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Sandia National Laboratories
Waste Isolation Pilot Plant

Features, Events and Processes Assessment for the Compliance Recertification Application – 2019, Revision 0

Author:	Ross Kirkes	Ross Kirkes	8881	10/11/19
	Print	Signature	Org.	Date
Technical Review:	Steve Wagner	Steve Wagner	8881	10/11/19
	Print	Signature	Org.	Date
Management Review:	Paul Shoemaker	Paul E. Shoemaker	8880	10/15/19
	Print	Signature	Org.	Date
QA Review:	Steve Davis	Steve Davis	8880	10/10/2019
	Print	Signature	Org.	Date

Sandia National Laboratories

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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 has submitted Compliance Recertification Applications (CRAs) that demonstrate continued compliance with EPA's requirements for radioactive waste disposal in March 2004, 2009, and 2014. As part of their review of each CRA, the EPA evaluates the FEPs basis as presented by the DOE and documents their review in their Compliance Application Review Documents (CARDs) and Technical Support Documents (TSDs). The EPA's most recent review of the WIPP FEPs baseline was for CRA-2014 and is presented in their CARD for Section 194.32 (EPA 2017a) and related TSD (EPA 2017b).

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," (Kirkes 2016). Through this procedure, the FEPs baseline is managed and updated systematically over time. The method provided in SP 9-4 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-2014, and the identification of new information that has not been reviewed within the SP 9-4 FEPs assessments. The results of this analysis thereby identify the changes to the FEPs basis for the CRA-2019. The entire FEPs baseline, including those changed as a result of this assessment and those that were unchanged will be documented in Appendix SCR-2019.

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 2017c). The FEPs baseline is represented

by: (1) the most current version of Attachment SCR (currently, Appendix SCR-2014); (2) FEPs assessment results and other information in Sandia Records Package 549146 (the records package for SP 9-4 reports); (3) changes planned for the conduct of the CRA-2019 PA; 4) information relevant to the PA baseline that originates from sources outside the PA program; and 5) changes resulting from comments and responses between the DOE and the EPA during review of the CRA-2014. This analysis will evaluate the FEPs baseline and identify areas of change in three steps.

First, this analysis will evaluate changes to the PA baseline since the CRA-2014 by reviewing all FEPs assessments that have been conducted under SP 9-4 since that time. 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 consider changes described in AP-181 (Zeitler 2019a) and identify FEPs for evaluation resulting from the changes described for the deferred performance assessment.

Third, this analysis will evaluate new information from outside the WIPP PA program. This information may come from DOE monitoring programs, EPA evaluations of compliance published in their CARDs and TSDs of the most recent certification decision (U.S. EPA 2017a and 2017b), 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. Note that some data that originates outside the WIPP program will be addressed as part of the changes identified by AP-181 above (step 2). 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 human-induced FEPs are applied. Historic, current, and near-future (HCN) are those FEPs that have 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-2019. Records package 549146 includes the following FEPs assessments conducted since the CRA-2014:

1. Features, Events and Processes Assessment for Changes Described in Analysis Plan -169, Impact Assessment of Additional WIPP Shaft, Revision 0 (Kirkes 2014).

2. Features, Events and Processes Assessment for Changes Described in Analysis Plan-177, Assessment of Abandoned Panel Closures in South End of Repository and Lack of Waste Emplacement in Panel 9 (Kirkes 2017).

3. Limited FEPs Assessment for a Bounding Waste Inventory Using PFLOTRAN, Revision 0 (Kirkes and Park 2015).

Kirkes and Park (2015) listed as Item 3 above was not used for compliance purposes but rather to evaluate the suitability of a new computer code under development (PFLOTRAN) for comparative analyses with existing baseline codes. As such, it is not included in this assessment as PFLOTRAN is still under development and is not yet a fully-qualified WIPP PA code.

The remainder of this section will discuss the scope and results of items (1) and (2) above.

2.1.1 FEPs Assessment for AP-169

AP-169 (Camphouse 2014) describes the analyses necessary to evaluate the impact of an additional exhaust ventilation shaft and any associated access tunnels to the WIPP repository performance.

AP-169 identified the following changes associated with adding a fifth WIPP shaft:

1) Representing an additional shaft and associated access drifts within the current repository grid.

2) Constructing BRAGFLO modeling cases which represent the new shaft and access drift changes and compare to the most recent PA results.

Kirkes (2014) reviewed the planned analysis against the then-current FEPs baseline and determined that no revision to FEPs or their bases was warranted, however modeling changes would be necessary to conduct this analysis. FEPs that are related to the analysis conducted for AP-169 are provided below in Table 1:

Table 1: FEPs Related to Changes in AP-169

Related FEPs	Screening Classification	Relationship to Proposed Change
W1 Disposal Geometry	UP	The repository layout must be adequately represented in the BRAGFLO grid.
W6 Shaft Seal Geometry	UP	Shafts are planned to be sealed upon repository closure. The long-term properties of these seals are represented in performance assessment.
W8 Shaft Seal Chemical Composition	SO-C (Beneficial)	An additional shaft may change the ratio of chemicals present in the repository.

