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SANDIA NATIONAL LABORATORIES
WASTE ISOLATION PILOT PLANT

AP-151

Analysis Plan for the WIPP Panel Closure Redesign and Repository Reconfiguration Performance Assessment

Task 1.4.1.2

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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 are maintained and updated with new information as part of a recertification process that occurs at five-year intervals following the receipt of the first waste shipment at the site in 1999.

PA calculations were included in the 1996 Compliance Certification Application (CCA) (U.S. DOE 1996), and in a subsequent Performance Assessment Verification Test (PAVT) (MacKinnon and Freeze 1997a, 1997b and 1997c). Based in part on the CCA and PAVT PA calculations, the EPA certified that the WIPP met the containment criteria in the regulations and was approved for disposal of transuranic waste in May 1998 (U.S. EPA 1998). PA calculations were also an integral part of the 2004 Compliance Recertification Application (CRA-2004) (U.S. DOE 2004). During their review of the CRA-2004, the EPA requested an additional PA calculation, referred to as the CRA-2004 Performance Assessment Baseline Calculation (PABC) (Leigh et al. 2005), be conducted with modified assumptions and parameter values (Cotsworth 2005).

Since the CRA-2004 PABC, additional PA calculations were completed for the second WIPP recertification and documented in the 2009 Compliance Recertification Application (CRA-2009). The CRA-2009 PA resulted from continued review of the CRA-2004 PABC, including a number of technical changes and corrections, as well as updates to parameters and improvements to the PA computer codes (Clayton et al. 2008). To incorporate additional information which was received after the CRA-2009 PA was completed, but before the submittal of the CRA-2009, the EPA requested an additional PA calculation, referred to as the 2009 Compliance Recertification Application Performance Assessment Baseline Calculation (PABC-2009) (Clayton et al. 2010), be undertaken which includes the updated information (Cotsworth 2009). Following the completion and submission of the PABC-2009, the WIPP was recertified in 2010 (U.S. EPA 2010).

In addition to its role in certification decisions for the repository, performance assessment is used to determine the impacts of repository modifications proposed by the DOE as part of planned change requests (PCRs). Previous analyses have been performed to assess the impacts of modifications to the panel closure system (PCS) implemented in the repository. The 1998 rulemaking that certified WIPP to receive TRU waste had several conditions, one of which involved the design of the panel closure system. The EPA based its certification decision on the condition that the DOE implement the most robust panel closure design, referred to as the "Option D" design in the CCA (U.S. EPA 1998). In 2002, the DOE submitted a PCR to the EPA that proposed an alternate PCS design consisting of 100 foot run of mine salt backfill emplaced

against a 30 foot concrete block wall (Triay 2002). The DOE requested that SNL conduct an analysis to determine the impact of the redesigned PCS on the WIPP repository long term performance. SNL conducted their analysis using the PA baseline that was approved by the EPA and established by the PAVT (Hansen & Thompson 2002, Hansen 2002a, Hansen 2002b). The EPA determined that the change to the panel closure design would require a rulemaking, and so their review of the PCR was deferred until after the CRA-2004 certification decision. With the recertification of the WIPP in March of 2006 (U.S. EPA 2006), a new PA baseline was established by the CRA-2004 PABC. In January 2007, the DOE renewed their request for EPA approval of the 2002 panel closure PCR using the PA baseline that was established by the CRA-2004 PABC. In addition, the DOE requested a delay in permanent panel closure to allow for gas monitoring, through a substantial barrier, with the installation of the permanent closure depending on the results of the monitoring. The proposed monitoring was intended to develop an understanding of flammable gas generation rates in filled panels of waste in order to optimize the final panel closure design. The EPA agreed with the request to delay closure for gas monitoring. Sandia conducted an additional performance assessment, using the CRA-2004 baseline, and analyzed the impacts of the panel closure redesign proposed in the 2002 PCR on repository performance (Vugrin and Dunagan 2006). Following a June 2007 panel closure meeting between the New Mexico Environment Department, the EPA, and the DOE, the DOE withdrew the request to modify the panel closure design pending results of the gas monitoring and development of a final closure design.

With the recertification of the WIPP in November of 2010 (U.S. EPA 2010), a new PA baseline was established by the PABC-2009. Following the CRA-2009 recertification decision, the DOE plans to submit two PCRs to the EPA that propose changes to the repository. The first PCR is centered on a new redesign of the WIPP panel closure system. The panel closure redesign consisting of 100 feet of run of mine salt backfill and a 30 foot concrete block wall considered in the 2002 and 2007 planned change requests is to be modified to a configuration consisting of 100 feet of run of mine salt backfill emplaced against a steel bulkhead. The second PCR proposes the relocation of future waste panels 9 and 10 to the south end of the repository, i.e. south of panels 4 and 5, where they will be denoted as panels 9a and 10a. With panels 9 and 10 relocated, the current repository configuration will be modified to one with an open central drift area with installed panel closures located only at the end of filled waste panels. The DOE has requested that SNL conduct a single performance assessment to determine the overall impact of the repository changes proposed in the two PCRs. Impacts of these changes will be determined by way of a comparison of release probabilities to those calculated in the PABC-2009. This document details how SNL will conduct the compliance decision analysis for the panel closure redesign and repository reconfiguration performance assessment, henceforth referred to as the PC3R PA.

