560488

Sandia National Laboratories
Waste Isolation Pilot Plant

Features, Events and Processes Assessment for the Compliance Recertification Application – 2014, Revision 0

Author:	Ross Kirkes	Ross Kirkes	6211	6/24/13
	Print	Signature	Org.	Date
Technical Review:	Steve Wagner	Steve Wagner	6211	6/25/13
	Print	Signature	Org.	Date
Management Review:	Sean Dunagan		6211	6/24/13
	Print	Signature	Org.	Date
QA Review:	Steve Davis	Steve Davis	6210	6/24/13
	Print	Signature	Org.	Date

Sandia National Laboratories

WIPP:1.3.1:PA:QA-L:RECERT:549146

CONTENTS

LIST OF TABLES

LIST OF ACRONYMS

CARD	Compliance Application Review Document
CCA	Compliance Certification Application
CFR	Code of Federal Regulation
CRA	Compliance Recertification Application
DBMAR	Delaware Basin Monitoring Annual Report
DOE	Department of Energy
DP	disturbed performance
EP	events and processes
EPA	Environmental Protection Agency
FEP	feature, event, or process
HCN	historic, current, or near-future
LWA	Land Withdrawal Act
PA	performance assessment
PAIR	Performance Assessment Inventory Report
PCS	panel closure system
ROM	run-of-mine
SNL	Sandia National Laboratories
SO-C	screened-out, consequence
SO-P	screened-out, probability
SO-R	screened-out, regulatory
SP	Specific Procedure
TRU	transuranic
TSD	Technical Support Document
UP	undisturbed performance
WIPP	Waste Isolation Pilot Plant

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 based on performance assessment (PA) calculations that were included in the DOE's Compliance Certification Application (CCA) (DOE 1996a). These calculations demonstrated that the predicted releases of radionuclides to the accessible environment would not exceed those allowed by the EPA standard, given the assumptions and understanding of the disposal system at that time.

The WIPP Land Withdrawal Act (LWA) (U.S. Congress 1996) requires that the WIPP's compliance with the EPA's disposal standards be recertified every five years. This recertification process allows the most recent and up-to-date information to be incorporated into the PA. As such, the DOE submitted its first Compliance Recertification Application (CRA) that demonstrated continued compliance with EPA's requirements for radioactive waste disposal in March of 2004 (hereafter called the CRA-2004) (DOE 2004). As part of the CRA-2004, a reassessment of the features, events, and processes (FEPs) baseline was conducted to assure that any new information pertaining to the basis of compliance was properly included (or excluded) in PA (Wagner et al. 2003). The FEPs reassessment for the CRA-2004 was a comprehensive look at the FEPs baseline, and considered all changes and new information and their impact to information within the FEPs baseline. The 2004 FEPs reassessment involved bringing the baseline up to date by considering all changes and new information since submittal of the CCA in 1996, roughly a seven year period. After a two-year review period, the EPA recertified the WIPP's continued compliance March 29, 2006 (EPA 2006a). As part of their review of the CRA-2004, the EPA published Compliance Application Review Documents (CARDs) and Technical Support Documents (TSDs) that document their review of important components of the CRA-2004. The CARD for Section 194.32 (EPA 2006b) and the TSD (EPA 2006c) were specifically focused at the FEPs reassessment. EPA's review concluded that the FEPs reassessment and documentation provided in the CRA-2004 was acceptable and appropriately accounted for changes since the initial certification of the WIPP.

In its role as the scientific advisor for the WIPP, Sandia National Laboratories (SNL) conducts periodic PAs to evaluate the performance of WIPP. With each PA, it is incumbent upon SNL to confirm that the FEPs basis is adequate and to account for any new or proposed changes to the repository design and/or the PA system. Such changes are evaluated incrementally according to SNL Specific Procedure (SP) SP 9-4, "Performing FEPs Baseline Impact Assessments for Planned and Unplanned Changes." Through this procedure, the FEPs baseline is managed and updated systematically over time, rather than updated immediately prior to recertification, as was done for the CRA-2004 (Wagner et al, 2003), and as described above. The method provided in SP 9-4 is preferred as it provides for constant maintenance of the baseline in that the FEPs baseline is evaluated each time a new performance assessment is conducted. This method provides assurance that PA analyses done in the interim between recertification applications are based on a valid and appropriate FEPs basis. An additional benefit of this method is that for the current recertification application, all that is needed is a "roll-up" of the FEPs assessments since the last recertification to document the changes to the FEPs basis, and a review of new information that originates outside the PA program. As such, this document presents the roll-up of the FEPs assessments that have been conducted since the CRA-2009, and the identification of new information that has not been

reviewed within the SP 9-4 FEPs assessments. The results of this analysis thereby document the impact to the FEPs basis for the CRA-2014 and identifies the changes that will be made to Appendix SCR-2014 to account for these impacts.

2. FEPS IMPACT ASSESSMENT APPROACH

As noted in the Introduction, the purpose of this document is to determine if the current FEPs baseline remains appropriate in consideration of new information that has become available since the most recent certification decision (U.S. EPA 2010a). The FEPs baseline is represented by: (1) the most current version of Attachment SCR (currently, Appendix SCR-2009); (2) related information published by the EPA in their CARDs and TSDs of the most recent certification decision (U.S. EPA 2010b and 2010c); and (3) FEPs assessment results and other information in Sandia Records Package 549146 (the records package for SP 9-4 reports). This analysis will evaluate the FEPs baseline and identify areas of change in two primary steps.

First, this analysis will evaluate changes to the PA baseline since the CRA-2009 by reviewing all FEPs assessments that have been conducted under SP 9-4 since EPA's most recent recertification (EPA 2010a). This information consists of the contents of Records Package 549146 and will assure that all changes that have been actively pursued by the DOE will be addressed in this assessment.

Second, this analysis will evaluate new information from outside the WIPP PA program. This information may come from DOE monitoring programs, updated waste inventory data, EPA evaluations of compliance (e.g., EPA CARDs), or other outside sources of information that may be relevant to the WIPP's certification basis. Information relating to human activities in the WIPP vicinity will be of primary interest because this information has the greatest potential for changes that could impact the FEPs basis. For example, the natural system is well defined and changes occur very slowly if at all, however technological advancements that relate to resource extraction may occur in a very short period of time. As mentioned, this assessment will also look at any new data included in the CRA-2014 PA.

