564433

Department of Energy
Carlsbad Field Office
P. O. Box 3090
Carlsbad, New Mexico 88221

MAY 2 9 2015

Mr. Jonathan D. Edwards, Director
Radiation Protection Division
U.S. Environmental Protection Agency
1200 Pennsylvania Ave, NW - MC 6608T
Washington, D.C. 20460

Subject: Response to Environmental Protection Agency Letters Dated December 17, 2014 and February 27, 2015 Regarding the 2014 Compliance Recertification Application

Dear Mr. Edwards:

In response to the U.S. Environmental Protection Agency (EPA) 2014 Compliance Recertification Application completeness review letters dated December 17, 2014 and February 27, 2015, the U.S. Department of Energy (DOE) is providing responses to 22 of EPA's completeness questions. The DOE will continue to submit phased responses to the EPA to ensure questions are answered in a timely manner, although some items will require additional analysis.

With this fourth submittal, the DOE has provided responses to all of EPA's completeness questions from the December 17, 2014 letter. Pending responses for the remaining questions in EPA's February 27, 2015 letter will be submitted at a later date, yet to be determined.
This submittal includes four enclosures:

- Enclosure 1 is a hardcopy of 22 of the EPA's comments and DOE's responses to those comments;
- Enclosure 2 (on compact disc) provides the electronic version of the references as noted in each response. Copyrighted references, marked with an asterisk in "References" of Enclosure 1, are not provided in Enclosure 2. If there are specific copyrighted references the EPA needs, the DOE will work to obtain a copy;
- Enclosure 3 is the "Status Report of DOE Responses to EPA Completeness Questions." The report is a Table showing EPA comments received on December 17, 2014 and February 27, 2015, in addition to DOE responses in this submittal, responses previously submitted, and responses still pending.
- Enclosure 4 is the "CRA-2014 Errata Tracking." The Table is a cumulative list of errata that have been identified and corrected up to this point. An updated list will be submitted to the EPA with future submittals.

If you have any questions regarding this response, please contact Russ Patterson at (575) 234-7457.

Sincerely,

Jose R. Franco, Manager
Carlsbad Field Office

Enclosures

CBFO:EPD:GTB:MN:15-1483:UFC 5486.00
WIPP:4.2.1:PA:NQ:RECERT:563151

cc: w/enclosures

T. Peake, EPA/ORIA	*ED
K. Economy, EPA/ORIA	ED
J. Walsh, EPA/ORIA	ED
S. Ghose, EPA/ORIA	ED
R. Lee, EPA/ORIA	ED
N. Stone, EPA Region 6	ED
F. Marcinowski, DOE/HQ	ED
D. Tonkay, DOE/HQ	ED
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*ED denotes electronic distribution

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EPA Comment
1-C-1 LANL Waste Stream With Added Cellulosic Material.

Organic kitty litter was used as an absorbent for nitrate salts for Waste Stream LA-MIN02-V.001 (NMED 2014) and 349 drums of this waste were placed in Panels 6 and 7 (Wallace 2014). Please address the following:

1. *Provide a complete waste profile for the kitty litter; including; cellulosic content and other ingredients; emplaced volume and mass.*
2. *Specify the number of drums with kitty litter placed in either Panel 6 or 7.*
3. *Identify the type of waste emplaced in the drums with the kitty litter.*
4. *Indicate whether this cellulosic kitty litter has been used in other waste streams and whether the corresponding waste profile reports adequately describe the waste material parameters.*
5. *Describe the effects of omitting the organic kitty litter in the waste stream(s) on the CPR inventory and consequent effects on gas generation rates calculated for the CRA-2014 PA.*
6. *Provide information of the quantities of soluble organics, such as organic ligands or surfactants that could affect actinide solubilities when this material is leached.*

DOE Response

The Department of Energy (DOE) is currently working through an Extent of Condition Review[1] and do not currently have all of the nitrate salt bearing waste data from Los Alamos National Laboratory (LANL). However, DOE, Carlsbad Field Office (DOE/CBFO) is providing the potential impacts of organic kitty litter on the Culebra K_d values from EPA comment 1-23-1 as part of the response to 1-C-1, since the questions address both LANL's nitrate salt bearing waste and organic sorbents.

Responses to the EPA's nitrate salt waste comments are discussed below and are identified by the comments number.

1. Pet Care Systems, Inc., is the manufacturer of Swheat Scoop® ("kitty litter"). The composition of the Swheat Scoop® is: wheat 74.498%, wheat midds 12.0%, moisture (maximum) 13.5% and natural soybean oil .0025%. Attachment 1 contains the manufacturer's profile for Swheat Scoop®.

2. Previous LANL reports and presentations may contain emplaced data for LA-MIN02-V.001 waste stream, but DOE/CBFO is not in the position to defend or justify these data. DOE/CBFO relies on the WIPP Waste Data System (WDS), which is the official database of record, to report emplaced data. WDS reports the number of emplaced containers for waste stream LA-MIN02-V.001 in Panels 6 and 7 as 257 55-gallon drums, 77 55-gallon pipe overpacks, and 15 standard waste boxes containing a total of 34 55-gallon drums. The total emplaced drum volume is 77.28 m^3 and the emplaced waste mass is 30,723.70 kg for the 55-gallon drums for waste stream LA-MIN02-V.001. The total mass of the Swheat Scoop® used in the emplaced LA-MIN02-V.001 waste containers is not currently known. LANL has reported that the total amount of Swheat Scoop® used in all TRU waste remediation activities at LANL is approximately 41,000 lbs (18,597 kg).

3. Waste material parameters that are reported in the WDS for emplaced waste stream LA-MIN02-V.001 are shown in Table 1.

[1] Extent of Condition Review is being performed on the nitrate salt waste at LANL to determine the extent to which the actual condition exists with other containers and waste streams.

Table 1

LA-MIN02-V.001 (Solidified Inorganic)
Iron Base Metal Alloys
Aluminum Base Metals/Alloys
Other Metals/Alloys
Other Inorganic Materials
Cellulosics
Rubber
Plastics
Solidified Inorganic Materials
Solidified Organic Materials

4. Thus far, LANL has reported three additional waste streams that contain nitrate salt waste in a portion of the containers in those waste streams. The three waste streams are LA-CIN01.001, LA-MHD01.001 and LA-MIN04-S.001. The number of containers and the amount of Swheat Scoop® for these three waste streams is currently unknown. The waste material parameters that describe these waste streams as reported in the WDS are shown in Table 2.

Table 2

LA-CIN01.001 (Solidified Inorganics)	LA-MHD01.001 (Heterogeneous Debris)	LA-MIN04-S.001 (Salt Waste)
Iron Base Metal Alloys	Iron Base Metal Alloys	Iron Base Metal Alloys
Aluminum Base Metals/Alloys	Aluminum Base Metals/Alloys	Other Metals/Alloys
Other Metals/Alloys	Other Metals/Alloys	Other Inorganic Materials
Other Inorganic Materials	Other Inorganic Materials	Cellulosics
Cellulosics	Cellulosics	Plastics
Rubber	Rubber	Solidified Inorganic Materials
Plastics	Plastics	
Solidified Inorganic Materials	Solidified Inorganic Materials	
Soils	Solidified Organic Materials	
	Soils	

5. The response on the potential impacts of organic kitty litter on the Culebra K_d values from EPA comment 1-23-1 and 1-C-1 sub-comment 5 are addressed together in the following response. These comments deal with the impacts of waste stream CPR (LA-MIN02-V.001) and the effects of organic kitty litter on the CPR inventory, on gas generation rates and on K_ds in the Culebra.

The cellulose in the organic absorbent makes up less than 0.4% of the currently expected (based on a scaled full repository volume) total amount of cellulose and 0.1% of the total CPR[2]. Historically, the estimates of the CPR used in previous recertification PAs have varied by as much as 33% with no impact on the CCDFs (DOE 2010) (the mass of CPR in the LA-MIN02-V.001 waste stream is listed in Table 4). This minor addition of cellulose will not impact assumptions made in the PA concerning CPR inventory, gas generation or K_ds.

Microbial consumption of the organic carbon in CPR can produce CO_2 and other gases. The presence of CO_2 in the repository affects gas pressure and chemical conditions of the brine in the repository which could be released to the Culebra. Changes to the chemical conditions of the brine in the Culebra could impact K_ds. Specifically, CO_2 can impact brine pH which could affect these assumptions. MgO is emplaced as an engineered barrier that sequesters CO_2 in the repository resulting in essentially no increase in pressure from CO_2. Additionally, MgO reduces the possible concentration of CO_2 in repository brine to essentially zero. A significant excess amount of MgO is emplaced in the repository, based on the CPR content of each waste container and associated emplacement materials such that there is more than enough MgO to react with all the CPR in the repository. By continually emplacing excess MgO in each disposal room, the chemical conditions modeled in the performance assessment will be maintained regardless of the amount of CPR. Additionally, there are conservative assumptions regarding the amount of MgO that is to be emplaced. For example, it is assumed that all carbon in the waste will be converted 100% to CO_2 which is improbable. Since the MgO maintains stable repository brine conditions with essentially no CO_2, the impact of a minor addition of cellulose from the LANL waste will not impact repository chemical conditions and therefore will not impact Culebra chemical conditions due to potential brine releases to the Culebra. Since these chemical conditions are maintained, there is no change in the chemical characteristics of the Culebra brine that would affect K_d assumptions.