2 Approach

The PC3R PA analysis will be used to demonstrate compliance of the WIPP repository with the containment requirements according to the Certification Criteria in Title 40 CFR paragraph 194. A focused set of PA calculations will be executed to determine the impact of the repository changes being proposed. The results of PC3R calculations will be compared to those obtained in the PABC-2009. In order to isolate the impacts of repository changes, the PC3R PA is designed to deviate as little as possible from the PABC-2009 implementation. In particular, PC3R will

utilize the same waste inventory information, drilling rate and plugging pattern parameters, and radionuclide solubility parameters as were used in the PABC-2009. The PC3R PA will examine all aspects of repository performance that are potentially impacted by the proposed changes to the repository.

The approach used for the PC3R PA will be very similar to that used for PABC-2009 (Clayton 2009). Performance assessment begins with a determination of the features, events, and processes (FEPs) that could occur at the WIPP site during the 10,000 years following facility closure. The FEPs are screened to determine which of them will be accounted for in a particular PA. These "screened-in" FEPs are described by conceptual models that, taken together, provide an overall descriptive model of the facility. Scenarios that describe potential future conditions in the WIPP are formed from logical groupings of retained FEPs. The scenario development process results in a probabilistic characterization for the likelihood of different futures that could occur at the repository. Using the retained FEPs, process models are developed that provide quantitative descriptions of WIPP conceptual models. Performance assessment utilizes these process models, with corresponding numerical implementations, to calculate probabilities of cumulative radionuclide releases to the accessible environment over a 10,000 year regulatory period. Uncertainties associated with future events and parameters used in the calculation of cumulative release probabilities are quantified and included in computed results.

The following sections detail the implementation of the PC3R PA with particular attention being given to the way proposed repository and panel closure design changes will be captured in individual PA codes and parameters.

2.1 Repository Reconfiguration

A schematic that depicts the WIPP spatial layout as it has been modeled in PA is shown in Figure 1. As seen in that figure, the waste disposal region consists of 10 waste panels. Panels 1-4 are located east of the central area with panels 5-8 located to the west. Panels 9 and 10 are located in the center area between panels 1-4 and panels 5-8. Additionally, panel closures are located at the innermost ends of panels 1-8. A set of panel closures is located between waste panels 9 and 10. Another set of closures is located between panels 1-10 and the southern end of the operations region. A final set of closures is located in the operations region south of the repository shafts. These locations of waste panels and panel closures have been implemented in the models used in performance assessments since the original CCA, including the PABC-2009.

The changes proposed to the repository configuration that will be modeled in the PC3R PA are aimed at relocating panels 9 and 10, eliminating panel closures in the central area, and redesigning the panel closures that remain. Panels 9 and 10 will be moved south of panels 4 and 5 in the PC3R PA and denoted as panels 9a and 10a. In effect, the waste area will be lengthened with duplicate copies of panels 4 and 5, and their corresponding panel closures, being located at the southernmost end of the repository. The resulting waste panel configuration will consist of panels 1-4, 9a east of the central area and panels 10a, 5-8 west of the center. Panels 1-8, 9a,10a will be modeled as having identical panel closures located at their innermost ends.