For this evaluation, each FEP presented in Attachment SCR-2009 (the current baseline FEPs document) is reviewed to determine if any changes are merited in consideration of new information from the sources listed above. FEPs are updated as needed and combined with those generated from step 1 of this analysis. Updates may consist of screening argument updates, screening decision changes, or references to new information, i.e., waste inventory changes, or combinations of these three types of changes. FEPs not requiring update will be noted as unchanged in Appendix SCR-2014 and will not be included in this report.

This report continues to use the same screening classifications used since the WIPP CCA: "UP" is the screening classification that represents those FEPs incorporated in undisturbed performance scenarios. The "DP" screening classification represents FEPs incorporated in disturbed performance scenarios. "SO-C" represents those FEPs the have been excluded or screened out of any scenario due to either low-, no-, or beneficial consequence. "SO-R" represents those FEPs that have been screened out due to regulatory provision, and "SO-P" represents those FEPs that have been screened out due to low probability. Additionally, there are two timeframes within which FEPs are applied. Historic, current, and near-future (HCN) are those FEPs that have either been known to have happened in the past, are currently occurring, or may happen within the near future. Future FEPs are those which have not happened, but may be possible in the long-term.

2.1 REVIEW OF SP 9-4 FEPS ASSESSMENTS

Section 2.4.8 of SP 9-4 requires that the results of all FEPs assessments be placed in Sandia Records Package number 549146. Therefore, the contents of this records package must be obtained to begin this review for the CRA-2014. Records package 549146 includes the following FEPs assessments:

1. FEPs Assessment for Changes Described in AP-145 (Kirkes 2009a)
2. FEPs Assessment for Changes Described in AP-151 (Kirkes 2011a)
3. FEPs Assessment for Changes Described in AP-156 Salt Disposal Investigations (Kirkes 2011b)

The remainder of this section will discuss the scope and results of each of these assessments.

2.1.1 FEPs Assessment for AP-145

AP-145 described changes to the PA modeling system planned for the PABC-2009. Changes included in the PABC-2009 were an updated inventory, updated actinide solubilities (derived from the updated inventory), new Culebra T-fields, updates to the drilling rate parameter and plugging pattern probabilities, and minor error corrections included in the CRA-2009 PA analysis. Kirkes (2009a) analyzed these changes against the then-current FEPs baseline, and determined that no revision to FEPs or their bases was warranted, as is usually the case for parameter value changes. Furthermore, no additional activities were identified to support the implementation of these activities within the PABC. No changes to the current FEPs baseline are warranted as a result of the PABC-2009.

2.1.2 Assessment for Changes Described in AP-151

Analysis Plan AP-151 describes the changes to the PA modeling system that were used to represent a different repository configuration. In summary, these changes include:

1) Modifying the repository layout to relocate panels 9 and 10 to lie south of panels 4 and 5.
2) Modify the repository layout such that panel closure systems (PCS) in the central areas will be eliminated as well as those isolating the north end of the repository workings from the waste disposal area.
3) Replacing modeling components for the Option D PCS with those that represent the proposed redesigned PCS.

While this analysis combined multiple changes in the repository configuration and construction, only the redesign of the PCS has been carried forward for consideration during this recertification cycle; repository layout changes have been deferred until after the CRA-2014 has been submitted to the EPA. Therefore, only FEPs related to Item 3 above are relevant to this reassessment, as only the new run-of-mine (ROM) salt PCS design will be included in the CRA-2014 PA calculations. Table 1 from Kirkes (2011a) identifies FEPs potentially affected by the changes described in AP-151. Of those, 12 FEPs are related to the redesigned PCS. These 12 FEPs are provided below in Table 1.

Table 1: FEPs Related to the PCS Redesign		
Related FEPs	**Screening Classification**	**Relationship to Proposed Change**
W18 Disturbed Rock Zone	UP	The DRZ above the new ROM salt PCS may have different properties than for concrete PCS.
W19 Excavation-Induced Change in Stress	UP	Stress changes may occur as the ROM salt PCS consolidates.
W20 Salt Creep	UP	Salt creep will affect the consolidation of the new ROM salt PCS.
W21 Change in the Stress Field	UP	Salt creep and consolidation of the new ROM salt PCS may lead to changes in the stress field.
W73 Concrete Hydration	SO-C	Proposed PCS material properties differ from current PA baseline.
W109 Panel Closure Geometry	UP	The proposed locations of the PCSs differ from the current PA baseline.
W110 Panel Closure Physical Properties	UP	Proposed PCS material properties differ from current PA baseline.
W111 Panel Closure Chemical Composition	SO-C (Beneficial)	Proposed PCS chemical composition differs from current PA baseline.
W112 Radiological effects on Panel Closures	SO-C	Proposed PCS material properties differ from current PA baseline.
W113 Consolidation of Panel Closures	UP	Proposed PCS material properties differ from current PA baseline.
W114 Mechanical Degradation of Panel Closures	UP	Proposed PCS material properties differ from current PA baseline.
W115 Chemical Degradation of Panel Closures	UP	Proposed PCS chemical composition differs from current PA baseline.

UP: Screened in, undisturbed performance scenario
SO-C: Screened out, consequence

The FEPs W18 *Disturbed Rock Zone,* W19, *Excavation-Induced Change in Stress*, W20 *Salt Creep,* and W21 *Changes in the Stress Field* are currently accounted for in PA calculations (classified UP). Implementation of the new ROM salt PCS in PA requires new parameters for the DRZ above the PCS. Further, salt creep and changes in stress will affect the consolidation of the ROM PCS over time. Modifications to relevant parameters are described in Camphouse (2013). These changes are downstream of the FEPs screening process, and will not change the screening decision; these FEPs will remain classified UP. However, their screening arguments in Appendix SCR-2014 will be updated to reflect the new ROM PCS.

The FEPs W109 *Panel Closure Geometry* and W110 *Panel Closure Physical Properties* are currently accounted for in PA calculations (classified UP). The location and geometry of the panel closures are represented in the BRAGFLO grid. For the CRA-2014, the changes described in AP-151 describe the manner that the revised PCS will be represented in the PA. Modifications to relevant parameters and the modeling grid are described in Camphouse (2013). Because these changes are subsequent to the FEPs screening process, they are considered modeling implementation changes. No changes will be made for the screening decisions or arguments for these FEPs, however new information will be added to Appendix SCR-2014 to note the planned changes for the PCS.

