repository since the original Compliance Certification Application (DOE 1996). To date, repository shafts have yielded no releases that impact long-term performance of the facility when included in WIPP PA. To be clear, WIPP PA demonstrates repository performance from facility closure to 10,000 years after closure. The recent radiological release at the site impacts current operational aspects of the facility, but is outside the scope of WIPP PA. However, repository design changes made to allow for the resumption of waste disposal at the site potentially comprise features of the repository that must be included in PA. An additional exhaust shaft is such a feature.

There are four shafts currently in the repository north end, namely a salt handling shaft, an exhaust shaft, a waste shaft, and an air intake shaft. These shafts are combined into a single shaft in WIPP PA that captures the combined impacts of all of them. An additional exhaust shaft is envisioned as a component of the WIPP recovery effort (see Attachment 1). The proposed additional exhaust shaft will be combined with the four existing shafts in this analysis to determine its impacts (if any) on long-term repository performance. Moreover, mined volume in

the repository north end will be modified in the repository representation so as to include additional drifts created to access the new shaft. The dimensions used for the additional shaft are a 14 foot diameter and a height of 2150 feet. It is assumed that two drifts will be necessary to access the new shaft. Each drift will be modeled as being 42 feet wide, 13 feet high, and 2,640 feet (½ mile) long (see Attachment 2). The additional shafts are assumed to connect to the current repository operations area. The shaft and drift dimensions are taken from the preliminary WIPP recovery plan, which includes a discussion of ventilation modifications necessary for the resumption of waste disposal at the facility. The proposed new shaft and associated drifts are similar to those that currently exist in the repository.

The addition of an exhaust shaft to the repository model used in WIPP PA has the potential of altering calculated brine and gas flow behaviors. The PA code BRAGFLO is used to quantify flow characteristics, and so will be used to ascertain changes to repository performance due to the additional shaft and associated drifts. BRAGFLO provides flow results for the undisturbed repository as well as several disturbance scenarios used to represent inadvertent human intrusion after facility closure. The six scenarios modeled by BRAGFLO are shown in Table 1.

Table 1: BRAGFLO Modeling Scenarios

Scenario	**Description**
S1-BF	Undisturbed Repository
S2-BF	E1 intrusion at 350 years
S3-BF	E1 intrusion at 1,000 years
S4-BF	E2 intrusion at 350 years
S5-BF	E2 intrusion at 1,000 years
S6-BF	E2 intrusion at 1,000 years; E1 intrusion at 2,000 years.

The most recent PA done to demonstrate WIPP regulatory compliance is that performed for the CRA-2014 (DOE 2014). The CRA-2014 PA considered four distinct cases, of which two potentially impact gas and brine flow behaviors calculated by BRAGFLO. Detailed descriptions of the four cases considered in the CRA-2014 PA can be found in Camphouse (2013), with a summary of results given in Camphouse et al. (2013). The four cases considered in the CRA-2014 PA are shown in Table 2. In that table, CRA-2014 PA modifications with red font are those that can have a direct impact on results calculated with BRAGFLO. The BRAGFLO repository representation used in the CRA-2014 PA will be modified to include the additional exhaust shaft and mined volume associated with its access drifts. For this analysis, BRAGFLO calculations will be performed for CRA-2014 cases CRA14-BL and CRA14-0 with the additional exhaust shaft and access drift volume included in the repository representation. Calculations corresponding to case CRA14-BL will be denoted as SHFT14-BL in this analysis. Similarly, calculations corresponding to case CRA14-0 will be denoted as SHFT14-0. The number of calculations listed in Table 2 for cases CRA14-BL and CRA14-0 will be used for cases SHFT14-BL and SHFT14-0, respectively, over the six scenarios listed in Table 1.

Table 2: Cases Considered in the CRA-2014 PA

CRA-2014 PA Cases				
	Case CRA14-BL	Case CRA14-TP	Case CRA14-BV	Case CRA14-0
CRA-2014 PA changes included	**Replacement of Option D PCS with the ROMPCS** **Inclusion of additional mined volume in the WIPP experimental area** **Updated WIPP waste inventory parameters** Updated radionuclide solubilities and uncertainty, colloid parameters Updated drilling rate and plugging pattern parameters	Replacement of Option D PCS with the ROMPCS Inclusion of additional mined volume in the WIPP experimental area Updated WIPP waste inventory parameters Updated radionuclide solubilities and uncertainty, colloid parameters Updated drilling rate and plugging pattern parameters BOREHOLE:TAUFAIL and GLOBAL:PBRINE parameter distribution refinements	Replacement of Option D PCS with the ROMPCS Inclusion of additional mined volume in the WIPP experimental area Updated WIPP waste inventory parameters Updated radionuclide solubilities and uncertainty, colloid parameters Updated drilling rate and plugging pattern parameters BOREHOLE:TAUFAIL and GLOBAL:PBRINE parameter distribution refinements Variable Brine Volume Implementation	**Replacement of Option D PCS with the ROMPCS** **Inclusion of additional mined volume in the WIPP experimental area** **Updated WIPP waste inventory parameters** Updated radionuclide solubilities and uncertainty, colloid parameters Updated drilling rate and plugging pattern parameters BOREHOLE:TAUFAIL and GLOBAL:PBRINE parameter distribution refinements Variable Brine Volume Implementation **Update to parameter STEEL:CORRMCO2** **Refinement to Repository Water Balance Implementation**
Number of replicates	1	1	1	3