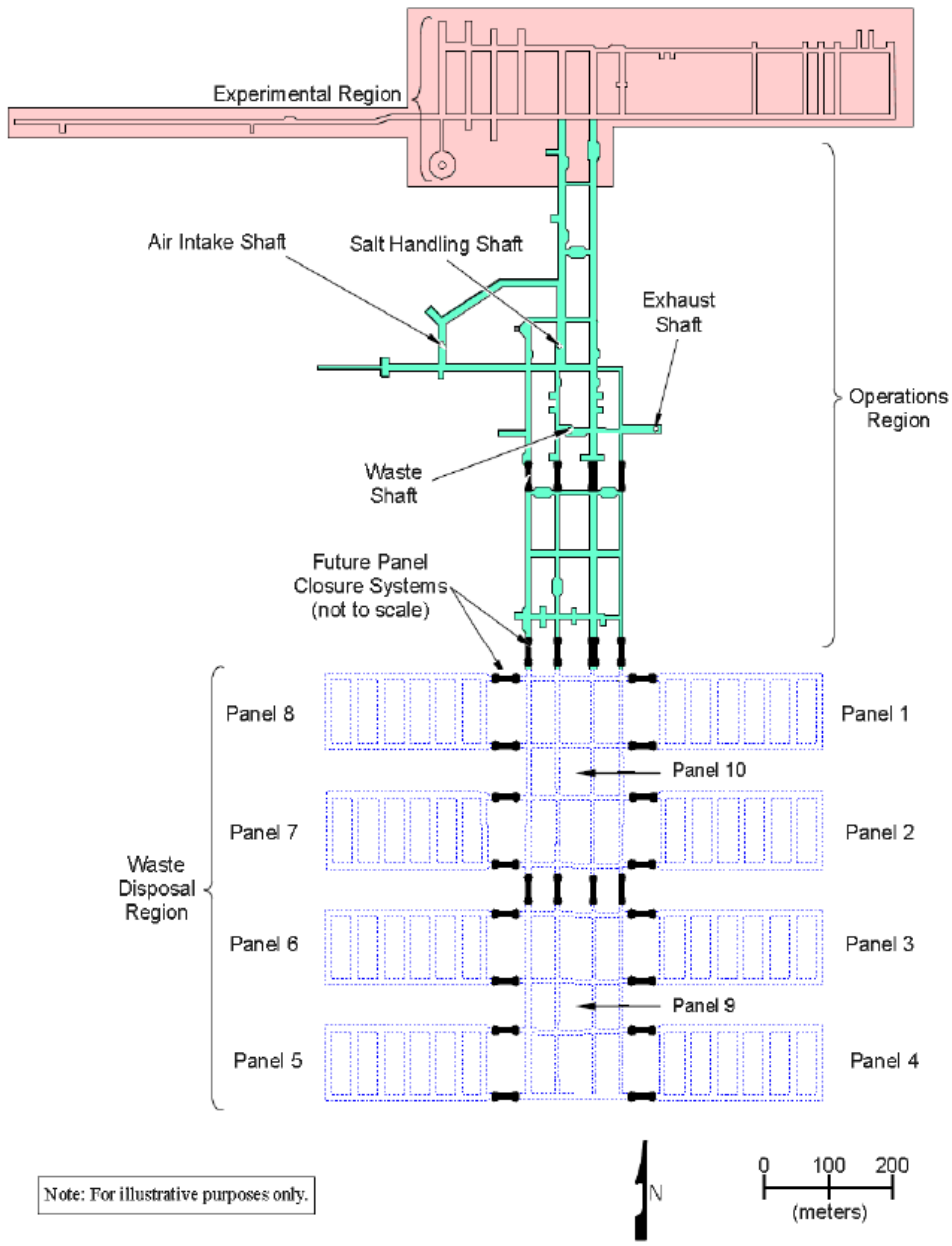

Figure 1: Historical WIPP Repository Layout

With the relocation of panels 9 and 10 to the southernmost end of the repository, panel closures located in the central area are proposed to be removed. Consequently, the set of panel closures located between current panels 9 and 10, between the waste disposal region and the operations area, and between the southern portion of the operations area and the repository shafts will be eliminated in the PC3R PA. With the panel closures in the center area removed, the central area in the PC3R PA will be modeled as a continuous open region. Finally, the PA representation of panel closures that remain for panels 1-8, 9a,10a will be modified. "Option D" panel closures were modeled in the PABC-2009, and are represented in Figure 1 by black segments at the ends of waste panels and at appropriate locations in the central drift area. Panel closures in the PC3R PA will be modeled to represent the new design consisting of 100 feet of run of mine salt

emplaced against a steel bulkhead. As the impact of the steel bulkhead on the long-term performance of the repository is minimal, PC3R panel closures will be modeled as consisting solely of 100 feet of run of mine salt. The reconfigured repository modeled in the PC3R PA is shown in Figure 2, where redesigned closures are depicted by oval segments at the innermost ends of waste panels.