The FEPs W113 *Consolidation of Panel Closures*, and W114 *Mechanical Degradation of Panel Closures* are currently accounted for in PA calculations (classified UP) through the permeability and porosity ranges assumed for the PCS. These FEPs should continue to be accounted for in PA calculations (UP); however updated parameter values for the "run-of-mine-salt" have been developed and are described in Camphouse (2013). New information will be added to Appendix SCR-2014 to note the changes planned for the PCS.

FEP W115 *Chemical Degradation of Panel Closures* has been included in past PA calculations (classified UP), due to the expected concrete construction. However, because the new PCS will be constructed of run-of mine (ROM) salt, it has been determined that it should be screened out of PA calculations because unlike the concrete in the Option D panel closure, the ROM salt will not be susceptible to chemical degradation. The ROM salt closure will be identical to the host rock chemistry, which will be at chemical equilibrium with any brine from the near field. In the event brine were present that differed significantly from the host rock chemistry, the PCS material will not be preferentially degraded from that of the host rock. Both of these cases support screening out W115 *Chemical Degradation of Panel Closures* based on low probability (SO-P) for the CRA-2014. The screening argument and decision will be updated as appropriate in Appendix SCR-2014.

The FEP W73 *Concrete Hydration*, is also currently identified above as being related to the new PCS properties, and is also currently screened out of PA calculations on the basis of consequence (SO-C). The current screening argument as presented in the CRA-2009 is discussed in terms of thermal rise due to exothermic reaction of concrete hydration. These temperature rises are short-lived and have no lasting effect upon the repository. If a significant quantity of concrete was omitted from the design of the PCS, there would be even less thermal rise due to concrete hydration. Therefore, the screening decision of SO-C remains appropriate for W73, *Concrete Hydration* for the CRA-2014. New information will be added to Appendix SCR-2014 to reflect the reduction in concrete due to the new PCS.

The current screening argument for FEP W111 *Panel Closure Chemical Composition* (SO-C, Beneficial) as presented in Appendix SCR-2009 is based on the understanding that interactions between contaminated brine and concrete in the panel closures would be of beneficial consequence due to sorption and sequestration of radionuclides. Therefore, neglecting to account for this beneficial interaction is a conservative position. While the proposed PCS design does not include the same concrete elements as did previous designs, choosing to ignore any sorptive properties potentially present in the new design does not create an inconsistency within the current FEPs basis or model. That is, radionuclide concentrations in brine are modeled to remain constant throughout each vector and are not reduced through sorption by any closure component, regardless of its composition, even though impurities in the host rock such as clays have sorptive properties. Therefore, the screening decision of SO-C Beneficial remains appropriate for W111 Panel Closure Chemical Composition. No changes are recommended for the screening decision for this FEP in the CRA-2014, however new information will be added to Appendix SCR-2014 to reflect the new material composition for the PCS.

The FEP, W112 *Radiological Effects on Panel Closures*, is identified as related to the new PCS properties. The current baseline Appendix SCR-2009 explains that ionizing radiation can change the physical properties of many materials. However, due to the low levels of activity in the WIPP waste, it is unlikely that a radiation field of sufficient intensity could cause such effects. Therefore, this FEP has been screened out on the basis of low consequence (SO-C). Bradshaw and McClain (1971) show that salt is very robust and shows little effects due to low energy radiation exposure. Therefore, it is expected that the ROM PCS may be even less susceptible to radiological effects than the previously planned concrete closures, therefore, the screening decision shall remain the same (SO-C). New information will be added to the screening argument to reflect the new material composition for the PCS.

The FEPs assessment for the changes described in AP-151 (Kirkes 2011a) evaluated each of these changes for impacts to the FEPs baseline according to the methodology in SP 9-4. The conclusion of the assessment states that, "No screening decision conflicts or impacts have been identified as a result of this review." However, since the new PCS is being incorporated into the CRA-2014 as a new baseline configuration, it is appropriate to change the screening decision for FEP W115 *Chemical Degradation of Panel Closures* to SO-P. The baseline FEPs list (Kirkes 2009b) and Appendix SCR-2014 will be updated as appropriate.

2.1.3 Assessment for Changes Described in AP-156

AP-156 describes the PA analysis planned to evaluate disposal of heat-generating waste in salt, also referred to as, "Salt Disposal Investigations," or "SDI." In summary, this PA was designed to:

1) Determine the maximum potential thermal rise due to SDI heater tests at the time of repository closure, and
2) Determine the impact of a modified repository layout that represents additional tunnels expressly for the conduct of the SDI heater experiments.

Kirkes (2011b) evaluated changes in described in AP-156 and found that any heat pulse generated by the SDI experiments would not negatively affect previous assumptions, screening arguments, or decisions currently in the FEPs baseline. The thermal rise expected by these tests will have dissipated prior to repository closure, and therefore will not affect any thermal effects over the long-term disposal period. The additional mined area in the experimental region of the repository would

not affect screening decisions or arguments, as the repository geometry is screened in (UP) PA calculations. Therefore, no screening decision conflicts or impacts would occur as a result of the changes planned in the AP-156 analysis. As concluded in Kirkes 2011b, the screening argument for FEP W1 *Disposal Geometry,* should be updated to state that the additional mined volume in the experimental area for these tests will be accounted for in the modeling grid. Since the FEP is classified as UP, this is a model implementation change, and not a FEP screening decision change, and no other changes are necessary to this FEP. Thermal-related FEPs W13 *Heat from Radioactive Decay,* W29 *Thermal Effects on Material Properties*, W30 *Thermally-Induced Stress Changes*, W31 *Differing Thermal Expansion of Repository Components*, W43, *Convection,* W72 *Exothermic Reactions,* and W73 *Concrete Hydration* should also be updated in Appendix SCR-2014 to describe that heat from these operational period tests does not impact current FEP arguments or screening decisions. These FEPs are listed below in Table 2:

Table 2: FEPs Related to the Salt Disposal Investigations

Related FEPs	Screening Classification	Appendix SCR-2014 Impact
W1 Disposal Geometry	UP	Update Appendix SCR-2014 to show that the modeling grid has been modified to reflect additional mined area in northern region of repository.
W13 Heat from Radioactive Decay	SO-C	Update FEP with new information related to heat experiments. Demonstrate that heat from experiments does not affect current screening argument or assumptions.
W29 Thermal Effects on Material Properties	SO-C	Update FEP with new information related to heat experiments. Demonstrate that heat from experiments does not affect current screening argument or assumptions.
W30 Thermally-Induced Stress Changes	SO-C	Update FEP with new information related to heat experiments. Demonstrate that heat from experiments does not affect current screening argument or assumptions.
W31 Differing Thermal Expansion of Repository Components	SO-C	Update FEP with new information related to heat experiments. Demonstrate that heat from experiments does not affect current screening argument or assumptions.
W43 Convection	SO-C	Update FEP with new information related to heat experiments. Demonstrate that heat from

Table 2: FEPs Related to the Salt Disposal Investigations		
Related FEPs	**Screening Classification**	**Appendix SCR-2014 Impact**
		experiments does not affect current screening argument or assumptions.
W72 Exothermic Reactions	SO-C	Update FEP with new information related to heat experiments. Demonstrate that heat from experiments does not affect current screening argument or assumptions.
W73 Concrete Hydration	SO-C	Update FEP with new information related to heat experiments. Demonstrate that heat from experiments does not affect current screening argument or assumptions.