Table 1: FEPs Related to Changes in AP-169

Related FEPs	Screening Classification	Relationship to Proposed Change
W17 Radiological Effects of Shaft Seals	SO-C	Additional shaft will be sealed upon repository closure.
W18 Disturbed Rock Zone (DRZ)	UP	Additional access drifts will create additional DRZ.
W19 Excavation-Induced Change in Stress	UP	Excavation to create the access drifts may change stress in repository.
W20 Salt Creep	UP	Salt creep may affect access drifts or shafts.
W21 Change in the Stress Field	UP	Excavation to create the access drifts may change stress in repository.
W22 Roof Falls	UP	Roof falls may occur in new drifts.
W24 Large Scale Rock Fracturing	SO-P	Additional access drifts may cause or be subjected to rock fracturing.
W36 Consolidation of Shaft Seals	UP	Additional shaft is expected to consolidate as other shafts.
W37 Mechanical Degradation of Shaft Seals	UP	Additional shaft will behave mechanically similar as current shafts.
W40 Brine Inflow	UP	Brine may flow into additional access drifts.
W73 Concrete Hydration	SO-C	Sealing additional shaft will increase the mass of concrete in the repository.
W74 Chemical Degradation of Shaft Seals	UP	Additional shaft will have the same chemical behavior as current shafts.

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

No changes to any screening decisions will be made as a result of changes evaluated by AP-169. Updated information to FEPs W1 *Disposal Geometry*, W6 *Shaft Seal Geometry*, W36 *Consolidation of Shaft Seals*, W37 *Mechanical Degradation of Shaft Seals*, W73 *Concrete*

Hydration, and W74 *Chemical Degradation of Shaft Seals* to note the new implementation of the additional shaft in PA will be necessary as a result of the FEPs assessment for AP-169.

2.1.2 Assessment for Changes Described in AP-177

Kirkes (2017) evaluated the impacts to the FEPs baseline as a result of studies conducted under Analysis Plan AP-177 (Zeitler and Day, 2017), which describes the analyses necessary to evaluate the impacts of abandoning panel closures in the south end of the repository and the lack of waste emplacement in Panel 9. These analyses sought to:

1. Evaluate the effect of the abandonment of panel closures in the south end of the repository;
2. Modify the representation of panel closures in the BRAGFLO and BRAGFLO_DBR grids;
3. Modify the properties (parameterization) of areas where panel closures were formerly planned;
4. Adapt and justify modeling assumptions regarding panel adjacency in the CCDFGF code; and
5. Justify modeling assumptions regarding the absence of waste in Panel 9.

Kirkes (2017) identified 16 FEPs related to activities in AP-177. These are listed below in Table 2.

Table 2: FEPs Related to Changes in AP-177

Related FEPs	Screening Classification	Relationship to Proposed Change
W1 Disposal Geometry	UP	The location of panel closures must be adequately represented in the BRAGFLO grid.
W18 Disturbed Rock Zone (DRZ)	UP	The DRZ is modeled differently for areas above and below panel closures.
W20 Salt Creep	UP	Salt creep will close open areas, including areas where panel closures were planned.
W21 Changes in the Stress Field	UP	Salt creep will affect the stress field around open areas, including areas where panel closure are planned.
W84 Cuttings	DP	The absence of waste in Panel 9 will preclude actual cuttings releases.
W85 Cavings	DP	The absence of waste in Panel 9 will preclude actual cavings releases.
W86 Spallings	DP	The absence of waste in Panel 9 will preclude actual spallings releases.

Table 2: FEPs Related to Changes in AP-177

Related FEPs	Screening Classification	Relationship to Proposed Change
W109 Panel Closure Geometry	UP	The location of panel closures must be adequately represented in the BRAGFLO grid.
W110 Panel Closure Physical Properties	UP	Appropriate representation of the effectiveness of panel closures (or their absence) must be adequately represented in the overall performance assessment.
W111 Panel Closure Chemical Composition	UP	The chemistry of panel closures should be considered within the performance assessment.
W112 Radiological Effects on Panel Closures	SO-C	Radiation could alter the effectiveness of panel closures.
W113 Consolidation of Panel Closures	UP	Run-of-Mine Salt Panel closures (where installed) will consolidate, reducing porosity and permeability.
W114 Mechanical Degradation of Panel Closures	UP	Gas pressurization and other factors could affect panel closure properties (where installed).
W115 Chemical Degradation of Panel Closures	SO-P	Chemical reactions could affect panel closure permeability.
H1 Oil and Gas Exploration	DP	Intrusions into waste areas could result in releases to overlying units or the ground surface.
H31 Natural Borehole Fluid Flow	DP	Intrusions into waste panels could result in flow upwards to overlying units or the land surface (i.e., direct brine release)

UP: Screened in, undisturbed performance scenario
DP: Screened in, disturbed performance scenario
SO-C: Screened out, consequence
SO-P: Screened out, probability

It was determined that no screening decision changes were merited; however, updates to the screening arguments should be made to reflect new information regarding the implementation of these FEPs. The following FEPs will need to be updated for the CRA-2019 as a result of the analyses carried out in AP-177.