In response to a similar comment from EPA on the CRA-2004, DOE assessed the impact of additional CPR on gas generation and repository performance. The CPR mass was increased by 250% with only a minor impact on repository performance (EPA 2004 and Dunagan et al. 2004). Changes in the quantity of CPR by the minor amount added from the LANL waste (i.e., 0.1% increase of the total CPR) will not impact repository performance.

References:

Dunagan, S., Hansen, C. and Zelinski, W. 2004. *Effects of Increasing Cellulosics, Plastics, and Rubbers on WIPP Performance Assessment*. ERMS 535941. Sandia National Laboratories, Carlsbad, NM.

McInroy, W. Email correspondence to S. Wagner dated January 14, 2015. ERMS 563787. Los Alamos National Laboratory, Carlsbad, NM.

U.S. Department of Energy (DOE). 2010. 5th Response Submittal to EPA, Enclosure 1, Comment 3-24-1. ERMS 553145. February 19, 2010.

U.S. Environmental Protection Agency (EPA). 2004. First CRA-2004 EPA completeness letter from E. Cotsworth to P. Detwiler dated May 20, 2004. ERMS 535554.

[2] Based on the possible 41,000 lbs of kitty litter in the LANL waste (McInroy 2015) and total CPR and C from the 2012 PAIR (Van Soest 2012).

Van Soest, G.D. 2012. *Performance Assessment Inventory Report*, INV-PA-12, Revision 0, LA-UR-12-26643. Los Alamos National Laboratory Carlsbad Operations, Carlsbad, NM.

6. The following tables specify the quantities of organics in the LA-MIN02-V.001 waste stream.

Table 3 – Organic Ligands (from McInroy 2015a)

Waste Stream	**Acetic Acid (kg)**	**Citric Acid (kg)**	**Oxalic Acid (kg)**	**Acetate (kg)**	**Citrate (kg)**	**EDTA (kg)**	**Oxalate (kg)**
LA-MIN02-V.001	0.354045962	38.93036512	484.7932261	0	0	0	0

Table 4 – Organic Waste Material Parameters (from McInroy 2015b)

Waste Stream	**Waste Material Parameter**	**Mass (kg)**
LA-MIN02-V.001	Cellulosics	445.9
LA-MIN02-V.001	Plastic	1,433.2
LA-MIN02-V.001	Rubber	204.5
LA-MIN02-V.001	Solidified Organics	92.1

References:

McInroy, W. 2015a. Email correspondence dated April 14, 2015, from McInroy to S. Wagner re: Organic Ligands Inventory Information. ERMS 563809. Los Alamos National Laboratory, Carlsbad, NM.

McInroy, W. 2015b. Email correspondence dated April 14, 2015, from McInroy to S. Wagner re: WDS Waste Material Parameters. ERMS 563808. Los Alamos National Laboratory, Carlsbad, NM.

Attachment 1

Natural Wheat Litter

Guaranteed Analysis

Product Name: Swheat Scoop Cat Litter

Composition of wheat litter:

Wheat	**74.498%**
Wheat Midds	**12.0%**
Moisture (maximum)	**13.5%**
Natural Soybean oil	**.0025%**
TOTAL	**100.00%**

We certify that the above product is composed of these ingredients.

A Material Safety Data Sheet (MSDS) is not required on wheat litter.

The difference is wheat.

Pet Care Systems, Inc. • 1421 Richwood Road • Detroit Lakes, MN 56502-1529 • 1-800-794-3287
www.swheatscoop.com

EPA Comment
2-23-1 ROM Salt Panel Closures Locations.

Please provide the WIPP configuration layout (a plan view) used for the 2014 CRA that includes all locations where the ROM salt panel closures are to be placed. Provide text that provides the exact location, dimensions and properties for the set of panel closures that lie furthest north in the repository.

DOE Response

A plan view of the WIPP configuration layout used for 2014 CRA calculations was included as Figure 3-2, Plan View of WIPP Underground Facility and Panel Closure Systems, in the EPA's Approval of the ROM Salt Panel Closure System (ROMPCS) (U.S. EPA 2014). The figure (included here as Figure 1) provides locations where the ROM salt panel closures are to be placed. This is consistent with current WIPP project planning. Panel closures will have the same basic properties as the closures approved by EPA (U.S. EPA 2014) for the panels in Panel Closure System Design (DOE 2011).

The northernmost panel closures would be located in north-south access drifts W-170, W-30, E-140 and E-300 just north of S-700 and just south of the waste and exhaust shafts. The approximate dimensions of the access drifts for the closures are as follows: W-170 – 16 feet wide, 13 feet tall, ROM salt length 100 feet. W-30 – 20 feet wide, 14 feet tall, ROM salt length 100 feet. E-140 – 24 feet wide, 18 feet tall, ROM salt length 100 feet. E-300 – 13 feet wide, 16 feet tall, ROM salt length 100 feet.

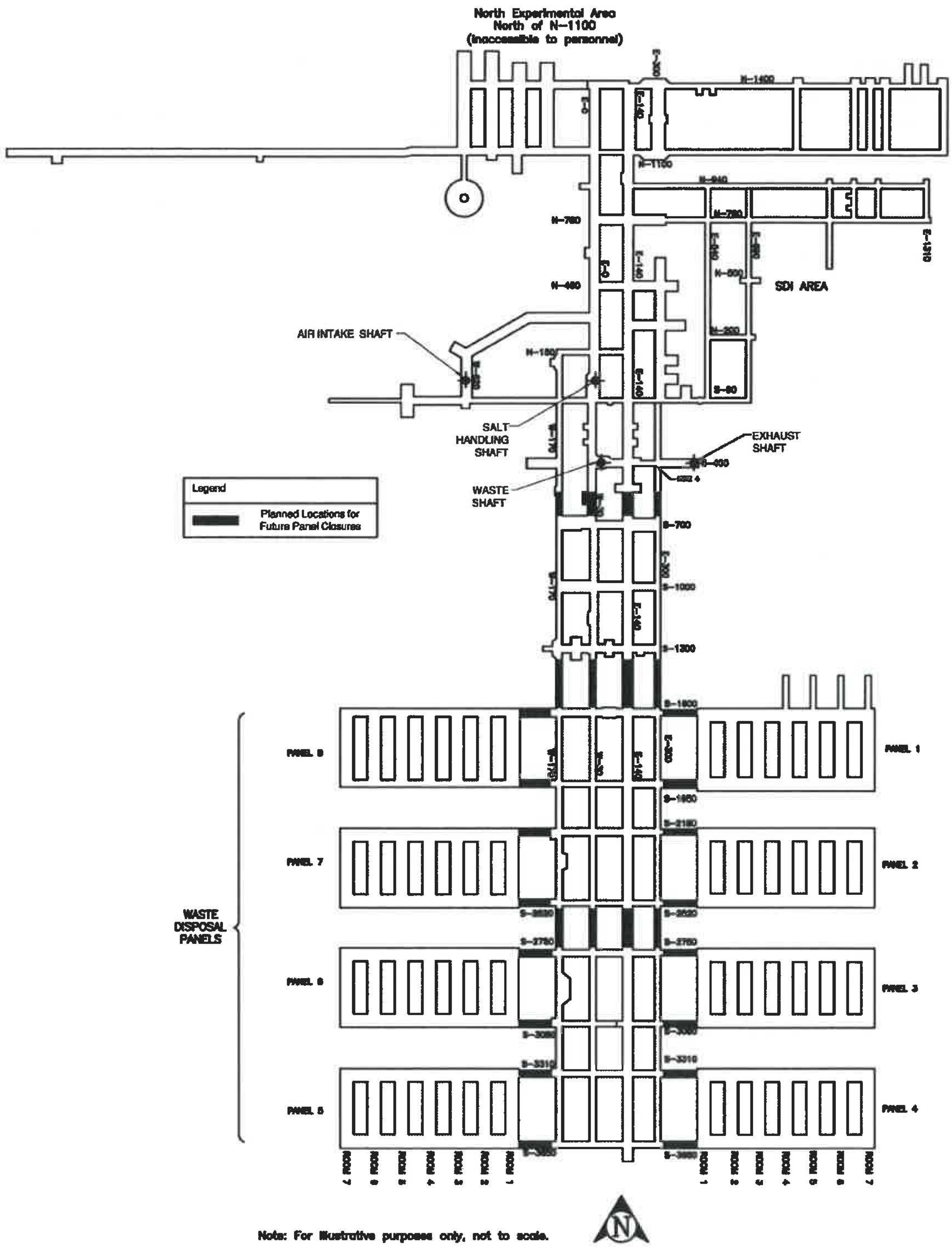

Figure 1 Plan View of WIPP Underground Facility and Panel Closure Systems.

References:

U.S. Environmental Protection Agency (EPA). 2014. Title 40 CFR Part 194: Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance With the Disposal Regulations; Panel Closure Redesign. Federal Register, Vol. 79, No, 195. (October 8, 2014): 60750-60756.

U.S. Department of Energy (DOE). 2011. *Panel Closure System Design Planned Change Request to the EPA 40 CFR Part 194 Certification of the Waste Isolation Pilot Plant*. DOE/CBFO-11-3479. . Carlsbad Field Office, Carlsbad, NM..

EPA Comment

2-23-2 Provide An Update of the Derivation of the Shaft Properties at the Repository Horizon.