UP: Screened in, undisturbed performance scenario
SO-C: Screened out, consequence

2.1.4 Assessment for Changes Described in AP-164

AP-164 describes the PA analysis to be conducted and included in the CRA-2014 in order to demonstrate continued compliance with the long-term disposal regulations. This process, called recertification, is an opportunity for the DOE to "roll-up" any changes to the compliance baseline that have occurred since the previous recertification application, as well as include any new information that has not previously been incorporated into PA. As such, some of the changes identified in AP-164 have already been represented in a PA and submitted to the EPA for approval. Other changes and updates, however, have not yet been incorporated. The nature of changes which have not yet been incorporated or submitted to EPA is that of updates and/or enhancements to current models, codes, or parameters. These changes are not considered significant and represent the most recent information available. Therefore, the PA conducted for the CRA-2014 will establish a new compliance baseline.

AP-164 describes the PA planned for the CRA-2014.

1. Replacement of the Option D panel closure with the ROM salt PCS
2. Inclusion of an additional mined region in the repository north end
3. An update to the probability that a drilling intrusion into a repository excavated region will result in a pressurized brine encounter.
4. Refinement to the corrosion rate of steel.
5. Refinement to the effective shear strength of WIPP waste
6. Updates to drilling rate and plugging pattern parameters.
7. Updates to WIPP waste inventory parameters.
8. Calculation of radionuclide concentration in brine as a function of the actual brine volume present in the waste panel.
9. Updates to the radionuclide solubilities and their associated uncertainty.

10. Implementation of a more detailed repository water balance that includes MgO hydration.
11. Parameter corrections.

FEPs assessments for changes that relate to Items 1 and 2 above were described previously in sections 2.1.2 and 2.1.3 of this report. The remaining items in this list will be evaluated within this report to determine if any changes to FEPs screening arguments and decisions are warranted as a result of the updates identified in AP-164. As a matter of practice, changes to parameter values are not typically reviewed in the FEPs assessment process, because the mere existence of a PA parameter indicates that a FEP or group of FEPs is being represented in one or more performance scenarios. That is, parameterization is "downstream" of the FEPs screening process, and considered part of PA implementation. These parameter changes are being discussed here for completeness, and the descriptions of FEPs may also be updated to reflect any new information, as appropriate.

2.1.4.1 Update to Probability of Pressurized Brine Parameter, Drilling Rate and Plugging Patterns

As required by 40 CFR 194.15(a)(2), recertification applications must include additional monitoring data. In the case of item 3 above, this parameter has been updated based on information that has been collected since the mid-1990's, but has not been incorporated into the derivation of the parameter until now. Additionally, parameters associated with item 6 above have been updated based on monitoring data gathered since the last recertification application.

Human FEPs H1 *Oil and Gas Exploration* and H23 *Blowouts* are classified DP for the future timeframe. The natural FEP, N2 *Brine Reservoir* is also classified as DP. Inadvertent intrusion is represented in the disturbed case via the FEP H1, and encountering pressurized brine beneath the repository is represented via the FEP H23. The existence of this hypothetical brine reservoir and its properties represent FEP N2. The probability that an inadvertent exploratory borehole in the future will penetrate the repository is established by EPA's prescribed method, and is updated for each recertification based on the latest drilling data. This event is represented in PA via the parameter GLOBAL: LAMDAD. The probability that such a repository intrusion also encounters a zone of pressurized fluid (brine) beneath the repository is represented in the PA parameter GLOBAL:PBRINE. Kirchner et al. (2012) describes the methodology and rationale for arriving at an updated value for this parameter that honors over 10 years of new data relevant to the probability of encountering pressurized brine in WIPP PA. Physical parameters associated with FEP N2 are not affected by the change in probability associated with GLOBAL:PBRINE. These FEPs will be updated with new information in Appendix SCR-2014 that describes the parameter updates related to their implementation within PA.

Human FEPs H31, *Natural Borehole Fluid Flow* and H32, *Waste-Induced Borehole Flow* are classified DP for the future timeframe. Per regulatory guidance, PA employs current drilling and plugging practices in intrusion scenarios as appropriate. These two FEPs are implemented, in part, by the types of borehole plugs used in the vicinity of the WIPP when plugging and abandoning boreholes. The frequency of use for each of the three borehole plug types implemented in PA is updated periodically, based on actual plugging data. These frequencies are represented as probabilities in PA by the parameters GLOBAL:ONEPLG, GLOBAL:TWOPLG, and GLOBAL:THREEPLG. These FEPs will be updated with new information that describes the parameter updates related to their implementation within PA.

2.1.4.2 Refinement to the Corrosion Rate of Steel

As required by 40 CFR 194.15(a)(3), recertification applications must include all additional analyses and results of laboratory experiments conducted that relate to the WIPP program. Since the last recertification, experiments have been conducted to determine steel corrosion rates in WIPP relevant conditions (Roselle 2013). Metal corrosion is represented in WIPP PA via FEPs W49 *Gasses from Metal Corrosion* and W51 *Chemical Effects of Corrosion* through the PA parameter STEEL:CORRMCO2. These FEPs will be updated with new information that describes the parameter updates related to their implementation within PA.

2.1.4.3 Refinement Shear Strength of WIPP Waste

Similar to the refinement of the steel corrosion rates mentioned above, recent experiments were completed that improve the PA parameter that represents the effective shear strength of WIPP waste (Herrick 2013). Waste-related FEP W85 *Cavings* (DP) represents waste erosion as part of the intrusion process in disturbed scenarios. The PA parameter BOREHOLE:TAUFAIL represents the effective shear strength for erosion of WIPP waste. This FEP will be updated with new information that describes the parameter update related to its implementation within PA.