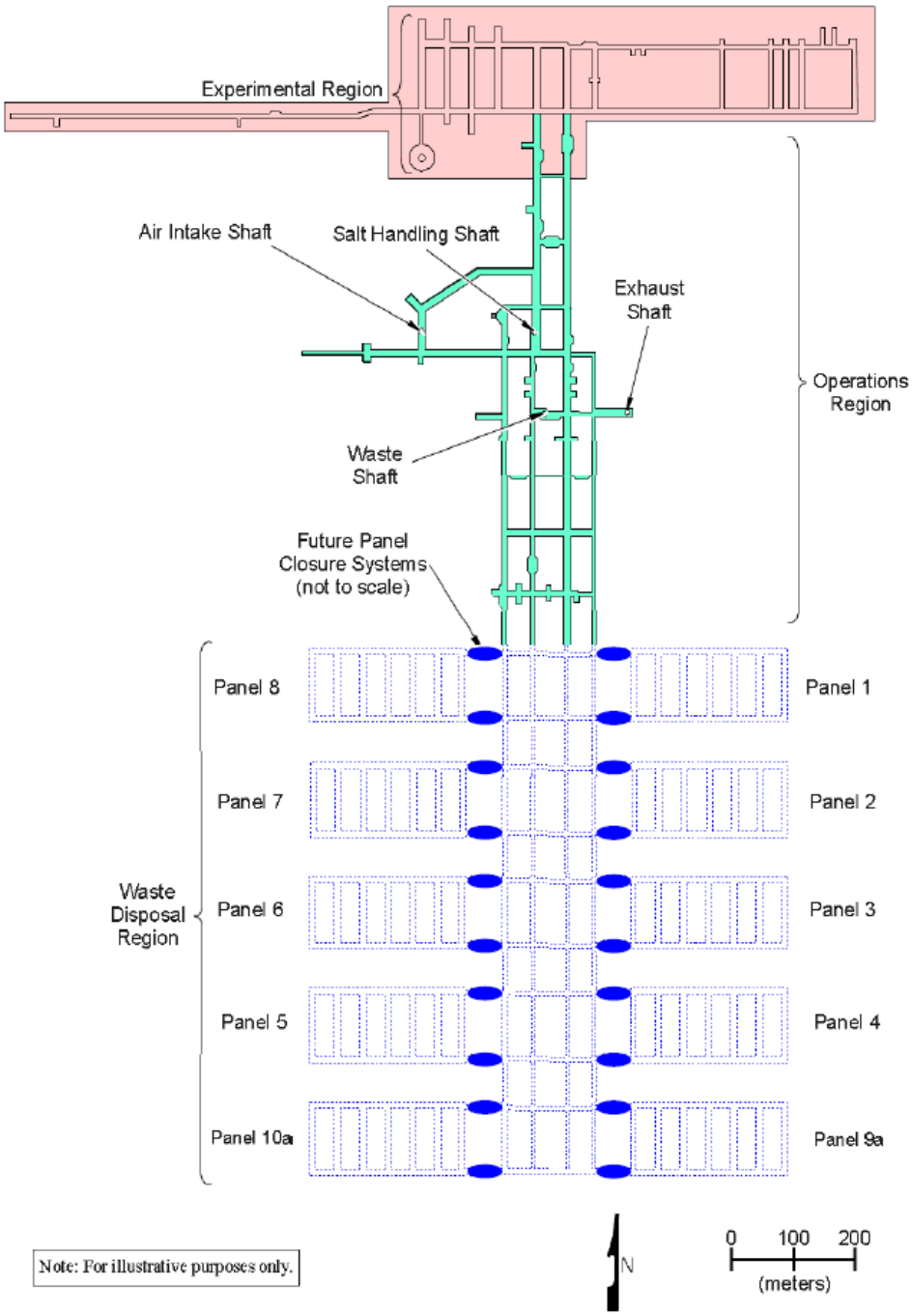

Figure 2: WIPP Layout Modeled in PC3R PA

2.2 Redesigned Panel Closure Model

The PC3R PA will replace the PABC-2009 representation of the Option D panel closure with a representation of the redesigned closure system. As the redesigned panel closures will be modeled as consisting of 100 feet of run of mine salt, the new panel closure system will have initial permeabilities and porosities that are significantly different than the permeabilities and porosities expected to be present for the vast majority of the 10,000 year regulatory timeframe. In particular, redesigned panel closures will have "short-term" initial characteristics and "long-term" characteristics. As a result, two materials will be used to describe the redesigned panel closures. This is similar to the approach taken in the panel closure redesign impact assessment performed in 2006 (Vugrin and Dunagan 2006). For simplicity, the same material names as were used in that analysis will be utilized in the PC3R PA. Material PCS_T1 is the material that will represent redesigned panel closures for the initial time period (to be determined). Material PCS_T2 will be used to represent closures for all time remaining in the 10,000 year regulatory period. Initial and long-term time periods will be selected to be consistent with the lengths of time required for the run of mine salt used in the closure redesign to reach steady-state permeability.

The effective permeability and porosity of the redesigned panel closures are the two parameters expected to have the greatest impact on calculations of pressure and brine saturation of the waste areas. Consequently, it will be necessary to establish permeability and porosity values that are representative of the redesigned closures for the materials PCS_T1 and PCS_T2. BRAGFLO calculations require additional property values for these materials. A list of properties to be established for materials PCS_T1 and PCS_T2 is given in Table 1.

Table 1: PCS_T1 and PCS_T2 Properties to be Used in the PC3R PA

Property	Description
CAP_MOD	Model number, capillary pressure model
COMP_RCK	Bulk Compressibility
KPT	Flag for Permeability Determined Threshold
PC_MAX	Maximum allowable capillary pressure
PCT_A	Threshold Pressure Linear Parameter
PCT_EXP	Threshold pressure exponential parameter
PO_MIN	Minimum brine pressure for capillary model KPC=3
PORE_DIS	Brooks-Corey pore distribution parameter
POROSITY	Effective porosity
PRMX_LOG	Log of intrinsic permeability, X-direction
PRMY_LOG	Log of intrinsic permeability, Y-direction
PRMZ_LOG	Log of intrinsic permeability, Z-direction
RELP_MOD	Model number, relative permeability model
SAT_RBRN	Residual Brine Saturation
SAT_RGAS	Residual Gas Saturation
SAT_IBRN	Initial panel closure brine saturation

Healing of the run of mine salt used in the redesigned panel closures is expected to have an impact on the disturbed rock zone (DRZ) directly above and below panel closures. As discussed in Hansen and Thompson (2002), the closure of the DRZ around the salt used in the panel closures will cause them to consolidate, stiffen, and apply back stresses on the surrounding DRZ. This will cause the DRZ surrounding panel closures to quickly heal. As a result, two different materials will be used to represent different states of the DRZ directly above and below panel closures in the PC3R PA. For an initial time period (to be determined), material DRZ_1 will represent the DRZ before it has healed. Following the initial time period, material DRZ_PCS will be used to represent the DRZ above and below panel closures for all time remaining in the 10,000 year regulatory period.