In the BRAGFLO grid for the 2004 and 2009 CRA Performance Assessments (PAs), the modeled lower portion of the shaft included an effective permeability that incorporated both the concrete portion of the shaft (at the repository horizon level) and the furthest north panel closures located just south of the waste and exhaust shafts. The material properties of the modeled shaft (the concrete monolith segment) were combinations of the shaft properties and the Option D panel closure properties (Camphouse and Clayton 2011, ERMS 555204). Now, however, there is a new panel closure system that uses run of mine salt instead of the Option D design, and the properties of new panel closure system are different than that of the concrete portion in the lower shaft. In the CRA 2014 PA, however, it appears the material properties of the shaft at the repository horizon have not been updated to reflect the change. Please confirm this and identify how the properties would change to reflect the change in the panel closure design.

DOE Response

There are two issues that are relevant to EPA's comment; each is described in detail in the following DOE response:

1. **Material properties of CONC_MON.** The material properties of the concrete monolith at the base of the shaft, identified as material CONC_MON for BRAGFLO, are defined correctly. However, there is an error in the documentation of the basis for the CONC_MON properties.

2. **Size of Northernmost ROMPCS**. DOE has identified an error in the BRAGFLO grid for the CRA-2014. The northernmost panel closures should have been 200-feet long, rather than 100-feet long, as in the BRAGFLO model for CRA-2014. However, DOE has performed BRAGFLO calculations to demonstrate that this error has no significant impact on BRAGFLO results for CRA-2014.

Material Properties of CONC_MON (Concrete Portion of Lower Shaft)

There was an error in the description of the properties of CONC_MON in Camphouse and Clayton (2011). That document claimed that the properties of the lower shaft region in the BRAGFLO grid came from the "Option D" panel closure properties and the lower shaft properties: "the operations (Ops) and experimental (Exp) regions have been separated by a material [CONC_MON] combining panel closure and waste shaft properties." However, the properties of the shaft concrete material do not in fact reflect a combination of panel closure and waste shaft properties, but solely waste shaft properties. The properties of the northernmost set of panel closures were not incorporated into the properties for CONC_MON, at the base of the shaft. Thus, there is no need to update the properties of the lower shaft (i.e., CONC_MON), but the properties of the northernmost set of panel closures will be changed because of an error in the BRAGFLO grid, described next.

Updating the Size of the Northernmost ROMPCS

The BRAGFLO grid used in the CRA-2014 PA did not take into account the properties of the northernmost set of panel closures. In order to account for these properties, we now implement the strategy used in the transition from the Technical Baseline Migration (TBM) BRAGFLO grid to the grid used for the CRA-2004 (Stein 2003). This strategy was peer-reviewed and accepted during the TBM modifications and carried forward for use in the CRA-2004 and CRA-2009. From the analysis report that examined the change to the BRAGFLO grid (Stein 2003):

"To account for this panel closure that is immediately south of the shaft, the dimensions of the concrete portion of the panel closure located between the northern rest of repository (nRoR) and the operations area was doubled (7.9 m x 2 = 15.8 m). This ensures that gas produced in the waste regions must effectively travel though [sic] the same number of panel closures to reach the experimental area as was modeled in the TBM. This is an important part of the revised conceptual model of repository geometry that was presented to the Salado Flow Peer Review panel."

This strategy resulted in three sets of panel closures in the BRAGFLO grid. In the TBM grid (and the CRA-2004 and CRA-2009 representations of the repository), the northernmost set of panel closures (located between the northern rest of repository and the operations area) had a length twice that of the other two. When the ROMPCS was implemented in the grid used for the PCS-2012 analysis, all three sets of "Option D" panel closures were replaced in the BRAGFLO grid with the ROMPCS having a length of 30.48 m (Camphouse et al. 2012). To be consistent with the representation of the northernmost panel closures as modeled in the TBM, the CRA-2004, and the CRA-2009, the northernmost set of panel closures should have had twice the length of the other two (i.e., 60.96 m) in the CRA-2014 PA.

Updated BRAGFLO Calculations

Here, we have modified the CRA-2014 BRAGFLO grid (Figure 1) in order to double the length of the northernmost set of panel closures. The BRAGFLO calculations were performed as deviations under AP-164 (Camphouse 2013) and the calculation details are summarized in Zeitler (2015). We present an analysis of the impact of this change in the BRAGFLO grid on the pressure and brine saturation in the NRoR, south rest of repository (SRoR), and waste panel as compared to the CRA-2014 PA. We compare the mean results for 100 vectors in each of three scenarios (1, 2, and 4) for replicate 1.

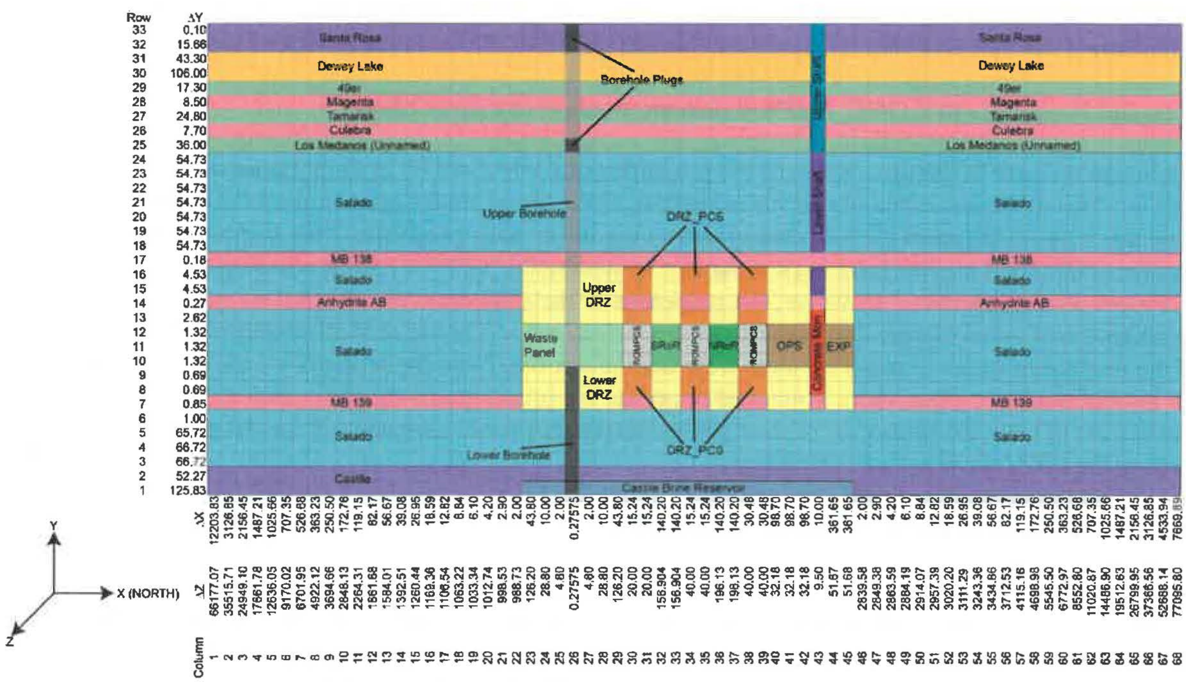

Figure 2. Computational grid used in BRAGFLO for this analysis.

Figure 2 shows the impact of the increased size of the northernmost ROMPCS on pressure in the NRoR for scenarios 1, 2, and 4. Overall, there is a small increase in mean pressure in the NRoR, as expected, because the increased length of the relatively low-permeability ROMPCS (after 200 years) makes the barrier to gas and brine flow greater in the northern direction. The increased pressure results in a very small decrease in brine saturation (Figure 3).

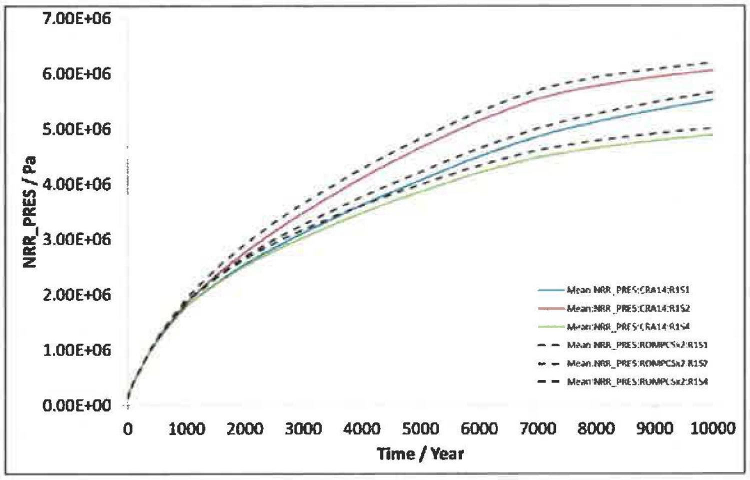

Figure 3. Replicate 1 means of NRoR pressure for scenarios 1, 2, and 4.

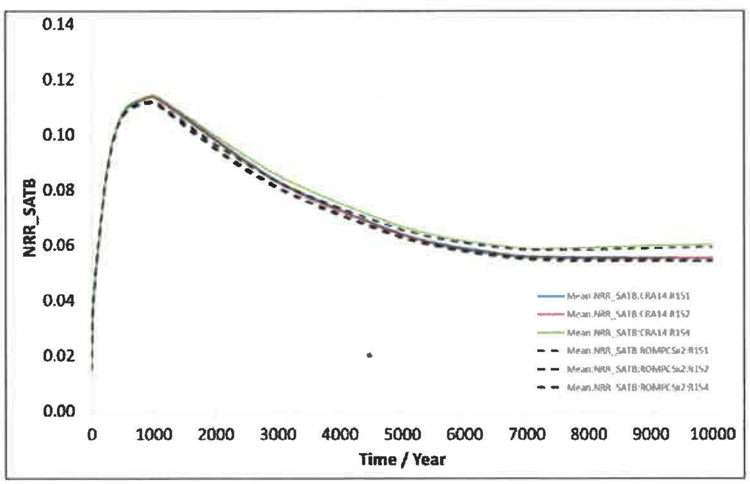

Figure 4. Replicate 1 means of NRoR brine saturation for scenarios 1, 2, and 4.