2.1.4.4 Updates to WIPP Waste Inventory Parameters

The CRA-2014 PA will use the most recent inventory information available. This information is presented in the Performance Assessment Inventory Report (PAIR) – 2012 (Van Soest 2012). The PAIR – 2012 contains updated estimates to the radionuclide content and waste material parameters, scaled to a full repository, based on inventory information collected up to December 31, 2011. Waste-related FEPs will be updated, as necessary, to reflect the most recent inventory data.

The FEPs that require updating to reflect the most recent inventory data are:

W2 *Waste Inventory*

W3 *Heterogeneity of Waste Forms*

W4 *Container Form*

W13 *Heat from Radioactive Decay*

W14 *Nuclear Criticality: Heat*

W15 *Radiological Effects on Waste*

W16 *Radiological Effects on Containers*

W17 *Radiological Effects on Seals*

W28 *Nuclear Explosions*

W29 *Thermal Effects on Material Parameters*

W30 *Thermally-induced Stress Changes*

W31 *Differing Thermal Expansion of Repository Components*

W33 *Movement of Containers*

W44 *Degradation of Organic Material*

W45 *Effects of Temperature on Microbial Gas Generation*

W47 *Effects of Radiation on Microbial Gas Generation*

W48 *Effects of Biofilms on Microbial Gas Generation*

W53 *Radiolysis of Cellulose*

W54 *Helium Gas Generation*

W55 *Radioactive Gases*

W72 *Exothermic Reactions*

W73 *Concrete Hydration*

W89 *Transport of Radioactive Gases*

W93 *Soret Effect*

W112 *Radiological Effects on Panel Closures*

As a result of the new inventory data, screening arguments for these FEPs will be updated to reflect the new information. Because the radioactive aspect of the inventory continues a downward trend, it is not expected that any conclusions drawn in previous screening arguments will result in a screening decision change. CRA-2014 FEP arguments will continue to be bounded by previous arguments when the radioactive content was much higher than the current projected inventory.

2.1.4.5 Implementation of Variable Brine Volume in the Calculation of Radionuclide Concentration

Previous PAs have used a minimum brine volume in the repository in order for a direct brine release to occur. This minimum volume has been necessary in the calculation of radionuclide brine concentrations. As WIPP organic ligand inventory has increased, mass-balance issues have occurred when projecting this initial concentration of radionuclides in brine to larger, but possible brine volumes. To remedy this, brine volumes of 1x, 2x, 3x, 4x, and 5x the minimum necessary volume will be used in the calculation of radionuclide concentration. This approach will keep radionuclide *mass* constant over realized brine volumes, rather than keeping radionuclde *concentration* constant over realized brine volumes (Camphouse 2013). Waste-related FEPs W68 *Organic Complexation* and W69 *Organic Ligands* are both accounted for in undisturbed scenarios and classified as UP. This change in the implementation of variable brine volume is considered a model enhancement as it corrects a mass balance issue that was present in previous PAs. The FEPs continue to be screened in as UP. New information will be added to these FEPs to note the enhancement of variable brine volume within PA.

2.1.4.6 Updates to Radionuclide Solubilities

The solubilities of actinide elements are influenced by the chemical components of the waste. As mentioned, the PA inventory used for the CRA-2014 has been updated (Van Soest 2012). To incorporate the updated information, parameters used to represent actinide solubilities will be updated for the CRA-2014. Waste-related FEPs W68 *Organic Complexation* and W69 *Organic Ligands* are both classified as UP. The new inventory information may contain different quantities of various complexing agents which in turn may result in different radionuclide solubility ranges

incorporated in PA. The process of updating these values has been done for each recertification PA, and does not change screening arguments or decisions. New information will be added to these FEPs to note the update of inventory data as appropriate.

2.1.4.7 Refinement of Repository Water Balance

Expected repository conditions vary based factors such as contents of the repository, brine present, elapsed time since closure and the most recent hypothetical intrusion. These factors (and others) are considered interdependent and represent the complex interactions that might prevail over time in the repository environment. These interactions are accounted for in the Chemical Conditions Conceptual Model. As part of their review of the CRA-2009, the EPA noted that the existing treatment for water balance within the repository could be improved to include additional chemical reactions that affect the water balance within the repository (EPA 2010d). As such, the CRA-2014 PA calculations will include an improved treatment of water balance. The main objective of refining the repository water balance is to include the major gas and brine producing and consuming reactions within the existing conceptual model. FEPs that are related to this change include W2 *Waste Inventory*, W5 *Container Material Inventory*, W10 *Backfill Chemical Composition*, W40 *Brine Inflow*, W41 *Wicking*, *W42 Fluid Flow Due to Gas Production*, and W86 *Spallings*. This change in the implementation of repository water balance is considered a model enhancement as it adds additional reactions (magnesium oxide hydration, and the carbonation of brucite to form hydromagnesite) that represent transitional compounds in the reaction path. The FEPs listed above continue to be screened in as UP (DP for Spallings). New information will be added in Appendix SCR-2014 to these FEPs to note the implementation improvements related to water balance within the repository model.

2.2 REVIEW OF NEW INFORMATION ORIGINATING OUTSIDE PERFORMANCE ASSESSMENT

This section will review information that originates outside the WIPP PA program and determine if any changes to FEPs screening decisions and arguments are warranted. Examples of this type of information include changes in technology as it relates to resource exploration, development, and exploitation. This evaluation will primarily focus on human-initiated events and process (EPs), although some natural FEPs may be affected by new data. (e.g., new seismic data may need to be incorporated). Sources of information for this review will include the Delaware Basin Monitoring Annual Report (DBMAR) for 2012 (DOE 2012), and independent contractor reports.

2.2.1 Delaware Basin Monitoring Annual Report for 2012

FEPs from current baseline (Appendix SCR-2009) were reviewed to determine if any required specific data and information from the DBMAR-2012. This review concluded that the following FEPs were in need of update.

2.2.1.1 N12 Seismic Activity

Summary of New Information

Seismic Activity N12 is accounted for in PA and is screened UP. Since the CRA-2009, there were five seismic events recorded in the Delaware Basin. Two seismic events occurred in Reeves County Texas with magnitudes of 1.5 and 2.0. Three seismic events occurred in Eddy County New Mexico

with magnitudes of 1.2, 1.6, and 2.4. The seismic event in Eddy County which occurred on March 18, 2012 (magnitude 2.4) has been attributed to a mine collapse.