The need to perform additional modifications to the repository material mappings used in the PABC-2009 may become apparent during the execution of the PC3R PA, and these changes will be implemented as necessary.

Each of the repository changes to be captured in the PC3R PA impact a portion of the numerical models, and a subset of the implemented parameters, used in PA. In addition, they necessitate that a FEPs re-assessment be performed to determine the set of FEPs to consider in the PC3R PA.

2.3 FEPs Re-assessment

An assessment of the FEPs baseline will be conducted to determine if the FEPs basis remains valid in consideration of changes introduced by the PC3R PA, and 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 by the changes implemented in the PC3R PA and the effect on the screening determination for those FEPs will be documented in a report separate from the final summary report.

2.4 Calculation Methodology

As described above, the PABC-2009 parameters will be modified to represent the redesigned panel closures in place of the Option D design. The PC3R PA will consist of a full set of PA compliance calculations. That is, three replicates of PA calculations, each replicate consisting of 100 vectors, will be performed. The random seeds from the PABC-2009 will be preserved so that results from the PC3R PA analysis can be compared to those from the PABC-2009 on a vector-by-vector basis.

The structure of the calculations for the PC3R PA will be similar to that of the PABC-2009 (Clayton 2009). The calculations that are affected by the changes discussed above will be updated, while the results from previous PAs will be used for individual numerical codes not affected by these changes. The calculations to be conducted for the PC3R PA are listed below.

2.4.1 Parameters

The relocation of panels 9 and 10 to the southern end of the repository requires an update to parameter REFCON:VREPOS. In the current configuration, panels 9 and 10 have slightly different volumes than panels 1 – 8. Reference constant VREPOS will be updated to reflect that

panels 1-8, 9a, and 10a all have identical volumes in the new configuration. In addition, the value used for the permeability of material DRZ_PCS will be updated so that it is consistent with material properties of the redesigned panel closures. With the exception of the parameters mentioned in Section 2.2 and the two discussed in this section, the PC3R PA will use the same parameters and parameter values that were used for the PABC-2009 (Clayton 2009).

2.4.2 Parameter Sampling: LHS

Three replicates of 100 vectors will be created using the computer code LHS. The random seed and parameter ordering from the PABC-2009 will be used for the PC3R PA. Use of the PABC-2009 random seeds and ordering will result in identical sampled parameter values for parameters that are common to both the PABC-2009 and the PC3R PA. As a result, the PC3R PA can be compared with the PABC-2009 on a vector-by-vector basis.

Fifty-six subjectively uncertain parameters were sampled for the PABC-2009 (Kirchner 2010a). The sampling of parameter CELLULS:FBETA in PA calculations is unnecessary as methanogenesis has been removed from the microbial gas generation model (Nemer and Zelinski 2005). As a result, parameter CELLULS:FBETA will not be sampled in the PC3R PA. The same parameters sampled for the PABC-2009 will be sampled for the PC3R PA with the exception of CELLULS:FBETA and the CONC_PCS parameters. CONC_PCS parameters will be replaced with the corresponding PCS_T1 and PCS_T2 parameters (see Table 2). The code LHS version 2.42 will be used for the PC3R PA, which is the same code used for the PABC-2009.

Table 2: Sampled Parameters for the CONC_PCS and PCS_T1 and PCS_T2 Materials

MATERIAL:PROPERTY Sampled for the PABC-2009	MATERIAL:PROPERTY to be Sampled for PC3R PA
CONC_PCS:PRMX_LOG	PCS_T2:PRMX_LOG
CONC_PCS:SAT_RGAS	PCS_T1:SAT_RGAS
CONC_PCS:SAT_RBRN	PCS_T1:SAT_RBRN
CONC_PCS:PORE_DIS	PCS_T1:PORE_DIS

2.4.3 Inventory Calculations

Fox et al. (2009, 2010) give a comprehensive description of the projected inventory that was used for the PABC-2009. Because the inventory used for the PABC-2009 is the most recent baseline inventory, the PC3R PA will use this inventory in order to maintain comparability with the PABC-2009.

2.4.4 Salado Flow: BRAGFLO

The two-phase flow code BRAGFLO simulates the brine and gas flow in and around the WIPP repository and incorporates the effects of disposal room closure, gas generation, brine consumption, and inter-bed fracturing in response to gas pressure. The results of BRAGFLO scenarios S1-S5 are used as an input of the repository conditions for Salado radionuclide transport, direct brine releases (DBRs), and spallings releases. BRAGFLO scenario S6 is used for radionuclide transport to the Culebra, but is not used for DBR or spallings releases.