Figure 4 shows the impact of the increased size of the northernmost ROMPCS on pressure in the SRoR for scenarios 1, 2, and 4. Overall, there is a very small increase in mean pressure in the SRoR, as expected, because the increased length of the relatively low-permeability ROMPCS (after 200 years) makes the barrier to gas and brine flow greater in the northern direction. The small pressure increase results in a barely noticeable decrease in brine saturation (Figure 5). The differences in pressure and brine saturation are smaller in the SRoR than in the NRoR. This is expected, as the SRoR is separated from the OPS/EXP areas by an additional set of ROMPCS compared to the NRoR.

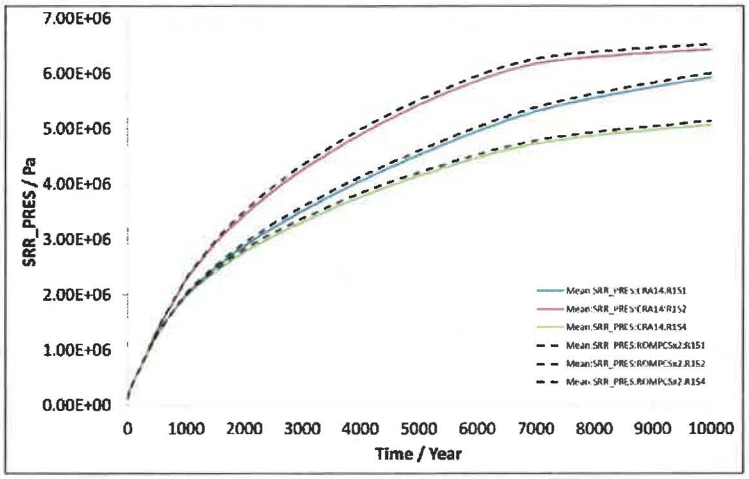

Figure 5. Replicate 1 means of SRoR pressure for scenarios 1, 2, and 4.

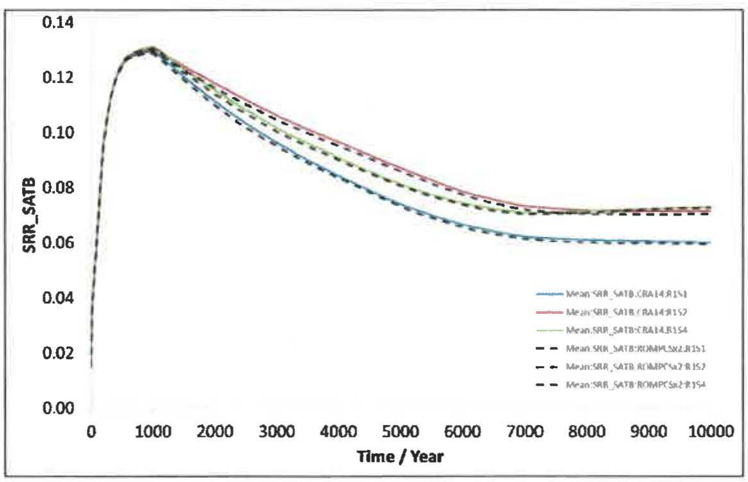

Figure 6. Replicate 1 means of SRoR brine saturation for scenarios 1, 2, and 4.

Figure 6 shows the impact of the increased size of the northernmost ROMPCS on pressure in the waste panel for scenarios 1, 2, and 4. Overall, there is a negligible change in mean pressure in the waste panel. The differences in pressure and brine saturation are smaller in the waste panel than in the SRoR. This is expected, as the waste panel is separated from the OPS/EXP areas by an additional set of ROMPCS compared to the SRoR. The negligible difference in pressures results in a negligible difference in brine saturation (Figure 7). Additionally, there are only small changes in the 10th and 90th percentile values for pressure and brine saturations (Figures 8-11). Due to the negligible effect of the change in length of the northernmost ROMPCS on waste panel pressures and brine saturations, there is no impact on releases from the repository that result from a hypothetical drilling intrusion.

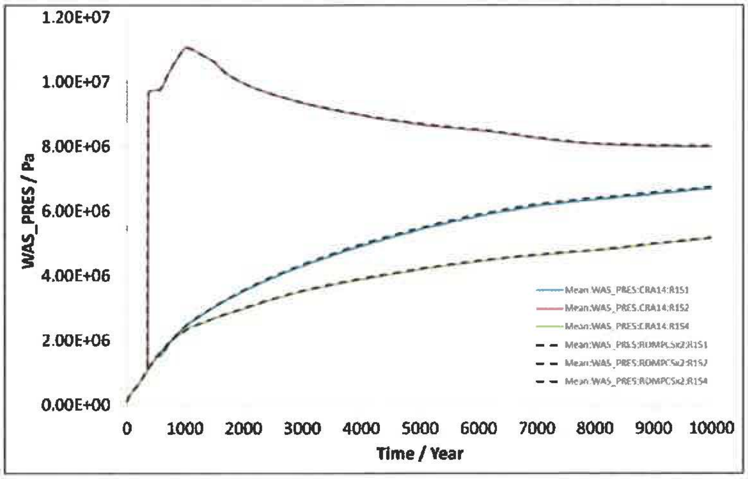

Figure 7. Replicate 1 means of waste panel pressure for scenarios 1, 2, and 4.

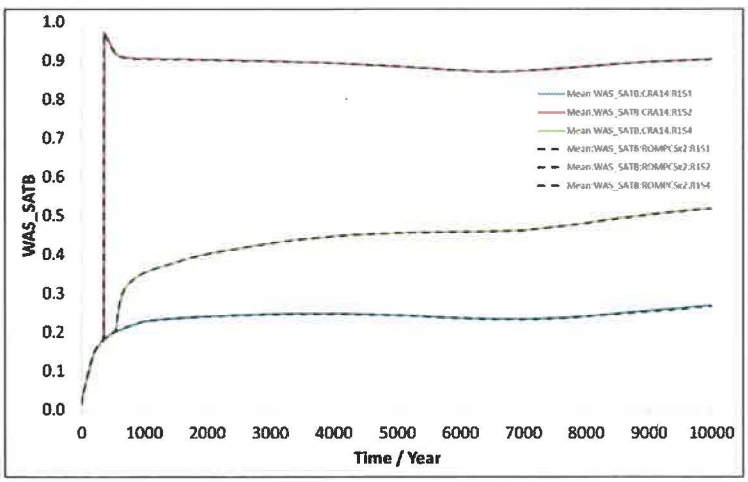

Figure 8. Replicate 1 means of waste panel brine saturation for scenarios 1, 2, and 4.

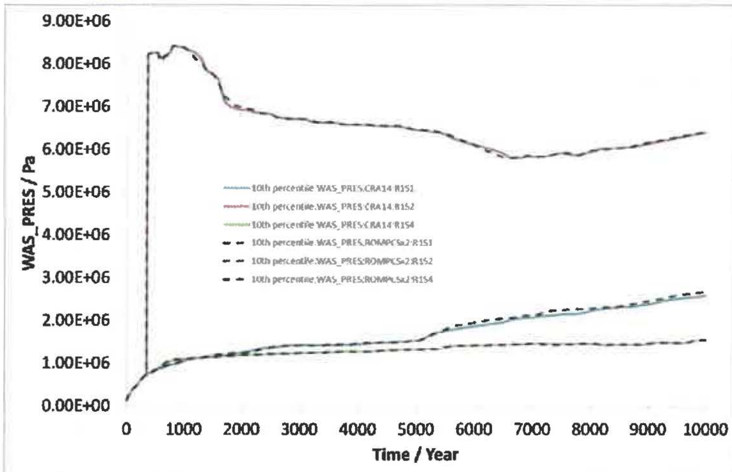

Figure 9. Replicate 1 10th percentiles of waste panel pressure for scenarios 1, 2, and 4.

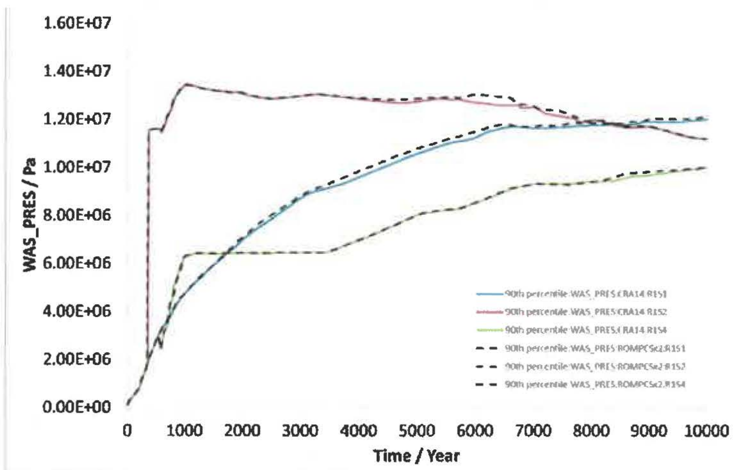

Figure 10. Replicate 1 90th percentiles of waste panel pressure for scenarios 1, 2, and 4.