2.2.1.2 H3 *Water Resources Exploration* and H5 *Groundwater Exploitation*

Summary of New Information

Both H3 Water Resources Exploration and H5 Groundwater Exploitation are screened SO-C for the future timeframe. The Delaware Basin Monitoring Program records and tracks the development of deep and shallow wells within the vicinity of the WIPP. Updated drilling data is reported annually in the Delaware Basin Monitoring Annual Report (DOE 2012). While this information has been updated since the last recertification, it does not result in a change in the screening arguments or decisions of these FEPs.

2.2.1.3 H58 *Solution Mining for Potash*

Summary of New Information

H58 Solution Mining for Potash is screened SO-R. There are no solution mines for Potash in the Delaware Basin. Intrepid Potash, formerly Mississippi Potash has recently begun an in-situ solution mining process that is occurring in the former Eddy Potash, Inc. mine. The location of this solution process is outside the Delaware Basin, however the evaporation ponds are located within the Delaware Basin boundary, as this location is near a refinery located at the current Intrepid Potash west facility. The FEP screening argument will require updating to reflect this new activity. The screening argument will not change, however, as the solution activity lies outside the Delaware Basin boundary.

2.2.1.4 *H59 Solution Mining for Other Resources*

Summary of New Information

H59 Solution Mining for Other Resources is screened SO-C. Since the CRA-2009, there have been two new brine wells put into service within the Delaware Basin. One, located in Eddy County, New Mexico and the other located in Ward County, Texas. Additionally, there have been two previously active brine wells taken out of service and plugged and abandoned. These two decommissioned wells are both in Eddy County, New Mexico. Therefore, the total active brine well count remains at 12, the same as in 2009. These changes are illustrated below in Table 3. This new information will be incorporated in Appendix SCR-2014 into the H59 FEP screening argument, but the screening decision will not change as a result.

Table 3: Delaware Basin Brine Well Status

County	Location	API No.	Well Name and No.	Operator	CRA-2009 Status	CRA-2014 Status
Eddy	22S-26E-36	3001521842	City of Carlsbad #WS-1	Key Energy Services	Active Brine Well	**Plugged Brine Well**
Eddy	22S-27E-03	3001520331	Tracy #3	Ray Westall	Plugged Brine Well	Plugged Brine Well
Eddy	22S-27E-17	3001522574	Eugenie #WS-1	I & W Inc	Active Brine Well	**Plugged Brine Well**
Eddy	22S-27E-17	3001523031	Eugenie #WS-2	I & W Inc	Plugged	Plugged Brine

Table 3: Delaware Basin Brine Well Status						
County	**Location**	**API No.**	**Well Name and No.**	**Operator**	**CRA-2009 Status**	**CRA-2014 Status**
					Brine Well	Well
Eddy	22S-27E-23	3001528083	Dunaway #1	Mesquite SWD, Inc.	Active Brine Well	Active Brine Well
Eddy	22S-27E-23	3001538084	Dunaway #2	Mesquite SWD, Inc.	--	**Active Brine Well**
Loving	Blk 29-03	4230110142	Lineberry Brine Station #1	Chance Properties	Active Brine Well	Active Brine Well
Loving	Blk 01-82	4230130680	Chapman Ford #BR1	Herricks & Son Co.	Plugged Brine Well	Plugged Brine Well
Loving	Blk 33-80	4230180318	Mentone Brine Station #1D	Basic Energy Services	Active Brine Well	Active Brine Well
Loving	Blk 29-28	4230180319	East Mentone Brine Station #1	Permian Brine Sales, Inc.	Plugged Brine Well	Plugged Brine Well
Loving	Blk 01-83	4230180320	North Mentone #1	Chance Properties	Active Brine Well	Active Brine Well
Reeves	Blk 56-30	4238900408	Orla Brine Station #1D	Mesquite SWD Inc.	Active Brine Well	Active Brine Well
Reeves	Blk 04-08	4238920100	North Pecos Brine Station #WD-1	Chance Properties	Active Brine Well	Active Brine Well
Reeves	Blk 07-21	4238980476	Coyanosa Brine Station #1	Chance Properties	Active Brine Well	Active Brine Well
Ward	Blk 17-20	4247531742	Pyote Brine Station #WD-1	Chance Properties	Active Brine Well	Active Brine Well
Ward	Blk 01-13	4247534514	Quito West Unit #207	Seaboard Oil Co.	Active Brine Well	Active Brine Well
Ward	Blk 34-200	4247520329	Barstow Brine Station #1	Basic Energy Services, LP	--	**Active Brine Well**
Ward	Blk 34-174	4247582265	Barstow Brine Station #1	Energy Equity Company	Active Brine Well	Active Brine Well

2.2.2 Information from the EPA CARDs and TSDs

EPA's review of the CRA-2009 is documented in their CARDs and TSDs (EPA 2010b and 2010c). EPA's review of the FEPs assessment for CRA-2009 and resulting FEPs baseline resulted in modification to only one FEP, W45 *Effects of Temperature on Microbial Gas Generation.* As a result of their review, EPA requested additional information regarding the screening argument for this FEP. EPA stated that the updated screening argument in the Appendix SCR-2009 does not adequately demonstrate that the microbial gas generation models used in PA remain appropriate under the increased repository temperatures. As such, DOE submitted additional information in their 5th response package to the EPA (Moody 2010). The additional information provided will be included in the screening argument for this FEP for the CRA-2014. Also, as indicated in Section 2.1.4.4, this FEP will be updated with the most recent inventory information.

3. FEPS ASSESSMENT SUMMARY

The FEPs baseline has been re-evaluated to determine if any new information affects the baseline screening descriptions, arguments, and decisions for WIPP FEPs. Results from FEPs assessments conducted under SP 9-4 since the CRA-2009 were reviewed to identify information that is in need of update. In addition, new information that originates outside the Sandia WIPP PA system was reviewed and compared against the FEPs baseline to identify areas of change. This review concludes with 245 FEPs in the baseline for the CRA-2014. No FEPs have been added, and none deleted since the CRA-2009. Of these, 187 FEPs were unchanged from the CRA-2009. For the CRA-2014, 58 FEPs will be updated with new information, one of which will also be updated as a result of EPA's review of the CRA-2009. Of these 58 FEPs, one has had a screening decision change. FEP W115, *Chemical Degradation of Panel Closures* formerly screened UP, has been changed to SO-P, due to its ROM salt construction. The 58 FEPs that have been updated or added for the CRA-2014 are listed below in Table 4.