The FEP W1 *Disposal Geometry* is currently accounted for in PA calculations. No change is needed to the screening decision for this FEP; however, appropriate changes must be made at

the model implementation level of the PA methodology as described in AP-177. This FEP will be updated in the CRA-2019 to reflect the changes in implementation.

The FEP W109 *Panel Closure Geometry* is currently accounted for in PA calculations. No change is needed to the screening decision for this FEP; however, updates will be in the CRA-2019 to reflect the changes in implementation.

The FEP W110 *Panel Closure Physical Properties* is currently accounted for in PA calculations. Panel closures will continue to be represented in PA models. No change is needed to the screening decision for this FEP; however, updates will be in the CRA-2019 to reflect the changes in implementation.

The FEPs W111 *Panel Closure Chemical Composition* is currently accounted for in PA calculations. Since the planned changes associated with this analysis do not alter the construction or composition of panel closures, the screening decision for this FEPs is not affected. This FEP will be updated in the CRA-2019 to reflect the changes in implementation.

The FEP W113 *Consolidation of Panel Closures* is accounted for in PA calculations. The screening decision for this FEP will remain unchanged. This FEP will be updated in the CRA-2019 to reflect the elimination of panel closures in the south end of the repository.

The FEP W114 *Mechanical Degradation of Panel Closures* is accounted for in PA calculations through the assigned material properties for panel closures. This FEP will be updated in the CRA-2019 to reflect the elimination of panel closures in the south end of the repository.

The FEPs W84 *Cuttings,* W85 *Cavings, and* W86 *Spallings* are currently accounted for in PA calculations in disturbed performance scenarios. No change needed to the screening decision for these FEPs; however, these FEPs will be updated in the CRA-2019 to reflect the changes in implementation of these FEPs with regard to Panel 9.

2.2 ASSESSMENT FOR CHANGES DESCRIBED IN AP-181

FEPs assessments for changes that relate to Section 2.1 Items 1 and 2 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-181 (Zeitler 2019a). 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 any updates to the descriptions or screening arguments of FEPs will be noted as appropriate.

AP-181 describes the PA analysis to be conducted and included in the CRA-2019 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-181 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-2019 will establish a new compliance baseline.

AP-181 describes the PA planned for the CRA-2019.

1. Inclusion of an approach to accommodate the operational decisions to not emplace panel closures in Panels 3, 4, 5, and 6 and to not emplace waste in Panel 9.
2. Inclusion of an approach to accommodate an additional shaft connecting the repository to the surface, as well as an additional mined region in the repository north end to accommodate drifts that lead to the new shaft.
3. Refinement of the gas generation process model to include brine radiolysis.
4. An update to the probability that a drilling intrusion into a repository excavated region will intersect the Castile brine reservoir modeled in BRAGFLO.
5. Refinement to the corrosion rates of steel under humid and inundated conditions.
6. Refinement to the effective shear strength of WIPP waste.
7. Refinement to colloid enhancement parameters associated with actinide mobilization.
8. Refinement to the hydromagnesite to magnesite conversion rate.
9. Removal of two chemical reactions associated with iron sulfidation.
10. Correction to the length of the northernmost panel closure representation in the BRAGFLO grid.
11. Updates to drilling rate and plugging pattern parameters.
12. Updates to WIPP waste inventory parameters.
13. Updates to radionuclide solubilities and their associated uncertainty.
14. An update to the BH_OPEN:RELP_MOD parameter.
15. Introduction of new materials to define properties in some disturbed rock zone areas.
16. Hardware and computational code updates, including two codes that have been qualified for WIPP PA and added to the Software Baseline—those codes were previously qualified and used under Nuclear Waste Management Procedure NP 9-1: Analyses.

Items 1 and 2 above (changes from AP-169 and AP-177 were discussed in Sections 2.1.1 and 2.1.2 respectively and will not be discussed further. The remainder of this section will focus on items 3-15. Item 16 relates only to computer and hardware updates and is not related to the FEPs screening process or the FEPs baseline. It will not be discussed in this assessment.

2.2.1 Refinement of the gas generation process model to include brine radiolysis

Routine queries and investigations into the PA system prompted the re-evaluation of the screening decisions for WIPP FEPs W52 *Radiolysis of Brine* and W53 *Radiolysis of Cellulose*. Day (2019) concluded that radiolysis of brine should be screened in for CRA-2019 due to a better understanding of the interplay between gas generation, pore-pressure, and brine saturation in the waste areas of the repository. Additionally, Day concluded that radiolysis of cellulose, plastic, and rubber (CPR) remains to be an unimportant contributor to overall gas generation and should therefore remain screened out of PA calculations.

Day (2012) presents four new PA parameters necessary to implement radiolysis of brine within the PA gas generation process model. Further implementation of these changes can be found in Zeitler (2019a). Therefore, the screening decision and screening argument for W52, *Radiolysis of Brine* will be updated for the CRA-2019. Only the screening argument will be modified for the FEP W53, *Radiolysis of Cellulose*, as it remains screened out of PA calculations. Lastly, W26, *Pressurization* and W67 *Localized Reducing Zones* will be updated to note additional gas quantities that may be produced by the radiolysis of brine.