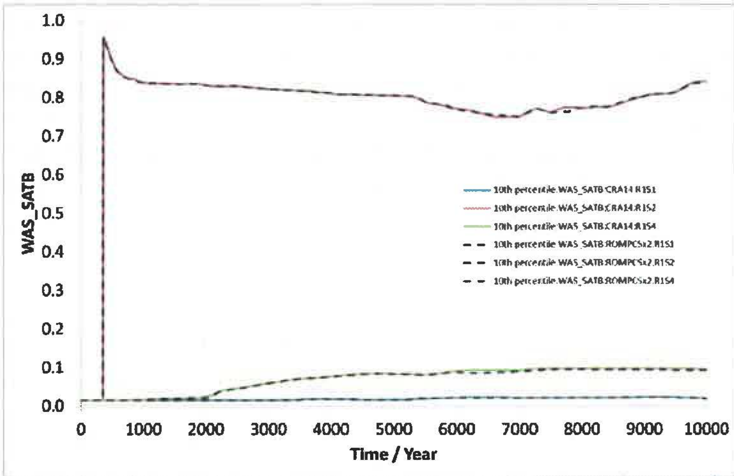

Figure 11. Replicate 1 10th percentiles of waste panel brine saturation for scenarios 1, 2, and 4.

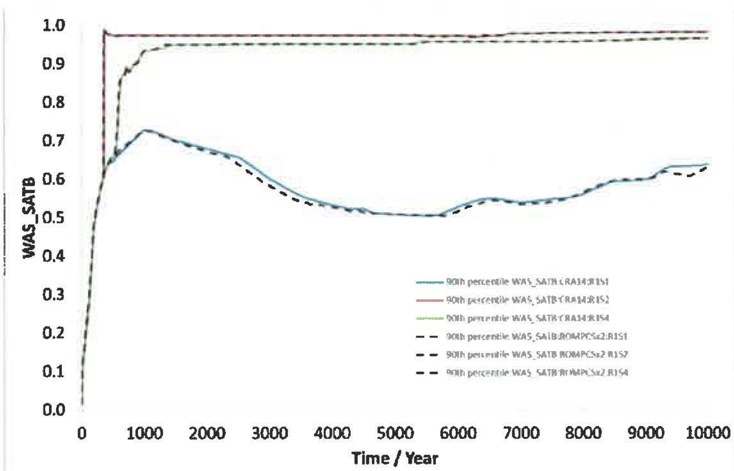

Figure 12. Replicate 1 90th percentiles of waste panel brine saturation for scenarios 1, 2, and 4.

Conclusion

The EPA's comment that the material properties of the concrete portion of the lower shaft should be updated to reflect the change in panel closure system was based on an error in Camphouse and Clayton (2011) that incorrectly described the properties of the "Option D" panel closure as being incorporated into the properties of the lower shaft. There is no need to update the properties of the lower shaft (i.e., CONC_MON).

However, EPA's comment has brought to light that there was an error in implementation of the ROMPCS in PCS-2012, which carried through to the CRA-2014. The BRAGFLO grid should have represented the northernmost set of ROMPCS as being twice as long as the other two ROMPCS representations. Here, we have updated the BRAGFLO grid and run BRAGFLO calculations to judge the impact of the grid change on pressures and brine saturations in the repository. The update to the size of the northernmost ROMPCS has negligible effect on pressures and brine saturations in the waste panel during the 10,000-year regulatory period. Our judgment is that there is therefore no impact of the grid change on radionuclide releases. The corrected length of the northernmost set of panel closures will be implemented in future PA calculations and will be tracked in Enclosure 4, *CRA-2014 Errata Tracking*.

References:

Camphouse, R.C. and D. Clayton. 2011. *Analysis Package for Salado Flow Modeling Done in the AP-151 (PC3R) Performance Assessment.* ERMS 555204. Sandia National Laboratories, Carlsbad, NM.

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

Camphouse, R.C., D. Kicker, T. Kirchner, J. Long, B. Malama, and T. Zeitler. 2012. *Summary Report and Run Control for the 2012 WIPP Panel Closure System Performance Assessment*. ERMS 558365. Sandia National Laboratories, Carlsbad, NM.

Stein, J.S. and W. Zelinski. 2003. *Analysis Report for: Testing of a Proposed BRAGFLO Grid to be used for the Compliance Recertification Application Performance Assessment Calculations*. ERMS 526868. Sandia National Laboratories, Carlsbad, NM.

Zeitler, T.R. 2015. Memo to Records: BRAGFLO calculations for updated northernmost ROMPCS representation. ERMS 563875. Sandia National Laboratories, Carlsbad, NM.

EPA Comment

2-33-1 Future Drilling Into Nitrate Waste.

Please provide the probability and describe the potential consequence(s) to PA calculation of drilling into the nitrate waste.

DOE Response

With respect to Los Alamos National Laboratory waste, four CH waste streams have been identified as containing some amount of nitrate waste. The number of drums with nitrate-containing waste in each of these waste streams is currently not known, but is expected to be less than the total number of drums, such that the probability of hitting a nitrate-containing drum in a waste stream would be less than the probability of hitting the waste stream. Until the number of drums that contain nitrate waste is known for each waste stream, the probability of hitting nitrate waste in a given waste stream will not be known.

However, an upper limit of the probability of hitting nitrate waste can be calculated by assuming that all containers in these four waste streams contain nitrate waste. The waste stream volumes and hit probabilities that were used in the CRA-2014 PA calculations for the four nitrate-containing waste streams are summarized in Table 1. The probability of a drilling event hitting an individual waste stream (given that the drilling event results in an intrusion into a waste-containing area[1]), as implemented in WIPP PA calculations, is equal to the ratio of the volume of the waste stream to the total inventory volume for that type of waste (CH or RH). (The nitrate containing waste streams are all CH waste.) That probability is then multiplied by the probability of a drilling event resulting in a waste encounter (17.7%)[1] to result in the probability of a single drilling event hitting a given waste stream. The total probability of 1.4% represents an absolute maximum probability of a drilling event hitting nitrate waste for a randomly placed drilling intrusion within the WIPP repository footprint. This upper bound is based on the total volume of the nitrate-containing waste streams, but the probability of hitting nitrate waste is expected to be lower, because as mentioned earlier, it is expected that only a fraction of the containers in these four waste streams contain nitrate waste.

[1] In WIPP PA, the probability of a drilling event resulting in a waste encounter is equal to the ratio of the excavated region of the repository (sum of parameters REFCON:AREA_CH and REFCON:AREA_RH, the areas associated with CH and RH waste, respectively) to the area of the footprint of the entire repository (parameter REFCON:ABERM). For the CRA-2014, this ratio is (111,500 + 15,760 m^2)/628,500 m^2 = 0.202. Thus, there is only a 20.2% chance of a single drilling event within the WIPP footprint resulting in a waste encounter (17.7 % for CH waste and 2.5 % for RH waste). The probabilities presented in column 5 of Table 1 are representative of drilling events that indeed encounter CH waste. So, for a single drilling event, the probability of a drilling event resulting in the hitting of one of the waste streams in Table 1 is equal to the probability of hitting the waste stream (given a waste hit) multiplied by the probability of a drilling event resulting in a CH waste encounter (0.177). For context, there is an average of about 7.5 drilling events per 10,000 year future for the CRA-2014.

Table 1. Waste stream volumes and hit probabilities for nitrate-containing waste streams

TRU Waste Stream	Waste Stream Volume (m^3)	Total CH Inventory Volume (m^3)	Percent Volume	Probability of Hitting Waste Stream (Given a CH Waste Hit)*	Probability of Hitting Waste Stream
LA-CIN01.001**	826	168496	0.490	0.00490	0.00087
LA-MHD01.001**	12720	168496	7.549	0.07549	0.01339
LA-MIN02-V.001	10.2	168496	0.006	0.00006	0.00001
LA-MIN04-S.001	14.4	168496	0.009	0.00009	0.00002
		Total	8.054	0.08054	0.01429

*The volume ratio expressed as a fraction (i.e., the value in the previous column divided by 100).

**The volume of the LA-CIN01.001 and LA-MHD01.001 waste streams include the emplaced volume from those waste streams, denoted as separate waste streams (WP-LA-CIN01.001 and WP-LA-MHD01.001, respectively) in Van Soest (2012).

In regard to the potential consequences to PA calculations of drilling into nitrate waste, there is no difference in hitting a nitrate-containing waste stream or a waste stream that does not contain nitrates. In regard to the waste inventory, a drilling event in WIPP PA calculations is solely dependent on the waste stream properties of volume and activity per unit volume. The PA calculations do not consider a release mechanism that is specific to nitrate-containing waste; thus the PA calculations do not depend on the likelihood that a drilling event into the repository encounters a nitrate-containing waste stream.

Reference:

Van Soest, G.D. 2012. *Performance Assessment Inventory Report*, INV-PA-12, Revision 0, LA-UR-12-26643. Los Alamos National Laboratory Carlsbad Operations, Carlsbad, NM.

EPA Comment

2-44-1 MgO Physical Segregation.

In Franco (2012) DOE notified EPA that MgO emplacement has been modified by placing a 3,000 pound supersack of MgO on every other waste stack or on each waste stack in every other row. In the Franco 2012 letter the "effective diffusion penetration length of CO_2" was considered but the information on physical segregation is limited.

Please provide updated documentation to more explicitly and clearly address whether the larger lateral separation distance still allows sufficient reactions between MgO and CO_2.