The panel closure redesign and repository reconfiguration significantly change the BRAGFLO computational grid that was used in the PABC-2009. In particular, Option D panel closures represented in the PABC-2009 BRAGFLO grid will be replaced by panel closures consisting of 100 feet of run of mine salt for the PC3R PA. Healing of the DRZ directly above and below redesigned panel closures as discussed in Section 2.2 will also be captured in PC3R PA calculations. Finally, the relocation of panels 9 and 10 to their 9a and 10a locations in the reconfigured repository, and the removal of panel closures in the central area, invoke additional changes in the BRAGFLO grid. The separation of panels 1-4, 9a and 10a, 5-8 by a continuous, open central area will be represented in the BRAGFLO grid used in the PC3R calculations. With these changes implemented in the grid, a complete suite of calculations will be run for the PC3R PA: 3 replicates, 100 vectors per replicate, and 6 scenarios (Table 3) per vector. With the exception of the redesigned panel closure parameters discussed in Section 2.2, the PC3R PA BRAGFLO calculations will use the same procedures that were used in the PABC-2009 BRAGFLO calculations. The codes PREBRAG version 8.0, BRAGFLO version 6.0 and POSTBRAG version 4.00A will be used for the PC3R PA, which are the same codes used for PABC-2009.

Table 3: WIPP PA BRAGFLO scenarios

Scenario	# of Drilling Intrusions	Time of Intrusion (Years)	Castile Brine Pocket encountered
S1	0 (Undisturbed)	NA	NA
S2	1	350	Yes
S3	1	1,000	Yes
S4	1	350	No
S5	1	1,000	No
S6	2	1,000 and 2,000	Only at 2,000

2.4.5 Actinide Mobilization: PANEL

The PANEL code calculates the quantities of actinides mobilized by colloids and as dissolved species in WIPP brines. PANEL uses actinide solubilities from the parameter database. As the PC3R PA will use the same inventory as was used for the PABC-2009 and no changes to the geochemistry conceptual model have been made, no new solubility calculations will be performed for the PC3R PA. The PC3R PA will use the same actinide solubilities and uncertainties that were used in the PABC-2009. However, the total volume of waste panels in the reconfigured repository modeled in the PC3R PA will be slightly different than that specified in the PABC-2009. This slight volume change may have an impact on actinide concentrations. As a result, the code PANEL version 4.03 will be used for the PC3R PA, which is the same code utilized to generate the actinide mobilization used for the PABC-2009.

2.4.6 Salado Transport: NUTS and PANEL

The WIPP radioisotope mobilization and decay code NUTS will be used to simulate the transport of radionuclides through the Salado Formation for scenarios S1 through S5. Since BRAGFLO results affect NUTS calculations, NUTS calculations will be run for the PC3R PA. With the exception of the updated parameters discussed in Section 2.2, the PC3R PA NUTS calculations

will use the same procedure that was used in the PABC-2009. The code NUTS version 2.05C will be used for the PC3R PA, which is the same code used for the PABC-2009.

Based on the characteristics of each drilling event, the intrusions were classified as no change (not significantly changing repository behavior), and E1 type (where the brine pocket is hit) or an E2 type (where the brine pocket is not hit). Radionuclide transport to the Culebra for the E1E2 intrusion combination (BRAGFLO scenario S6) is calculated by running the PANEL code in "intrusion mode" (PANEL_INT). PANEL_INT calculations will be run for the PC3R PA with the same procedure that was used in the PABC-2009 PANEL_INT calculations. The code PANEL version 4.03 will be used for the PC3R PA, which is the same code used for the PABC-2009.

2.4.7 Culebra Flow and Transport- MODFLOW and SECOTP2D

The same transmissivity fields as were developed in the PABC-2009 will be used for the PC3R PA. As a result, the Culebra flow and transport results obtained in the PABC-2009 will be used for the PC3S PA. These results are documented in Kuhlman (2010).

2.4.8 Direct Solids Releases

2.4.8.1 Spallings: DRSPALL

The implementation of the changes discussed in Section 2.1 does not affect the DRSPALL calculations. Thus, the DRSPALL calculations that were utilized to generate the spallings results used for the PABC-2009, i.e. those calculated in the PABC-2004, will be used in the PC3R PA.

2.4.8.2 Cuttings and Cavings: CUTTINGS_S

The code CUTTINGS_S has two major functions for WIPP PA: 1) calculation of cuttings and cavings volumes from a single borehole intrusion and 2) interpolation of DRSPALL volumes to calculate spallings volumes in the scenarios for drilling intrusions. The relocation of panels 9 and 10 to their 9a and 10a locations, and the inclusion of an open central drift area, requires that cuttings and cavings volumes be calculated for the PC3R PA. The PC3R PA CUTTINGS_S calculation will use the same general procedure that was used in the PABC-2009.

Repository pressures may be affected by replacing the Option D panel closure with the redesigned closure as well as the inclusion of the open central drift area. Changes in repository pressures have the potential to impact spallings results. Consequently, spallings releases for the PC3R PA may differ from those found in the PABC-2009 due to differences in repository pressures calculated by BRAGFLO. Spallings volumes from a single borehole intrusion are calculated by DRSPALL at initial repository pressures of 10, 12, 14, and 14.8 MPa. The PC3R PA will use the same procedure to interpolate DRSPALL volumes to calculate spallings volumes in the scenarios for drilling intrusions that was used for the PABC-2009. The initial repository pressure for a given scenario, time, location, and vector will be retrieved from the BRAGFLO results, and CUTTINGS_S will calculate a spallings volume for each scenario, time, location, and vector combination by interpolating the DRSPALL results using the initial pressure from the BRAGFLO results. The code CUTTINGS_S version 6.02 will be used for the PC3R, which is the same code used for the PABC-2009.