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

Human FEPs H1 *Oil and Gas Exploration,* H4 *Oil and Gas Exploitation,* 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 FEPs H1 and H4, 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.

Drilling-related parameters implemented in PA are based on the most recent data gathered and reported in the Delaware Basin Monitoring Annual Report (DBMAR) (DOE 2018). The WIPP PA parameter GLOBAL:LAMBDAD represents the current drilling rate. The CRA-2019 will use the current rate of 9.90×10^{-3} boreholes per km^2 per year. Screening decisions for FEPs H1, *Oil and Gas Exploration*, H4, *Oil and Gas Exploitation*, and H23, *Blowouts* will not change, however updates to their screening arguments will be made to reference new drilling data for the CRA-2019.

The probability that an inadvertent exploratory borehole in the future will penetrate the repository is established by EPA's prescribed method (EPA 2017d), and the value was changed from that used in the CRA-2014. As mentioned, FEP N2 *Brine Reservoir* is classified as DP, and remains unchanged, but the EPA-directed parameter distribution for the probability of encountering pressurized brine will be changed for the CRA-2019 as shown in Zeitler (2019a). The screening argument for FEP N2, *Brine Reservoir* will be updated to reference the new EPA-mandated parameter distribution.

Human FEPs H31, *Natural Borehole Fluid Flow* and H32, *Waste-Induced Borehole Flow* are classified DP for the future timeframe. 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, although their screening decisions will not change.

2.2.3 Refinement to the Corrosion Rate of Steel

Since the last recertification, a cumulative distribution for HUMCORR was developed (Zeitler and Hansen 2015b) and later revised based on an updated estimate of the CO^2 level expected in the repository, which itself is recalculated each time the thermodynamic database is revised (Zeitler and Hansen 2015c). To avoid recalculation of the HUMCORR distribution each time the

thermodynamic database is revised in the future, a CO^2 level that is expected to bound future predicted CO^2 levels was selected and used to again revise the HUMCORR distribution (Zeitler 2018). Metal corrosion is represented in WIPP PA via FEPs W26 *Pressurization,* W42 *Fluid Flow Due to Gas Production*, 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.

2.2.4 Refinement to the Shear Strength of WIPP Waste

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. Since the CRA-2014, the EPA requested that the DOE reconsider the data to be included in the TAUFAIL distribution, including lowering the lower bound of the distribution. The resulting cumulative distribution for TAUFAIL is described in U.S. EPA (2017e) and summarized in Zeitler (2019b). This FEP will be updated with new information that describes the parameter update related to its implementation within PA. The screening for FEP W85 *Cavings* will remain DP for the CRA-2019.

2.2.5 Refinement to colloid enhancement parameters associated with actinide mobilization

Elements of PA that relate to actinide mobility will be updated based on new laboratory data (Swanson et al. 2019; Reed et al. 2019; and Mariner 2019). These parameters do not affect any FEP screening decisions, as they are already accounted for in PA. Related FEPs descriptions and arguments will be updated to reflect this implementation change. Updated FEPs include W78 *Colloidal Transport*, W79 *Colloidal Formation and Stability*, W80 *Colloidal Filtration*, and W81 *Colloidal Sorption.*

2.2.6 Refinement of Hydromagnesite Conversion Rate

In their review of the CRA-2014, the EPA recommended a different distribution for the hydromagnesite conversion rate to be used in the CRA-2019 PA (U.S. EPA 2017f). The uniform distribution used for HYMAGCON in the CRA-2019 PA is described in U.S. EPA (2017f). This change is considered a PA implementation change and does not affect the screening decisions for the two related FEPs, W26 *Pressurization* and W42 *Fluid Flow Due to Gas Production.* An update to these FEPs will be made to reflect this change.

2.2.7 Removal of Iron Sulfidation Reactions

The EPA requested the removal of two iron sulfidation reactions from WIPP PA (EPA 2017e). This was done by the use of zero values for these stoichiometric coefficients. These zero values were used by the DOE as part of the CRA14_SEN4 sensitivity study (Zeitler and Day 2016) and will also be used for the CRA-2019. These parameter changes are considered PA implementation changes and are downstream of the WIPP FEP screening process. An update to FEPs W26 *Pressurization* and W42 *Fluid Flow Due to Gas Production* to reflect this change.

2.2.8 Correction to Length of Northernmost Panel Closure Representation

As part of the DOE/EPA completeness determination discussions for CRA-2014, an error in the length of the northernmost panel closure was identified by the DOE—the northernmost panel closure in the BRAGFLO grid should represent the length of two panel closures; that is the

northernmost panel closure should have been 200 ft. (60.96 m) long, rather than 100 ft. (30.48 m) long, as had been used in the BRAGFLO model for the CRA-2014 PA. Corrected values will be used for the CRA-2019, as identified in Table 2-12 of Zeitler (2019a). This parameter change is considered a PA implementation change and is downstream of the WIPP FEP screening process. Repository layout and the placement and dimensionality of panel closures are represented by FEPs W1 *Disposal Geometry* and W109 *Panel Closure Geometry*. Updates will be made to these FEPs to indicate this error correction.