References:

Franco, J.R. 2012. Letter to A. Perrin (Subject: "Planned Change Notice for Placement of MgO Supersacks," with enclosure (Analysis of an alternative placement scheme for MgO supersacks). February 14, 2012. Carlsbad, NM: U.S. Department of Energy Carlsbad Field Office.

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Vugrin, E.D., M.B. Nemer, and S.W. Wagner. 2006. Uncertainties Affecting MgO Effectiveness and Calculation of the MgO Effective Excess Factor (Rev. 0, November 17). ERMS 544781. Carlsbad, NM: Sandia National Laboratories.

DOE Response

Introduction

The WIPP repository uses magnesium oxide (MgO) backfill as the engineered barrier. MgO is emplaced in the WIPP repository along with the waste as a chemical control agent. The presence of adequate amounts of MgO ensures that favorable and consistent conditions are maintained in WIPP brines by reacting with any carbon dioxide (CO_2) produced by microbial consumption of organic carbon in the waste materials. The reaction of MgO with CO_2 and water ensures that the pH of WIPP brines remains in a limited range that provides predictable brine conditions that support relatively low solubility limits for the actinides in transuranic waste.

WIPP's current operational procedures require DOE to emplace a supersack with 3,000 or 4,200 pounds of MgO on top of each stack of waste containers, beginning with the even numbered rows in a room. The amount of MgO (3,000 or 4,200 pounds per sack) is based on the masses of cellulose, plastic and rubber emplaced in the room. DOE tracks the emplaced masses of MgO and organic carbon on a room-by-room basis at the end of each waste emplacement shift. Additional supersacks are emplaced on odd numbered rows if required to maintain an MgO excess factor of 1.2 or greater in the repository (NWP 2013, Section 3.0, Backfill).

The supersacks holding MgO are hexagonal in shape and are made of woven polypropylene material (WTS 2009). The mean thickness of the polypropylene is 0.017 inches (Batchelder 2014). The supersacks are expected to fail when room closure applies compressive loads to the waste containers and supersacks. After failure of the supersacks, MgO can directly react with CO_2 generated by microbial degradation of waste, and the presence of the supersacks is not considered in this diffusion mixing analysis.

Microbially generated CO_2 can be transported away from the point of generation by several mixing processes. Bulk movement of brine in the repository will transport dissolved CO_2 by advection. Hydrodynamic dispersion (mixing caused by pore-scale velocity variations as the brine flows through the tortuous pore spaces of the waste and backfill) will cause dissolved CO_2 to spread both longitudinally and transverse to the direction of the bulk flow. Dissolved CO_2 will also be transported via molecular diffusion from brine regions with higher CO_2 concentrations to regions with lower CO_2 concentrations. In the absence of significant brine flow, molecular diffusion will be the dominant mixing mechanism and its effectiveness has been analyzed in two previous studies.

In *Effectiveness of Mixing Processes in the Waste Isolation Pilot Plant Repository*, Wang (2000) concluded that, during a minimum hydraulic residence time for brine in the repository, diffusion alone is sufficient to mix CO_2 with WIPP brine over a distance greater than the final room height after creep closure. This result means that MgO emplaced on top of waste stacks will be effective in sequestering the CO_2 generated by all the containers beneath the supersack. In *Updated Analysis of Characteristic Time and Length Scales for Mixing Processes in the WIPP Repository to Reflect the CRA-2004 PABC Technical Baseline and the Impact of Supercompacted Mixed Waste and Heterogeneous Waste Emplacement*, Kanney and Vugrin (2006) updated Wang's analysis based on the Performance Assessment Baseline Calculation for the 2004 Compliance Recertification Application (CRA-2004). They concluded that the range of diffusion penetration distances bracketed the range of final room heights, and that diffusion alone provided sufficient mixing of CO_2 over the final room height during the minimum hydraulic residence time. They also confirmed that the presence of supercompacted waste and heterogeneous waste emplacement did not change their conclusions.

Microbially generated CO_2 can also be transported away from the point of generation by gaseous diffusion if all CO_2 is not dissolved in brine. The focus of this analysis is on the mixing of CO_2 dissolved in brine because the primary purpose of the MgO backfill is to limit actinide concentrations in brine. However, diffusive transport will efficiently mix any CO_2 remaining in the gaseous state on a panel-wide scale, as shown later in this document.

Update of Diffusion Mixing Analysis for the CRA-2014

The diffusion analysis of Kanney and Vugrin (2006) has been updated to reflect changes in the performance assessment for the 2014 Compliance Recertification Application (CRA-2014) (DOE 2014). BRAGFLO simulations for the CRA-2014 performance assessment provide the input data for the updated mixing analysis. The methodology for the analysis follows the technical approach in Kanney and Vugrin (2006) and in Wang (2000), with appropriate parameter changes for the CRA-2014.

Waste panel porosities, pore volumes, and brine flow are based on the BRAGFLO simulations for Replicate R1, Scenario S2 (R1S2) of the CRA-2014. Replicate 1 has 100 vectors whose input parameters are sampled from distributions using Latin Hypercube Sampling. Scenario 2 has a borehole intrusion that intersects the waste panel and a brine pocket in the Castile at 350 years after closure. Scenario 2 is a reasonable choice for this analysis because vectors with high flow up the intrusion borehole result in lower hydraulic residence times and lower diffusion penetration lengths in comparison to an undisturbed scenario.

Attachment A to this response provides the BRAGFLO output data for waste panel porosity, waste panel pore volume, and cumulative brine flow up the intrusion borehole for each of the 100 vectors in R1S2. Attachment A also provides the calculated hydraulic residence times and diffusion penetration lengths for the 100 vectors in R1S2. The key output parameter from this analysis is the diffusion penetration length, which varies from 1.43 m for vector 17 to 453 m for vector 99. The output for vector 17 provides the basis for this analysis, and the use of data from vector 17, with the minimum diffusion penetration length over 100 vectors, is a lower bound on the effectiveness of diffusive mixing. To put this conservatism in perspective, the second smallest diffusion penetration length is 1.87 m (for vector 7) and the mean diffusion penetration length is 108 m for all 100 vectors (see Table A-1 in Attachment A).

Calculations for Vector 17

The diffusion penetration distance is a function of the characteristic hydraulic residence time for brine in the repository and the effective diffusivity of CO_2 in brine in a waste-filled panel. The hydraulic residence time is defined as:

$$T_{hr} = \frac{V_{pore}}{Q_{brine}}, \quad (1)$$

where T_{hr} is the hydraulic residence time [T], V_p is the waste panel pore volume [L^3], and Q_{brine} is the volumetric flow rate up the intrusion borehole to the Culebra [m^3/year]. The cumulative brine flow up the intrusion borehole in vector 17 is 1.73×10^5 m^3 at 10,000 years after closure (see Table A-1 in Attachment A). This flow occurs over a duration of (10,000 years – 350 years) = 9,650 years, resulting in a characteristic brine flow rate of Q_{brine} = (1.73×10^5 m^3)/(9,650 years) = 17.9 m^3/year. The waste panel porosity at 10,000 years in vector 17 is 0.1247 (see Table A-1), resulting in a waste panel pore volume[1] of 5,750 m^3.

The hydraulic residence time is calculated to be 320 years (see Table 1). This is also the minimum hydraulic residence time over all 100 vectors in R1S2 (see Table A-1).

Table 1. Hydraulic residence time in the waste panel for vector 17 (CRA-2014)

V_{pore}	Q_{brine}	$T_{hr} = \frac{V_{pore}}{Q_{brine}}$
5,750 m^3	17.9 m^3/year	320 years

Assuming Fickian (linear) diffusion, the one-dimensional equation for solute diffusion through a homogeneous porous medium can be written as:

$$\frac{\partial C}{\partial t} = D_{eff} \frac{\partial^2 C}{\partial x^2} \quad (2)$$

where C is the concentration of the diffusing species [M/L^3], t is time [T], x is distance [L], and D_{eff} is the effective diffusion coefficient [L^2/T]. The effective diffusion coefficient accounts for two features: 1) diffusion occurs only through fluid-filled pores and not throughout the entire volume of the porous medium; and 2) the diffusion pathway at the pore scale is a complicated and tortuous network, not a straight line.

The effective diffusion coefficient is often modeled as:

$$D_{eff} = F_f D \quad (3)$$

[1] The excavated volume of the waste panel is 46,136 m^3 (DOE 2014, Appendix PA-2014, Figure PA-12). The pore volume is the product of BRAGFLO waste porosity and panel volume: (0.1247)(46,136 m^3) = 5,753 m^3 ~ 5,750 m^3.

where F_f is a "formation factor" (dimensionless) and D is the free liquid diffusion coefficient $[L^2/T]$. The free liquid diffusion coefficient for CO_2 in sea water is approximately 2×10^{-5} cm^2/sec (Li and Gregory 1974). The formation factor is a function of the porosity, tortuosity of the pores, and the constrictivity of the pores, but is often modeled as a function of porosity alone:

$$F_f \approx \phi^2. \tag{4}$$

Combining Equations (3) and (4), the effective diffusion coefficient in a porous medium is:

$$D_{eff} = \phi^2 D. \tag{5}$$

To calculate the effective diffusion coefficient in Equation (5), BRAGFLO porosity must be converted to actual (intrinsic) porosity using the following relation:

$$\phi = \frac{\phi_B}{1 + \phi_B - \phi_0}, \tag{6}$$

where ϕ is the intrinsic porosity [-], ϕ_B is the BRAGFLO porosity [-], and ϕ_0 is the initial porosity [-]. The initial porosity of the waste-filled rooms is 0.848. Substituting the BRAGFLO porosity of 0.1247 at 10,000 years for vector 17 into Equation (6), the intrinsic porosity in the waste panel at 10,000 years is 0.451. The effective diffusion coefficient for CO_2 in WIPP brine is:

$$\begin{aligned} D_{eff} &= \phi^2 D, \\ &= (0.451)^2(\tfrac{1}{2})(2\times10^{-5}\ cm^2/s), \\ &= 2.03\times10^{-6}\ cm^2/s, \\ &= 6.4\times10^{-3}\ m^2/year. \end{aligned} \tag{7}$$

In Equation (7), the free liquid diffusion coefficient is reduced by a factor of one-half from the published value for diffusion of CO_2 in seawater (Wang 2000). This is reasonable correction because the ionic strength of WIPP brines is greater than that of seawater.