2.4.9 Direct Brine Releases: BRAGFLO

For WIPP PA, BRAGFLO is run in the DBR mode to calculate DBR volumes. Since the Salado flow results affect the DBR calculations, DBR calculations will be run for the PC3R PA. The numerical grid used to calculate DBRs will be updated to reflect the updated repository waste panel configuration and panel closure locations. With the exception of the parameters listed in Section 2.2, the PC3R PA DBR calculations will use the same procedures that were used in the PABC-2009 DBR calculations. Conditions required for the initiation of a DBR release will remain unchanged from PABC-2009, and the DBR volumes will be calculated for the same scenarios and times (Table 4). The codes PREBRAG version 8.0, BRAGFLO version 6.0 and POSTBRAG version 4.00A will be used for the PC3R PA, which are the same codes used for the PABC-2009.

Table 4: Direct brine release intrusion times

DBR Scenario	Intrusion Times (years)
S1	100, 350, 1000, 3000, 5000, 10000
S2 & S4	550, 750, 2000, 4000, 10000
S3 & S5	1200, 1400, 3000, 5000, 10000

2.4.10 CCDF Construction: CCDFGF

The PC3R PA will calculate CCDFs of individual vectors for total normalized releases, cuttings and cavings releases, spallings releases, DBRs, and releases from the Culebra. Mean CCDFs for each release pathway will be calculated by replicate and across all replicates. The 95% confidence limit on the mean across all replicates will also be calculated. The PC3R PA CCDF calculations will use the same procedures that were used in the PABC-2009 CCDF calculations.

Following the completion of the PABC-2009, updates were made to PA codes PRECCDFGF and CCDFGF. PRECCDFGF version 1.01 was updated to version 2.0 so that direct brine release data resulting from single or multiple brine volumes are captured in the release table file. CCDFGF was updated to version 6.0 so that it could utilize the brine volume-concentration tables generated by PRECCDFGF version 2.0. CCDFGF was then updated to version 7.0 to add the capability of specifying the configuration of waste panels (relative position and probability of drilling intrusions) in PA calculations. The codes PRECCDFGF version 2.0 and CCDFGF version 7.0 will be used for the PC3R PA. Validation documents for PRECCDFGF version 2.0 and CCDFGF version 7.0 can be found in Camphouse (2010) and Kirchner (2010b), respectively.

2.4.11 Sensitivity Analysis: STEPWISE

The PC3R PA will implement sensitivity analyses for results from the major codes in a manner consistent with those employed for the PABC-2009. Specifically, global sensitivity analyses will be conducted on the results from CCDFGF using the linear regression code STEPWISE. Since the Salado flow results from the BRAGFLO calculations are used as input to many other codes, additional sensitivity analyses will be performed with the BRAGFLO results. As parameter CELLULS:FBETA will not be sampled by PA code LHS, its corresponding parameter in STEPWISE, namely WFBETCEL, will not be included in sensitivity analyses performed in the

PC3R PA. WIPP PA codes such as PCCSRC, as well as Commercial Off-The Shelf (COTS) statistical software, may be used to assess the sensitivity of BRAGFLO results to input parameters.

2.5 Reports and Documentation

Several reports will be generated as a result of this analysis plan. The results of the FEPs impact assessment will be documented in a report, along with a summary of the parameters used for the PC3R PA. Each set of calculations discussed in Section 2.4 and its subsections will be documented in an analysis report. These reports will include:

1) discussion of any implementation changes (parameters, modeling assumptions, etc.) relative to the corresponding PABC-2009 calculations; and
2) analysis of results relevant to the long term performance of the repository. The analysis will include comparisons of PC3R PA results with PABC-2009 results.

A summary report describing the major results of the PA will also be written.

An additional record of the run control will be created for the PC3R PA. This document will contain:

1. A description of the hardware platform and operating system used to perform the calculations.
2. A listing of the codes and versions used to perform the calculations.
3. A listing of the scripts used to run each calculation.
4. A listing of the input and output files for each calculation.
5. A listing of the library and class where each file is stored.
6. File naming conventions.

3 Tasks

The tasks, responsible personnel and estimated task schedule are summarized below in Table 5.