2.2.9 Updated Waste Inventory Information

The CRA-2019 PA will use the most recent inventory information available. This information is presented in the Performance Assessment Inventory Report (PAIR) – 2018 (Van Soest 2018). The PAIR – 2018 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, 2017. 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*
W5 Container Material Inventory
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*
W42 *Fluid Flow Due to Gas Production*
W43 *Convection*
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*
W49 *Gases from Metal Corrosion*

W51 *Chemical Effects of Corrosion*

W54 *Helium Gas Generation*

W55 *Radioactive Gases*

W56 *Speciation*

W68 *Organic Complexation*

W69 *Organic Ligands*

W72 *Exothermic Reactions*

W73 *Concrete Hydration*

W78 *Colloidal Transport*

W79 *Colloidal Formation and Stability*

W80 *Colloidal Filtration*

W81 *Colloidal Sorption*

W87 *Microbial Transport*

W89 *Transport of Radioactive Gases*

W93 *Soret Effect*

W97 *Chemical Gradients*

W112 *Radiological Effects on Panel Closures*

As a result of the new inventory data, these FEPs will be updated as appropriate to reflect the new information.

2.2.10 Updates to Radionuclide Solubilities and Uncertainties

The solubilities of actinide elements are influenced by the chemical components of the waste. As mentioned, the PA inventory used for the CRA-2019 has been updated (Van Soest 2018). To incorporate the updated information, parameters used to represent actinide solubilities will be updated for the CRA-2019. Waste-related FEPs W56 *Speciation*, W68 *Organic Complexation* and W69 *Organic Ligands* are 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.

2.2.11 Update to the BH_OPEN:RELP_MOD Parameter

Zeitler (2019a) identifies a minor error correction in the BRAGFLO code related to the calculation of capillary pressure within the open intrusion borehole. This error correction is clearly an implementation change and does not affect FEP screening. The intrusion borehole is represented by FEPs H1 *Oil and Gas Exploration*, H21 *Drilling Fluid Flow*, and H31 *Natural Borehole Flow*. New information will be made to these FEPs to indicate this error correction.

2.2.12 New Materials to Define Properties of the Disturbed Rock Zone in Certain Repository Areas

As part of their review of the CRA-2014, the EPA directed multiple sensitivity studies that investigated impacts of parameter changes to the OPS, EXP, and panel closure areas and their associated disturbed-rock zones (DRZs), while leaving the DRZ surrounding the waste panel unchanged. To facilitate those analyses, new material names were used that introduced flexibility in specifying material properties independently across areas for which material properties in the CRA-2014 PA were identical. Zeitler (2019a) identifies these materials and describes their implementation in PA. This change is downstream of the FEPs screening process and will not affect the screening argument or decision. The FEP W18 *Disturbed Rock Zone* implements this change, and it will be updated to indicate that a change in implementation has occurred.

2.3 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 DBMAR for 2018 (DOE 2018), and independent contractor reports.

2.3.1 Underground Experiments at WIPP

2.3.1.1 Salt Disposal Investigations

Underground experiments titled "Salt Disposal Investigations" (SDI) are planned to gather data regarding the potential performance of a repository for heat-generating waste in bedded salt, and to better understand the integrated response of the salt at the field scale (Otto 2017). No additional mining is expected for this phase of the SDI tests. This test will include the installation of a single full-size heated canister in the underground at WIPP near the air intake shaft to test the operability and heater power supply systems in in-situ conditions. FEPs related to this experiment will be W29 *Thermal Effects on Material Properties,* W30, *Thermally-Induced Stress Changes*, W31 *Differing Expansion of Repository Components*, W72 *Exothermic Reactions*, W73 *Concrete Hydration*, and W43 *Convection*. Screening arguments and decisions will not be affected, but these FEPs should be updated to reflect the conduct of this stage of the SDI tests.

2.3.1.2 Brine Availability Tests in Salt

A set of borehole heater tests called the "Brine Availability Tests in Salt (BATS) are underway to improve the existing long-term repository safety case for disposal of heat-generating radioactive waste in salt. The first phase of the BATS test employs two horizontal borehole heater tests to be conducted in the existing SDI area in the northern experimental area of the WIPP. One borehole will be heated, the other unheated with the purpose of determining brine movement due to the heat, thus simulating heat-generating waste forms. No additional mining will be conducted for this test. FEPs related to the BATS experiments will be W29 *Thermal Effects on Material*

Properties, W30, *Thermally-Induced Stress Changes*, W31 *Differing Expansion of Repository Components*, W72 *Exothermic Reactions*, W73 *Concrete Hydration*, and W43 *Convection.* Screening arguments and decisions will not be affected, but these FEPs should be updated to reflect the conduct of this stage of the SDI tests.

2.3.2 Delaware Basin Monitoring Annual Report for 2018

FEPs from current baseline (Appendix SCR-2014) were reviewed to determine if any required specific data and information from the DBMAR-2018 (DOE 2018). This review concluded that the following FEPs were in need of update.