Table 4: FEPs Reassessment Results

EPA FEP I.D.	FEP Name	Screening Decision Changed	Change Summary	Screening Classification
N2	***Brine Reservoirs***	No	Update with new parameter PBRINE	DP
N12	***Seismic Activity***	No	Update with new seismic data.	UP
H1	***Oil and Gas Exploration***	No	Update with new drilling rate.	SO-C (HCN) DP (Future)
H3	***Water Resources Exploration***	No	Updated with most recent monitoring information.	SO-C (HCN) SO-C (Future)
H5	***Groundwater Exploitation***	No	Updated with most recent monitoring information.	SO-C (HCN) SO-C (Future)
H23	***Blowouts***	No	Update with new parameter PBRINE	SO-C (HCN) DP (Future)
H31	***Natural Borehole Fluid Flow***	No	Update to reference new plug type probabilities.	SO C (HCN) SO-C (Future, holes not penetrating waste panels) DP (Future, holes penetrating panels)
H32	***Waste-Induced Borehole Flow***	No	Update to reference new plug type probabilities.	SO-R (HCN) DP (Future)

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
H58	***Solution Mining for Potash***	No	Update with information regarding solution activities in the region.	SO-R (HCN) SO-R (Future)
H59	***Solution Mining for Other Resources***	No	Update with new information regarding brine wells in the region.	SO-C (HCN) SO-C (Future)
W1	***Disposal Geometry***	No	Update with new information regarding additional mined volume in experimental region.	UP
W2	***Waste Inventory***	No	Update to reflect the inventory data sources used for the CRA-2014.	UP
W3	***Heterogeneity of Waste Forms***	No	Update to reflect the inventory data sources used for the CRA-2014.	DP
W4	***Container Form***	No	Update to reflect the inventory data sources used for the CRA-2014.	SO-C – Beneficial
W5	***Container Material Inventory***	No	Update to reflect the inventory data sources used for the CRA-2014.	UP
W10	***Backfill Chemical Composition***	No	Update to reflect implementation of water balance in PA.	UP
W13	***Heat from Radioactive Decay***	No	Update to reflect the inventory used for the CRA-2014, as well as note SDI heater tests.	SO-C

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
W14	***Nuclear Criticality: Heat***	No	Update to reflect the inventory used for the CRA-2014.	SO-P
W15	***Radiological Effects on Waste***	No	Update to reflect the inventory used for the CRA-2014	SO-C
W16	***Radiological Effects on Containers***	No	Update to reflect the inventory used for the CRA-2014.	SO-C
W17	***Radiological Effects on Shaft Seals***	No	Update argument to reflect the inventory used for the CRA-2014.	SO-C
W18	***Disturbed Rock Zone***	No	Update to include ROM PCS implementation.	UP
W19	***Excavation-Induced Change in Stress***	No	Update to include ROM PCS implementation.	UP
W20	***Salt Creep***	No	Update to include ROM PCS implementation.	UP
W21	***Change in the Stress Field***	No	Update to include ROM PCS implementation.	UP
W28	***Nuclear Explosions***	No	Update to reflect the inventory used for the CRA-2014	SO-P
W29	***Thermal Effects on Material Properties***	No	Update to reflect the inventory used for the CRA-2014, as well as SDI heater tests.	SO-C
W30	***Thermally-Induced Stress Changes***	No	Update to reflect the inventory used for the CRA-2014, as well as SDI heater tests.	SO-C

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
W31	***Differing Thermal Expansion of Repository Components***	No	Update to reflect the inventory used for the CRA-2014, as well as SDI heater tests.	SO-C
W33	***Movement of Containers***	No	Update to reference new inventory data.	SO-C
W40	***Brine Inflow***	No	Update to reflect water balance implementation in PA.	UP
W41	***Wicking***	No	Update to reflect water balance implementation in PA.	UP
W42	***Fluid Flow Due to Gas Production***	No	Update to reflect water balance implementation in PA.	UP
W43	***Convection***	No	Update to reflect the SDI heater tests.	SO-C
W44	***Degradation of Organic Material***	No	Update to reference new inventory data.	UP
W45	***Effects of Temperature on Microbial Gas Generation***	No	Update to reference new inventory data.	UP
W48	***Effects of Biofilms on Microbial Gas Generation***	No	Update to reference new inventory data.	UP
W47	***Effects of Radiation on Microbial Gas Generation***	No	Update screening argument with new radionuclide inventory, and add information from EPA request for additional information on CRA-2009.	SO-C

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
W49	***Gases from Metal Corrosion***	No	Update to reference new corrosion experiments and associated parameters.	UP
W51	***Chemical Effects of Corrosion***	No	Update to reference new corrosion experiments and associated parameters.	UP
W53	***Radiolysis of Cellulose***	No	Update screening argument with new radionuclide inventory.	SO-C
W54	***Helium Gas Production***	No	Update screening argument with new radionuclide inventory.	SO-C
W55	***Radioactive Gases***	No	Reference CRA-2014 inventory data.	SO-C
W68	***Organic Complexation***	No	Update to reflect implementation of variable brine volume in PA.	UP
W69	***Organic Ligands***	No	Update to reflect implementation of variable brine volume in PA.	UP
W72	***Exothermic Reactions***	No	Update to reflect the inventory used for the CRA-2014, as well as SDI heater tests.	SO-C
W73	***Concrete Hydration***	No	Update to reflect the inventory used for the CRA-2014, as well as SDI heater tests.	SO-C

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
W85	***Cavings***	No	Update with new waste shear strength data.	DP
W86	***Spallings***	No	Update with new water balance information.	DP
W89	***Transport of Radioactive Gases***	No	Update screening argument with CRA-2014 inventory data.	SO-C
W93	***Soret Effect***	No	Update to reference new inventory data.	SO-C
W109	***Panel Closure Geometry***	No	Update screening argument with new information regarding ROM PCS materials.	UP
W110	***Panel Closure Physical Properties***	No	Update screening argument with new information regarding ROM PCS materials.	UP
W111	***Panel Closure Chemical Composition***	No	Update screening argument with new information regarding ROM PCS materials.	Beneficial SO-C
W112	***Radionuclide Effects on Panel Closures***	No	Update screening argument with new information regarding ROM PCS materials.	SO-C
W113	***Consolidation of Panel Closures***	No	Update screening argument with new information regarding ROM PCS materials.	UP
W114	***Mechanical Degradation of Panel Closures***	No	Update screening argument with new information regarding ROM PCS materials.	UP

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
W115	***Chemical Degradation of Panel Closures***	Yes	Update screening argument with new information regarding ROM PCS materials, change screening decision to SO-P.	(SO-P)

3.1 ADDITIONAL ACTIVIITES

As a result of this assessment, the following activities are required to assure that the FEPs baseline is accurately updated and documented.