3 FEPs Implications

An assessment of the Features, Events, and Processes (FEPs) baseline will be conducted to determine if the FEPs basis remains valid in consideration of the additional shaft and mined volume associated with its access drifts. The re-assessment will be performed according to SP 9-4, Performing FEPs Impact Assessment for Planned or Unplanned Changes. A discussion of the way FEPs are affected will be included in the summary report for this analysis.

4 Reports and Documentation

A single summary report will be generated as a result of this analysis plan. The summary report will present and discuss the gas and brine flow results obtained with BRAGFLO. It will also include a discussion of FEPs as they pertain to the additional shaft as well as a listing of run control for the calculations.

5 Tasks

The tasks, responsible personnel, and estimated task schedule are summarized below in Table 3.

Table 3: Task list and estimated schedule for the additional shaft impact analysis.

Task	Description	Guiding Document	Approximate Completion Date	Responsible Individual(s)
1	Shaft BRAGFLO Calculations	AP-169	09/24/14	J. Long
2	Shaft Impact Analysis	AP-169	10/15/14	C. Camphouse T. Zeitler
3	FEPS Implications	SP 9-4	10/15/14	R. Kirkes
4	Summary Report	AP-169	11/17/14	C. Camphouse R. Kirkes J. Long T. Zeitler

6 Software

The major WIPP PA codes to be used for this analysis are listed in Table 4. The execution of these codes for the analysis described herein comprises a compliance decision calculation. These codes will be executed on the WIPP PA Sun Blade Cluster, which is described in Table 5. Additionally, we may utilize COTS (Commercial off-the-shelf) software such as Mathematica®, Matlab®, Sigma Plot®, Mathcad®, Excel®, Access®, Grapher®, Python, or Kaleidagraph®, running on workstations. The use of any COTS application will be verified per NP 9-1 Appendix C as appropriate.

Table 4: Codes to be used for the Additional Shaft Impact Assessment

Code	Version	Build Date	Executable
ALGEBRACDB	2.36	11-SEP-2012	algebracdb.exe
BRAGFLO	6.03	01-FEB-2013	bragflo.exe
GENMESH	6.09	11-SEP-2012	genmesh.exe
ICSET	2.23	11-SEP-2012	icset.exe
MATSET	9.21	06-NOV-2012	matset.exe
POSTBRAG	4.02	10-JAN-2013	postbrag.exe
POSTLHS	4.08	05-MAR-2013	postlhs.exe
PREBRAG	8.03	23-JAN-2013	prebrag.exe
SUMMARIZE	3.02	31-OCT-2012	summarize.exe

Table 5: WIPP PA Sun Blade Cluster

Node	Hardware Type	CPU	Operating System
blackeyedpeas	Oracle Sun Blade X6260 M2	INTEL(R) XEON(R) CPU X5690	Solaris 11
blacksabbath	Oracle Sun Blade X6260 M2	INTEL(R) XEON(R) CPU X5690	Solaris 11
daveclark5	Oracle Sun Blade X6260 M2	INTEL(R) XEON(R) CPU X5690	Solaris 11
gratefuldead	Oracle Sun Blade X6260 M2	INTEL(R) XEON(R) CPU X5690	Solaris 11
ironmaiden	Oracle Sun Blade X6260 M2	INTEL(R) XEON(R) CPU X5690	Solaris 11
ledzepplin	Oracle Sun Blade X6260 M2	INTEL(R) XEON(R) CPU X5690	Solaris 11
pinkfloyd	Oracle Sun Blade X6260 M2	INTEL(R) XEON(R) CPU X5690	Solaris 11
vanhalen	Oracle Sun Blade X6260 M2	INTEL(R) XEON(R) CPU X5690	Solaris 11
greenday	Oracle Sun Blade X6260 M2	INTEL(R) XEON(R) CPU X5690	Solaris 11
zappa	Oracle Sun Blade X6260 M2	INTEL(R) XEON(R) CPU X5690	Solaris 11

7 Special Considerations

None

8 Applicable Procedures

All applicable WIPP QA procedures will be followed when conducting these analyses.