2.3.2.1 N12 Seismic Activity

Summary of New Information

Seismic Activity (N12) is accounted for in PA and is screened UP. Since the CRA-2014, there were 2,699 seismic events within the Delaware Basin. The large increase of reported seismic events during this period cannot necessarily be attributed to an increase in seismic activity. Rather, in 2016 New Mexico Institute of Mining and Technology (NMIMT) upgraded their seismic network equipment which dramatically increased network sensitivity, thereby allowing NMIMT the capability to report on previously undetectable seismic activity. Therefore, comparisons with previous data are difficult, if not impossible to trend. As these events are generally small in magnitude and are likely anthropogenic in nature due to the recent dramatic increase in oil exploration and extraction in the Delaware Basin. This screening decision will not change, however additional information explaining this data disparity will be added to the screening argument.

2.3.2.2 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 2018). 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.

2.3.2.3 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 continues its in-situ solution mining process 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 an update to the status of this activity. The

screening argument will not change, however, as the solution activity lies outside the Delaware Basin boundary and will continue to use a regulatory-based screening.

2.3.2.4 H59 Solution Mining for Other Resources

Summary of New Information

H59 *Solution Mining for Other Resources* is screened SO-C. Since the CRA-2014, there has been one new brine well put into service within the Delaware Basin, 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 Reeves County, Texas. Finally, there is one well whose status is unknown due to missing data. Therefore, the total active brine well count is at 10, a reduction of 2 from the CRA-2014. These changes are illustrated below in Table 3. This new information will be incorporated in Appendix SCR-2018 into the H59 FEP screening argument, but the screening decision will not change as a result.

Table 3: Delaware Basin Brine Well Status (U.S. DOE 2018)

County	Location	API No.	Well Name and No.	Operator	CRA-2014 Status	CRA-2019 Status
Eddy	22S-26E-36	3001521842	City of Carlsbad #WS-1	Key Energy Services	Plugged 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	Plugged Brine Well	Plugged Brine Well
Eddy	22S-27E-17	3001523031	Eugenie #WS-2	I & W Inc	Plugged Brine Well	Plugged Brine 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	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	**Plugged Brine Well**
Reeves	Blk 04-08	4238920100	North Pecos Brine Station #WD-1	Chance Properties	Active Brine Well	**Plugged Brine Well**
Reeves	Blk 07-21	4238980476	Coyanosa Brine Station #1	Chance Properties	Active Brine Well	Active Brine Well

Table 3: Delaware Basin Brine Well Status (U.S. DOE 2018)						
County	**Location**	**API No.**	**Well Name and No.**	**Operator**	**CRA-2014 Status**	**CRA-2019 Status**
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	Active Brine Well
Ward	Blk 34-174	4247582265	Barstow Brine Station #1	Energy Equity Company	Active Brine Well	**Unknown**
Ward	Blk 34-214	4247536227	Brine #1	Mesquite SWD, Inc.	-	Active Brine Well

2.3.3 Information from the EPA Review of CRA-2014, and their CARDs and TSDs

EPA's review of the CRA-2014 is documented in their CARDs and TSDs (EPA 2017a and 2017b). EPA's review of Appendix SCR and Section 32 of the CRA-2014 resulted in numerous changes to FEPs arguments, although no changes to FEPs screening decisions were made. Generally, EPA requested that FEPs screening arguments provide more information regarding how a screened-in FEP was implemented within the PA. Several of these requests were accepted by DOE, resulting in the agreement that FEPs would be updated with more detailed information regarding how a given FEP is accounted for with the PA models. Tables 1 and 2 from EPA's TSD (EPA 2017b) identify 28 FEPs as needing update prior to the next CRA. These are listed below.

H21 Drilling Fluid Flow
H22 Drilling Fluid Loss
H23 Blowouts
H28 Enhanced Oil and Gas Production
H58 Solution Mining for Potash
W1 Disposal Geometry
W3 Heterogeneity of Waste Forms
W18 Disturbed Rock Zone
W19 Excavation-Induced Changes in Stress
W20 Salt Creep
W21 Changes in the Stress Field
W25 Disruption Due to Gas Effects
W28 Nuclear Explosions
W40 Brine Inflow
W42 Fluid Flow Due to Gas Production
W44 Degradation of Organic Material
W45 Effects of Temperature on Microbial Gas Generation
W72 Exothermic Reactions
W73 Concrete Hydration
W110 Panel Closure Physical Properties

W111 Panel Closure Chemical Composition
W113 Consolidation of Panel Closures
W114 Mechanical Degradation of Panel Closures
W115 Chemical Degradation of Panel Closures
W5 Container Material Inventory*
W27 Gas Explosions*
W33 Movement of Containers*
W53 Radiolysis of Cellulose*

Those FEPs above identified with an asterisk (*) were not changed per specific EPA comments. This may be due to newer information that supersedes EPA's position, or because the EPA concern may be addressed in other, more appropriate FEP descriptions or arguments.