Table 5: Task list and estimated schedule for the PC3R PA

Task	Description	Guiding Document	Approximate Completion Date	Responsible Individual(s)
1	Preparation Tasks			
1a	Input files prepared	AP-151	12/10/10	Camphouse Clayton Garner Kicker Kim Kirchner Pasch
1b	Input file review	AP-151	12/16/10	Camphouse
2	Parameters			
2a	Development of redesigned panel closure parameters	SP 9-5	12/3/10	Camphouse Clayton Herrick Kicker
2b	Entry of redesigned panel closure parameters into PAPDB	SP 9-5	12/3/10	Long
3	Code Run Environment Preparation			
3a	Libraries Update	AP-151	12/20/10	Long
3b	Run Control Script Update	AP-151	1/26/11	Long
4	Calculations			
4a	Parameter Sampling: LHS	AP-151	12/23/10	Long
4b	Salado Flow: BRAGFLO	AP-151	1/10/11	Long
4c	Cuttings & Cavings: CUTTINGS_S	AP-151	1/11/11	Long
4d	Direct Brine Releases: BRAGFLO	AP-151	1/18/11	Long
4e	Actinide Mobilization: PANEL	AP-151	1/19/11	Long
4f	Salado Transport: NUTS & PANEL	AP-151	1/26/11	Long
4g	CCDF Construction: CCDFGF	AP-151	1/27/11	Long
4h	Sensitivity Analysis: STEPWISE	AP-151	1/31/11	Kirchner
5	Analysis & Documentation			
5a	FEPS Re-assessment	SP 9-4	3/15/11	Kirkes
5b	Run Control Document	AP-151	2/18/11	Long
5c	Parameter Sampling: LHS	AP-151	1/26/11	Kirchner
5d	Salado Flow: BRAGFLO	AP-151	2/14/11	Camphouse
5e	Cuttings & Cavings: CUTTINGS_S	AP-151	2/15/11	Kicker
5f	Direct Brine Releases: BRAGFLO	AP-151	2/22/11	Clayton Camphouse Pasch
5g	Actinide Mobilization: PANEL	AP-151	2/23/11	Garner Kim
5h	Salado Transport: NUTS & PANEL	AP-151	3/14/11	Garner Kim
5i	CCDF Construction: CCDFGF	AP-151	3/18/11	Kirchner Camphouse
5j	Sensitivity Analysis: STEPWISE	AP-151	3/25/11	Kirchner
5k	Summary Report	AP-151	4/8/11	Camphouse

4 Software

The major WIPP PA codes to be used for this analysis are listed in Table 6. These codes will be executed on the WIPP PA Alpha Cluster, which is described in Table 7. Additionally, COTS (Commercial off-the-shelf), such as MATHEMATICA®, MATLAB®, MATHCAD®, Excel®, Access®, Grapher®, or Kaleidagraph®, running on MS Windows XP®-based PC workstations may be utilized. The use of any COTS application will be verified per NP 9-1 Appendix C as appropriate.

Table 6: Codes to be used for the PC3R PA

Code	Version	Build Date	Executable
ALGEBRACDB	2.35	31-JAN-1996	ALGEBRACDB_PA96.EXE
BRAGFLO	6.0	12-FEB-2007	BRAGFLO_QB0600.EXE
CCDFGF	7.0	26-AUG-2010	CCDFGF_QC0700.EXE
CUTTINGS_S	6.02	9-JUN-2005	CUTTINGS_S_QA0602.EXE
GENMESH	6.08	31-JAN-1996	GM_PA96.EXE
ICSET	2.22	1-FEB-1996	ICSET_PA96.EXE
LHS	2.42	18-JAN-2005	LHS_QA0242.EXE
MATSET	9.10	29-NOV-2001	MATSET_QA0910.EXE
NUTS	2.05C	24-MAY-2006	NUTS_QA0205C.EXE
PANEL	4.03	25-APR-2005	PANEL_QA0403.EXE
PCCSRC	2.21	23-MAY-1996	PCCSRC_PA96.EXE
POSTBRAG	4.00A	28-MAR-2007	POSTBRAG_QA0400A.EXE
POSTLHS	4.07A	25-APR-2005	POSTLHS_QA0407A.EXE
PREBRAG	8.0	8-MAR-2007	PREBRAG_QA0800.EXE
PRECCDFGF	2.0	6-APR-2010	PRECCDFGF_QA0200.EXE
PRELHS	2.30	27-NOV-2001	PRELHS_QA0230.EXE
RELATE	1.43	6-MAR-1996	RELATE_PA96.EXE
STEPWISE	2.21	2-DEC-1996	STEPWISE_PA96_2.EXE
SUMMARIZE	3.01	21-DEC-2005	SUMMARIZE_QB0301.EXE

Table 7: WIPP PA alpha cluster

Node	Hardware Type	CPU	Operating System
CCR	HP AlphaServer ES45	Alpha EV68	Open VMS 8.2
TDN	HP AlphaServer ES45	Alpha EV68	Open VMS 8.2
BTO	HP AlphaServer ES45	Alpha EV68	Open VMS 8.2
CSN	HP AlphaServer ES45	Alpha EV68	Open VMS 8.2
GNR	HP AlphaServer ES47	Alpha EV7	Open VMS 8.2
MC5	HP AlphaServer ES47	Alpha EV7	Open VMS 8.2
TRS	HP AlphaServer ES47	Alpha EV7	Open VMS 8.2
TBB	HP AlphaServer ES47	Alpha EV7	Open VMS 8.2

5 Special Considerations

None

6 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.*

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