- Training of personnel will be conducted in accordance with the requirements of NP 2-1, *Qualification and Training*.
- FEPs assessment will be conducted according to SP 9-4, *Performing FEPs Impact Assessment for Planned or Unplanned Changes*.
- Analyses will be conducted and documented in accordance with the requirements of NP 9-1, *Analyses*.

- All software used will meet the requirements laid out in NP 19-1, *Software Requirements* and NP 9-1, as applicable.
- The analyses will be reviewed following NP 6-1, *Document Review Process*.
- All required records will be submitted to the WIPP Records Center in accordance with NP 17-1, *Records*.
- New and revised parameters will be created as discussed in NP 9-2, *Parameters.*

9 References

Camphouse, R.C. 2013. Analysis Plan for the 2014 WIPP Compliance Recertification Application Performance Assessment. ERMS 559198. Carlsbad, NM: Sandia National Laboratories.

Camphouse, R., D. Kicker, S. Kim, T. Kirchner, J. Long, B. Malama, T. Zeitler. 2013. Summary Report for the 2014 WIPP Compliance Recertification Application Performance Assessment. ERMS 560252. Carlsbad, NM: Sandia National Laboratories.

DOE (U.S. Department of Energy). 1996. Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant. DOE/CAO-1996-2184. U.S. Department of Energy, Waste Isolation Pilot Plant, Carlsbad Area Office. Carlsbad, NM.

DOE (U.S. Department of Energy). 2014. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant. DOE/WIPP-14-3503. U.S. Department of Energy, Waste Isolation Pilot Plant, Carlsbad Area Office. Carlsbad, NM.

Attachment 1

Camphouse, Russell Chris

From:	Dunagan, Sean
Sent:	Friday, August 22, 2014 5:41 PM
To:	Camphouse, Russell Chris
Cc:	Shoemaker, Paul E
Subject:	Fwd: [EXTERNAL] Recovery actions
Categories:	Red Category

Sent from my iPhone

Begin forwarded message:

From: "Basabilvazo, George - DOE" <George.Basabilvazo@wipp.ws>
Date: August 22, 2014 at 5:17:45 PM MDT
To: "Dunagan, Sean - SNL" <SDunaga@sandia.gov>, "Patterson, Russ - DOE" <Russ.Patterson@wipp.ws>
Subject: [EXTERNAL] Recovery actions

Sean,

I visited with Joe Franco this afternoon and he explained that the following is what he and Tom Tyner are expecting for Recovery PA PCN.

- Assume one shaft and two drifts located approximately one half mile to the west.

You may have already received this same/similar information from a different source and I just wanted to be sure you heard the CBFO expectation from CBFO. Russ will follow up with you if needed.

Thank you.

George T. Basabilvazo

Director, Environmental Protection Division

DOE/Carlsbad Field Office

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Carlsbad, New Mexico 88221

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Attachment 2

ESTIMATE BASIS URS

74.2 Bonds	Not required
74.3 Building Permits	Not included
74.4 Taxes	By Owner
75 First fills and Spare parts	Not included
80 Freight	Included to allow for shipping of all equipment and materials
94 Escalation	Not included, estimate based on 1st quarter 2014 pricing
92 Project Contingency	By Owner
92 Design & Construction contractor Overhead and G&A	Included as a percentage of entire project cost
95 Design & Construction contractor Fee	Included as a percentage of entire project cost, typical of an EPC execution philosophy

8. ALLOWANCES FOR VERTICAL SHAFTS AND HORIZONTAL DRIFTS

Vertical shafts and horizontal drifts based on Mine Cost Estimating software. Mine Cost Estimate prepared as pre-feasibility level estimate which provides guidance as to future evaluation efforts by advanced users.

- 2-14' dia x 2150 ft Vertical shafts includes basis of:

  Boring14' diameter ventilation raises (or shafts) partially through salt, sandstone, siltstone and other sedimentary units. Cost includes expense of lining the raise with concrete to a depth of 850' from the surface and for collecting and hauling all of the excavated material to the surface. Cost includes contractor markup and expenses associated with excavating a station for the cutter head. No allowance has been included for contaminated material.

- 4 Drifts (horizontal shafts) 13' x 42' w x 0.5 miles length includes the basis of:

  Drifts are based on continuous mining reflecting full suite of services. The drift is rock bolted. Excavated halite is collected by continuous miner and placed on conveyor, which transports it to a shaft station. The cut material is hoisted to the surface. Cost includes contractor markup and expenses associated with excavating a station for the cutter head. No allowance has been included for contaminated material.

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