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-2014 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-2019. No FEPs have been added, and none deleted since the CRA-2014. Of these, 164 FEPs were unchanged from the CRA-2014. For the CRA-2019, 81 FEPs will be updated with new information. Of these 81 FEPs, two have had their screening decisions changed. FEP W52 *Radiolysis of Brine* formerly screened SO-C, has been changed to UP, due to new analyses that demonstrate radiolysis of brine is no longer insignificant, and FEP W114, *Mechanical Degradation of Panel Closures* formerly screened UP, has been changed to SO-P, due to its ROM salt construction. The 81 FEPs that have been updated or added for the CRA-2019 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
N71	***Microbes***	No	Update for clarity.[1]	SO-C (UP – for colloidal effects and gas generation)

[1] N71 was not identified for change through any steps used in this analysis. It is included here for completeness.

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
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)
H4	***Oil and Gas Exploitation***	No	Updated with new drilling rate	SO-C (HCN) DP (Future)
H5	***Groundwater Exploitation***	No	Updated with most recent monitoring information.	SO-C (HCN) SO-C (Future)
H21	***Drilling Fluid Flow***	No	Updated with new information regarding the exclusion of experimental and northern areas of repository from intrusion.	SO-C (HCN) DP (Future)
H22	***Drilling Fluid Loss***	No	Updated with new information regarding the exclusion of experimental and northern areas of repository from intrusion.	SO-C (HCN) DP (Future)
H23	***Blowouts***	No	Update with new parameter PBRINE	SO-C (HCN) DP (Future)
H28	***Enhanced Oil and Gas Production***	No	Updated per EPA comment.	SO-C (HCN) SO-C (Future)
H31	***Natural Borehole Fluid Flow***	No	Update reflect corrections in BRAGFLO for open borehole parameters and reference new plug type probabilities.	SO C (HCN) SO-C (Future, holes not penetrating waste panels) DP (Future, holes penetrating panels)

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
H32	***Waste-Induced Borehole Flow***	No	Update to reference new plug type probabilities.	SO-R (HCN) DP (Future)
H58	***Solution Mining for Potash***	No	Update per EPA comment.	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 the abandonment of panel closures in the south end of the mine, correction of the northernmost panel closure dimensions, and additional shaft and associated drifts.	UP
W2	***Waste Inventory***	No	Update to reflect the inventory data sources used for the CRA-2019 and per EPA comment.	UP
W3	***Heterogeneity of Waste Forms***	No	Update to reflect the inventory data sources used for the CRA-2019 and per EPA comment.	DP
W4	***Container Form***	No	Update to reflect the inventory data sources used for the CRA-2019.	SO-C – Beneficial

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
W5	***Container Material Inventory***	No	Update to reflect the inventory data sources used for the CRA-2019.	UP
W6	***Shaft Seal Geometry***	No	Update to reflect additional shaft	UP
W8	***Shaft Seal Chemical Composition***	No	Update to reflect additional shaft	SO-C (Beneficial)
W13	***Heat from Radioactive Decay***	No	Update to reflect the inventory used for the CRA-2019.	SO-C
W14	***Nuclear Criticality: Heat***	No	Update to reflect the inventory used for the CRA-2019 and new criticality analysis.	SO-P
W15	***Radiological Effects on Waste***	No	Update to reflect the inventory used for the CRA-2019	SO-C
W16	***Radiological Effects on Containers***	No	Update to reflect the inventory used for the CRA-2019.	SO-C
W17	***Radiological Effects on Shaft Seals***	No	Update argument to reflect the inventory used for the CRA-2019.	SO-C
W18	***Disturbed Rock Zone***	No	Update to reference treatment of the DRZ near the ROM salt PCS.	UP
W19	***Excavation-Induced Change in Stress***	No	Update to reference treatment of the DRZ near the ROM salt PCS.	UP

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
W20	***Salt Creep***	No	Update to reference treatment of the DRZ near the ROM salt PCS.	UP
W21	***Change in the Stress Field***	No	Update to reference treatment of the DRZ near the ROM salt PCS.	UP
W22	***Roof Falls***	No	Roof falls may occur in new drifts and tunnels.	UP
W24	***Large Scale Rock Fracturing***	No	Additional access drifts may cause or be subjected to rock fracturing.	SO-P
W25	***Disruption Due to Gas Effects***	No	Update per EPA Comment.	UP
W26	***Pressurization***	No	Update to reflect gas generation due to radiolysis of brine, the removal of sulfidation reactions, and refinement of the hydromagnesite conversion process.	UP
W28	***Nuclear Explosions***	No	Update to reflect the inventory used for the CRA-2019 and per EPA comments.	SO-P
W29	***Thermal Effects on Material Properties***	No	Update to reflect the inventory used for the CRA-2019, underground experiments, and EPA comments.	SO-C

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
W30	***Thermally-Induced Stress Changes***	No	Update to reflect the inventory used for the CRA-2019, underground experiments, and EPA comments.	SO-C
W31	***Differing Thermal Expansion of Repository Components***	No	Update to reflect the inventory used for the CRA-2019 and underground experiments.	SO-C
W33	***Movement of Containers***	No	Update to reflect the inventory used for the CRA-2019.	SO-C
W36	***Consolidation of Shaft Seals***	No	Update to reflect additional shaft.	UP
W37	***Mechanical Degradation of Shaft Seals***	No	Update to reflect additional shaft.	UP
W40	***Brine Inflow***	No	Update to reflect EPA-mandated parameter distribution for PBRINE, and elimination of panel closures in south end of repository.	UP
W42	***Fluid Flow Due to Gas Production***	No	Update to reflect EPA-mandated parameter distribution for PBRINE and the removal of two sulfidation reactions refinement of the hydromagnesite conversion process.	UP