1. Update the Baseline FEPs List (Kirkes 2009b) with the changes listed above in Table 4 and place in records package 549146.

2. Modify those FEPs identified above in the baseline FEPs screening document (currently, Appendix SCR-2009). The newly modified version of Appendix SCR will be submitted as part of the CRA-2014. The updated Attachment SCR should also be placed in records package 549146.

4. REFERENCES

Bradshaw, R.L. and W.C. McClain. 1971. Project Salt Vault: *A Demonstration of the Disposal of High-Activity Solidified Wastes in Underground Salt Mines.* April 1971. Oak Ridge National Laboratory. Oak Ridge, TN.

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

Herrick, C.G., M.D. Schuhen, D.M. Chapin, and D.C. Kicker. 2012. *Determining the Hydrodynamic Shear Strength of Surrogate Degraded TRU Waste Materials as an Estimate for the Lower limit of the Performance Assessment Parameter TAUFAIL.* ERMS 558479. Sandia National Laboratories, Carlsbad, NM.

Kirchner, T., T. Zeitler, and R. Kirkes. 2012. *Evaluating the Data in Order to Derive a Value for GLOBAL:PBRINE.* Memorandum to Sean Dunagan dated December 11, 2012. ERMS 558724. Sandia National Laboratories, Carlsbad, NM.

Kirkes, G.R. 2009a. *Features, Events and Processes Assessment for Changes Described in Analysis Plan – 145.* Revision 0. August 31, 2009. ERMS 551888. Sandia National Laboratories, Carlsbad, NM.

Kirkes, G.R. 2009b. *Baseline Features, Events, and Processes List for the Waste Isolation Pilot Plant, Revision 2.* August 25, 2009. ERMS 551874. Sandia National Laboratories, Carlsbad, NM.

Kirkes, G.R. 2011a. *Features, Events and Processes Assessment for Changes Described in Analysis Plan – 151.* Revision 0. March 29, 2011. ERMS 555237. Sandia National Laboratories, Carlsbad, NM.

Kirkes, G.R. 2011b. *Features, Events and Processes Assessment for Changes Described in Analysis Plan – 156*, Salt Disposal Investigations. Revision 0. June 6, 2011. ERMS 554671. Sandia National Laboratories, Carlsbad, NM.

Moody, D.C. 2010. Letter to Tom Kelly, Acting Director, Office of Radiation and Indoor Air, U.S. EPA. *"Response to the Environmental Protection Agency October 19, 2009 Letter on the 2009 Compliance Recertification Application."* 5th Response Package, Enclosure 1. February 19, 2010. U.S. Department of Energy, Carlsbad Field Office. Carlsbad, NM.

Roselle, G.T. 2013. *Determination of Corrosion Rates from Iron/Lead Corrosion Experiments to be used for Gas Generation Calculations.* ERMS 559077. Sandia National Laboratories, Carlsbad, NM.

U.S. Congress. 1996. Waste Isolation Pilot Plant Land Withdrawal Act, as amended. Public Law 102-579, September 1996. 104th Congress, Washington, D.C.

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

U.S. DOE. 2012. Delaware Basin Monitoring Annual Report. DOE/WIPP-12-2308.

U.S. EPA. 1993. Title 40 CFR Part 191: Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes; Final Rule. Federal Register, Vol. 58, No. 242, pp. 66398-66416. Office of Radiation and Indoor Air, Washington, D.C.

U.S. EPA. 1998. Title 40 CFR Part 194: Criteria for the Certification and Re-certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations: Certification Decision; Final Rule. Federal Register, Vol. 63, No. 95, pp. 27353-27406. Office of Radiation and Indoor Air, Washington, D.C.

U.S. EPA. 2006a. Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations: Recertification Decision. March 29, 2006. EPA-HQ-OAR-2004-0025; Office of Radiation and Indoor Air, Washington, D.C

U.S.EPA. 2006b. Compliance Application Review Document (CARD) for the Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations: Final Certification Decision, CARD No. 32, Scope of Performance Assessments. EPA Air Docket A-98-49. Docket Number V-B2-1. March 2006. USEPA, Office of Radiation and Indoor Air. Washington, D.C.

U.S. EPA 2010a. "40 CFR Part 194 Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the Disposal Regulations: Rectification Decision; Final Notice." *Federal Register*, vol. 75 (November 18, 2010): 70584 - 595.

U.S. EPA 2010b. "2009 Compliance Recertification Application (2009 CRA) Compliance Application Review Document No. 32: Scope of Performance Assessments." EPA Docket FDMS Docket ID No. EPA-HQ-OAR-2009-0330. Office of Radiation and Indoor Air. Washington, D.C.

U.S. EPA 2010c. "Technical Support Document for Sections 194.25, 194.32, and 194.33: Review of Changes to the WIPP Performance Assessment Features, Events, and Processes Since the 2004 CRA." EDOCKET No. EPA-HQ-OAR-2009-0330. November 2010. Office of Radiation and Indoor Air, Washington, D.C.

U.S. EPA 2010d. Technical Support Document for Section 194.24, Evaluation for the Compliance Recertification Actinide Source Term, Backfill Efficacy and Culebra Dolomite Distribution Coefficient Values (Revision 1). November 2010. Office of Radiation and Indoor Air, Washington, D.C.

Van Soest, G.D. 2012. *Performance Assessment Inventory Report – 2012*. Los Alamos National Laboratory Carlsbad Operations. LA-UR-12-26643. Carlsbad, NM.

Wagner, S., Kirkes, R., and Martell, M.A. 2003. *Features, Events and Processes: Reassessment*

for Recertification Report. Sandia National Laboratories, Carlsbad, New Mexico, ERMS #530184. Sandia National Laboratories, Carlsbad Programs Group. Carlsbad, New Mexico.