The characteristic diffusion penetration distance, L, is defined as:

$$L = \sqrt{D_{eff} T_{hr}}, \tag{8}$$

where D_{eff} is the effective diffusivity in the waste-filled panel and T_{hr} is the characteristic hydraulic residence time. The physical meaning of L derives from an analytical solution to the one-dimensional diffusion equation for a semi-infinite slab when the concentration at one end is held at a fixed value, C_0 (Cussler 1997, Section 2.3):

$$\frac{C(x,t)}{C_0} = 1 - erf(\xi) = erfc(\xi), \quad \xi = \frac{x}{\sqrt{4Dt}}, \tag{9}$$

where $erfc(\xi)$ is the complimentary error function (Abramowitz and Stegun 1972, Section 7). When distance $x = \sqrt{Dt}$, then $\xi = 0.5$ and $C/C_0 \approx 0.5$ (Abramovitz and Stegun 1972, page 310). Thus, $L = \sqrt{D_{eff} T_{hr}}$ corresponds to the distance over which the concentration of CO_2 in brine is reduced to approximately half of its concentration at its source. Stated differently, the aqueous concentration of CO_2 will be greater than one-half of the CO_2 concentration at the waste within a distance L from the waste.

The 50 percent reduction in source concentration at distance L is another conservative element of this analysis. In a room, the reduction in CO_2 concentrations within distance L from the source may be less than 50% because the physical domain for diffusion is not the semi-infinite region of the analytic solution.

Using Equation (8), the characteristic diffusion penetration distance for vector 17 is 1.43 m (4.7 feet) (see Table 2). This is the minimum characteristic diffusion penetration distance for the 100 vectors in R1S2 that are shown in Table A-1 in Attachment A.

Table 2. Diffusion penetration distance in the waste panel for vector 17 (CRA-2014)

D_{eff}	T_{hr}	$L = \sqrt{D_{eff} T_{hr}}$
6.4×10^{-3} m^3/year	320 years	1.43 m (4.7 feet)

Figure 1 illustrates the lateral coverage provided by MgO supersacks for an actual waste emplacement scheme. Figure 1 is based on the as-emplaced waste containers in Room 7 of Panel 7. Room 7 is only partly filled with waste, but provides a realistic example of supersack emplacement for a variety of waste container types with varying lateral separations between adjacent waste stacks. The light green regions surrounding each supersack of MgO illustrate the diffusive penetration length of 1.43 m for CO_2 and the darker green regions indicate where there is overlap from two supersacks. The dissolved CO_2 that is generated by waste containers within the green regions is within the minimum distance L that provides efficient diffusive mixing of CO_2 with MgO supersacks during the minimum hydraulic residence time for the R1S2 scenario in BRAGFLO. Figure 1 shows that the minimum diffusive penetration length of 1.43 m provides efficient lateral mixing of CO_2 over all of the waste containers in Room 7. In addition, lateral diffusion and mixing of dissolved CO_2 is enhanced by: (1) the supersacks will fail during room closure, allowing some MgO to fall into the lateral separation between adjacent waste stacks and accumulate on the floor, (2) channels are likely to exist within the consolidated waste after the drums collapse, providing higher porosity pathways for diffusion of CO_2 in brine, and (3) if the waste is not fully saturated, gaseous diffusion provides a mechanism that rapidly mixes gaseous CO_2 over panel-scale distances[2]. These effects provide added assurance of efficient lateral mixing throughout each room.

Summary

Molecular diffusion (alone) is sufficient to mix CO_2 with WIPP brines over time and length scales characteristic of conditions in a waste panel. This mixing will occur laterally around each MgO supersack, and will also occur vertically as discussed by Wang (2000) and by Kanney and Vugrin (2006). This analysis has a number of assumptions that provide a high level of confidence that sufficient mixing of CO_2 will occur throughout the regulatory period:

- The minimum diffusion penetration length for CO_2 in brine is 1.43 m for vector 17 in BRAGFLO simulations for R1S2 of CRA-2014. The second smallest diffusion penetration length is 1.87 m

[2] The gaseous diffusion coefficient of CO_2 in H_2 is 0.55 cm^2/s at standard temperature and pressure conditions (AIP 1972, Table 2s-1). The gaseous diffusion coefficient of CO_2 is a factor of 55,000 greater than the brine diffusion coefficient of CO_2, 1×10^{-5} cm^2/s. The corresponding gaseous diffusion penetration distance for CO_2 in the waste is 336 m, so diffusion maintains uniform CO_2 gaseous concentrations throughout a panel.

(for vector 7) and the mean diffusion penetration length is 108 m for all 100 vectors, so the effective penetration length is very likely to be greater than the minimum value for this analysis.

- The interpretation of the diffusion penetration length is based on an analytic solution for a semi-infinite domain. Within the finite confines of waste emplacement rooms, CO_2 concentrations should exceed the predictions of the analytic solution for a given residence time and for a given distance from the MgO supersack.

- Mixing from advection and dispersion will increase the mixing of CO_2 beyond that predicted for diffusion alone.

- If the waste is not fully saturated, any concentrations of gaseous CO_2 will rapidly equilibrate throughout a panel because the gaseous diffusion coefficient of CO_2 is 55,000 times greater than diffusion coefficient of CO_2 in brine. The gaseous diffusion penetration distance for CO_2 in the waste is 336 m, ensuring effective mixing on a panel scale.

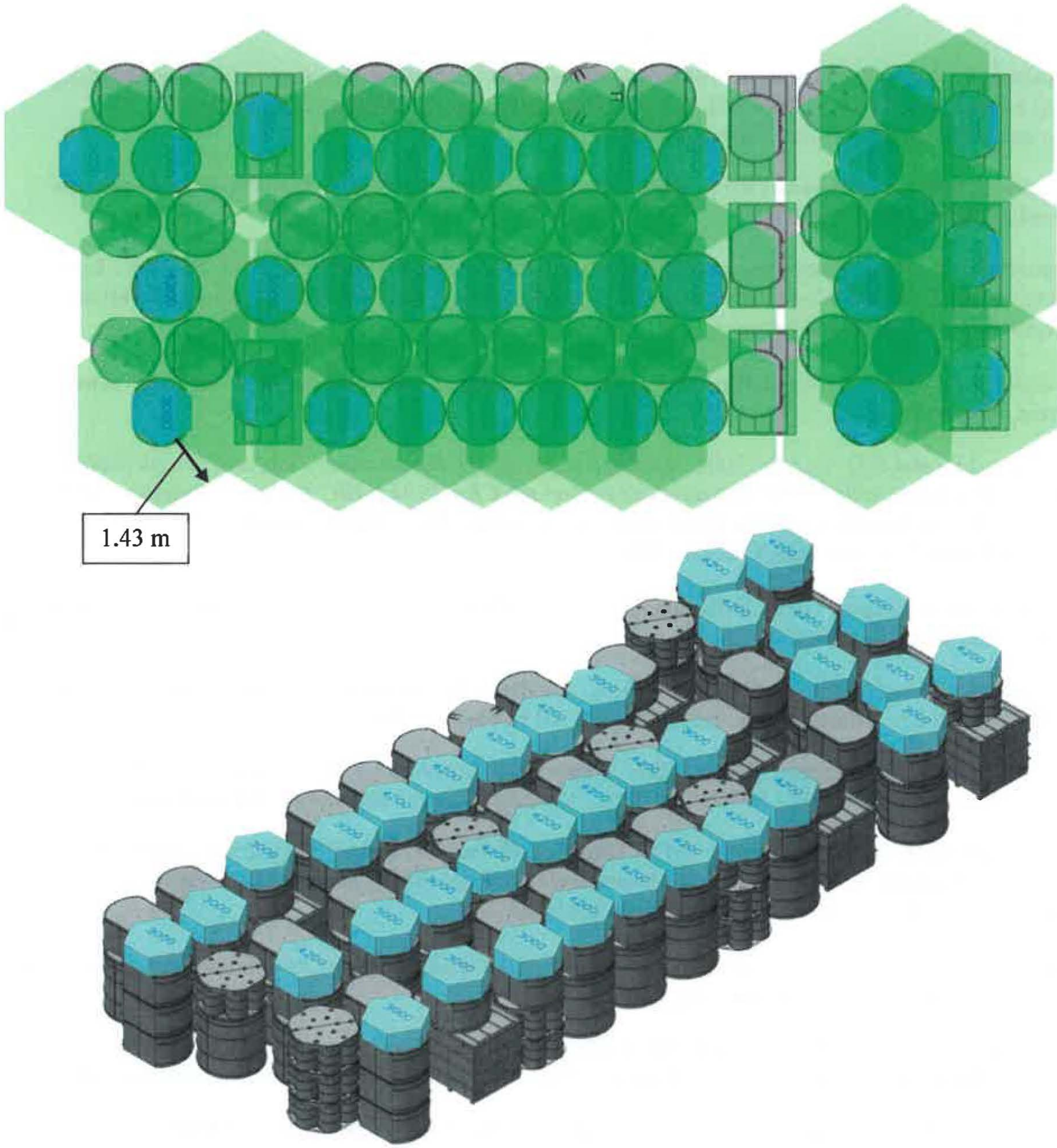

Figure 1. Diffusive mixing in the lateral direction provides high CO_2 concentrations near the MgO supersacks. This figure is based on the actual waste emplacement and supersack configuration in the air exhaust drift for Room 7 of Panel 7.