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
W43	***Convection***	No	Update to reflect the inventory used for the CRA-2019, underground experiments, and reference correction to mined volume in experimental area.	SO-C
W44	***Degradation of Organic Material***	No	Update to reflect the inventory used for the CRA-2019 and EPA comments.	UP
W45	***Effects of Temperature on Microbial Gas Generation***	No	Update to reflect the inventory used for the CRA-2019 and EPA comments.	UP
W48	***Effects of Biofilms on Microbial Gas Generation***	No	Update to reflect the inventory used for the CRA-2019.	UP
W47	***Effects of Radiation on Microbial Gas Generation***	No	Update to reflect the inventory used for the CRA-2019.	SO-C
W49	***Gases from Metal Corrosion***	No	Update to reference new corrosion rates of steel and to reflect the inventory used for CRA-2019.	UP
W51	***Chemical Effects of Corrosion***	No	Update to reference new corrosion rates of steel and to reflect the inventory used for CRA-2019.	UP

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
W52	***Radiolysis of Brine***	Yes.	Update with new analysis that demonstrates gas from radiolysis of brine no longer insignificant contributor to overall gas quantity.	UP
W53	***Radiolysis of Cellulose***	No	Update screening argument with new radionuclide inventory.	SO-C
W54	***Helium Gas Production***	No	Update to reflect new inventory used for the CRA-2019.	SO-C
W55	***Radioactive Gases***	No	Update to reflect new inventory used for the CRA-2019.	SO-C
W56	***Speciation***	No	Reference made to new solubility calculations based on new inventory components	UP in disposal rooms and Culebra. SO-C elsewhere, and SO-C Beneficial in cementitious seals.
W67	***Localized Reducing Zones***	No	Update to note the addition of gas generation via radiolysis of brine	SO-C
W68	***Organic Complexation***	No	Update to reflect new solubility calculations for use in the CRA-2019.	UP
W69	***Organic Ligands***	No	Update to reflect new solubility calculations for use in the CRA-2019.	UP

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
W72	***Exothermic Reactions***	No	Update to reflect the inventory used for the CRA-2019, underground experiments, and EPA comments.	SO-C
W73	***Concrete Hydration***	No	Update to reflect the inventory used for the CRA-2019, underground experiments, the additional shaft, and EPA comments.	SO-C
W74	***Chemical Degradation of Shaft Seals***	No	Update to reflect additional shaft.	UP
W78	***Colloidal Transport***	No	Update to reflect the inventory used for the CRA-2019 and updated colloidal source term.	UP
W79	***Colloidal Formation and Stability***	No	Update to reflect the inventory used for the CRA-2019 and updated colloidal source term.	UP
W80	***Colloidal Filtration***	No	Update to reflect the inventory used for the CRA-2019 and updated colloidal source term.	UP
W81	***Colloidal Sorption***	No	Update to reflect the inventory used for the CRA-2019 and updated colloidal source term.	UP

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
W84	***Cuttings***	No	Update to reflect new implementation in Panel 9	UP
W85	***Cavings***	No	Update with new waste shear strength data and implementation in Panel 9	DP
W86	***Spallings***	No	Update to reflect new implementation in Panel 9	DP
W87	***Microbial Transport***	No	Update with reference to new colloidal actinide source term and colloidal actinide parameters.	UP
W89	***Transport of Radioactive Gases***	No	Update to reflect the inventory used for the CRA-2019.	SO-C
W93	***Soret Effect***	No	Update to reflect the inventory used for the CRA-2019.	SO-C
W97	***Chemical Gradients***	No	Update to reference updated colloidal enhancement parameters.	
W109	***Panel Closure Geometry***	No	Update with new information regarding the abandonment of panel closures in the south end of repository, and correction of northernmost panel closure dimensions.	UP

Table 4: FEPs Reassessment Results				
EPA FEP I.D.	**FEP Name**	**Screening Decision Changed**	**Change Summary**	**Screening Classification**
W110	***Panel Closure Physical Properties***	No	Update to reflect new material properties for different panel closure areas.	UP
W111	***Panel Closure Chemical Composition***	No	Update screening argument with new information regarding steel bulkhead construction aide.	Beneficial SO-C
W112	***Radionuclide Effects on Panel Closures***	No	Update to reflect the inventory used for the CRA-2019.	SO-C
W113	***Consolidation of Panel Closures***	No	Update per EPA comment.	UP
W114	***Mechanical Degradation of Panel Closures***	Yes	Update screening argument per EPA comment. Update screening decision to reflect that ROM salt closures will not degrade.	SO-C
W115	***Chemical Degradation of Panel Closures***	No	Update screening argument per EPA comment.	(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 2016) 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-2014). The newly modified version of Appendix SCR will be submitted as part of the CRA-2019. The updated Attachment SCR should also be placed in records package 549146.

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