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* Copyrighted reference not provided in Enclosure 2.

ATTACHMENT A

BRAGFLO OUTPUT FOR R1S2 OF CRA-2014 AND CALCULATION OF DIFFUSION PENETRATION LENGTH FOR ALL VECTORS

Table A-1 provides the BRAGFLO output data for waste panel porosity, waste panel pore volume, and cumulative brine flow up the intrusion borehole for each of the 100 vectors in R1S2. Table A-1 also provides the calculated hydraulic residence time and diffusion penetration length for each vector in R1S2. The calculations of hydraulic residence time and diffusion penetration length require parameter values for the following quantities:

- Volume of the waste panel is 46,136 m^3
- Initial waste porosity is 0.848
- Duration of the flow in the intrusion borehole is 9,650 years
- Free diffusion coefficient for CO_2 in WIPP brine is 1×10^{-5} cm^2/s [3.16×10^{-2} m^2/year]. The free diffusion coefficient for CO_2 in WIPP brine is one-half of the free diffusion coefficient for CO_2 in seawater.

Exact BRAGFLO output values were used for the calculations of residence time and diffusion length in Table A-1, and results have been rounded for presentation purposes. Any small discrepancies are due to this round-off process. For example, the exact calculation of panel pore volume for vector 17 is (0.1246707)(46,135.568 m^3) = 5,751.75 m^3, while a calculation using rounded values in footnote 1 on page 3 of this document gives: (0.1247)(46,136. m^3) = 5,753 m^3.

The key output parameter from this analysis is the diffusion penetration length, which varies from 1.43 m for vector 17 to 453 m for vector 99. The output for vector 17 provides the basis for this analysis, and the use of data from vector 17, with the minimum diffusion penetration length, provides a conservative bias (i.e., underestimates) the effectiveness of diffusive mixing.

The two rightmost columns of Table A-1 provide the output from the 100 vectors, sorted by the smallest to the largest values of diffusion penetration length.

The BRAGFLO output for R1S2 is in file: *cra14_r1_s2_results.xlsx* that was provided by Sandia National Laboratories (Zeitler 2015).

Table A-1. BRAGFLO Output for R1S2 of the CRA-2014 and Calculation of Diffusion Penetration Length

Vector	Cumulative Flow Up Borehole (10k yrs) m^3	Waste Porosity (10k yrs) (-)	Panel Pore Volume (10k yrs) (-)	Borehole Flow Rate (10k yrs) m^3/yr	Residence Time yrs	Intrinsic Porosity (-)	Effective Diffusion Coefficient (m^2/yr)	Diffusion Length (m)
1	877.82	0.1232	5684.44	0.09	62490	0.4477	6.33E-03	19.88
2	5791.36	0.1404	6475.85	0.60	10791	0.4801	7.27E-03	8.86
3	4405.10	0.1220	5629.81	0.46	12333	0.4453	6.26E-03	8.79
4	5.77	0.1806	8332.38	0.00	13939868	0.5430	9.30E-03	360.15
5	29.63	0.1793	8273.59	0.00	2694933	0.5412	9.24E-03	157.84
6	2625.43	0.1846	8518.78	0.27	31312	0.5485	9.49E-03	17.24
7	100595.30	0.1240	5718.91	10.42	549	0.4492	6.37E-03	1.87
8	5306.25	0.1497	6905.73	0.55	12559	0.4962	7.77E-03	9.88
9	43702.39	0.1226	5658.27	4.53	1249	0.4466	6.29E-03	2.80
10	5.62	0.1277	5891.84	0.00	10122213	0.4566	6.58E-03	258.05
11	896.47	0.1261	5819.26	0.09	62641	0.4535	6.49E-03	20.16
12	54949.82	0.1229	5670.81	5.69	996	0.4471	6.31E-03	2.51
13	5811.01	0.1225	5650.11	0.60	9383	0.4462	6.28E-03	7.68
14	4183.25	0.1274	5875.49	0.43	13554	0.4559	6.56E-03	9.43
15	5.74	0.1415	6526.87	0.00	10975209	0.4821	7.33E-03	283.70
16	777.48	0.1691	7799.84	0.08	96810	0.5266	8.75E-03	29.10
17	173205.10	0.1247	5751.75	17.95	320	0.4506	6.41E-03	1.43
18	3.86	0.1802	8314.47	0.00	20778502	0.5425	9.29E-03	439.27
19	37.48	0.1435	6622.03	0.00	1704984	0.4857	7.44E-03	112.66
20	13877.29	0.1276	5886.04	1.44	4093	0.4563	6.57E-03	5.19
21	7.06	0.1462	6743.64	0.00	9222042	0.4902	7.58E-03	264.46
22	72249.68	0.1257	5799.42	7.49	775	0.4527	6.47E-03	2.24
23	3116.97	0.1249	5764.33	0.32	17846	0.4512	6.42E-03	10.71
24	338.12	0.1376	6346.08	0.04	181116	0.4751	7.12E-03	35.91
25	250.77	0.1677	7737.19	0.03	297734	0.5246	8.68E-03	50.85
26	530.61	0.1113	5135.95	0.05	93405	0.4228	5.64E-03	22.95
27	30644.34	0.1212	5593.25	3.18	1761	0.4437	6.21E-03	3.31
28	14071.58	0.1214	5598.88	1.46	3840	0.4440	6.22E-03	4.89
29	311.38	0.1154	5325.51	0.03	165044	0.4316	5.88E-03	31.15

Sorted Vector	Sorted Diffusion Length (m)
17	1.43
7	1.87
36	1.88
22	2.24
50	2.34
12	2.51
98	2.75
9	2.80
45	2.99
30	3.20
27	3.31
78	3.85
66	3.97
28	4.89
67	5.13
20	5.19
82	5.25
83	5.38
55	5.51
79	6.39
34	6.49
63	6.52
58	6.63
89	6.67
54	7.12
13	7.68
76	7.91
3	8.79
2	8.86

Vector	Cumulative Flow Up Borehole (10k yrs) m^3	Waste Porosity (10k yrs) (-)	Panel Pore Volume (10k yrs) (-)	Borehole Flow Rate (10k yrs) m^3/yr	Residence Time yrs	Intrinsic Porosity (-)	Effective Diffusion Coefficient (m^2/yr)	Diffusion Length (m)
30	34001.92	0.1235	5695.91	3.52	1617	0.4482	6.34E-03	3.20
31	6.49	0.1814	8371.07	0.00	12440241	0.5442	9.34E-03	340.94
32	5.70	0.1527	7044.16	0.00	11932109	0.5011	7.92E-03	307.50
33	7.50	0.1180	5443.57	0.00	7006394	0.4370	6.03E-03	205.49
34	9064.57	0.1290	5949.34	0.94	6334	0.4590	6.65E-03	6.49
35	38.05	0.1117	5154.87	0.00	1307479	0.4237	5.66E-03	86.06
36	97005.37	0.1227	5662.27	10.05	563	0.4467	6.30E-03	1.88
37	13.09	0.1491	6878.53	0.00	5071889	0.4952	7.74E-03	198.10
38	66.51	0.1914	8831.23	0.01	1281399	0.5574	9.80E-03	112.09
39	100.69	0.1551	7154.87	0.01	685704	0.5050	8.05E-03	74.29
40	6.52	0.1105	5097.92	0.00	7547411	0.4209	5.59E-03	205.44
41	210.28	0.1439	6639.08	0.02	304677	0.4863	7.46E-03	47.69
42	9.97	0.1090	5029.15	0.00	4866706	0.4176	5.50E-03	163.67
43	317.12	0.1236	5701.78	0.03	173508	0.4485	6.35E-03	33.18
44	287.95	0.1741	8033.66	0.03	269229	0.5339	9.00E-03	49.21
45	36031.22	0.1189	5486.88	3.73	1470	0.4390	6.08E-03	2.99
46	2662.66	0.1287	5937.85	0.28	21520	0.4585	6.63E-03	11.95
47	111.66	0.1187	5475.38	0.01	473179	0.4385	6.07E-03	53.58
48	9.29	0.1460	6734.33	0.00	6997079	0.4899	7.57E-03	230.19
49	9.08	0.1081	4988.42	0.00	5301234	0.4157	5.45E-03	170.01
50	60055.71	0.1203	5550.94	6.22	892	0.4418	6.16E-03	2.34
51	8.34	0.1645	7588.41	0.00	8776410	0.5197	8.52E-03	273.51
52	1449.37	0.1381	6371.45	0.15	42422	0.4760	7.15E-03	17.42
53	8.61	0.1986	9162.83	0.00	10268764	0.5665	1.01E-02	322.46
54	6706.32	0.1221	5631.75	0.69	8104	0.4454	6.26E-03	7.12
55	10756.29	0.1197	5523.31	1.11	4955	0.4406	6.13E-03	5.51
56	8.00	0.1296	5977.76	0.00	7214414	0.4602	6.68E-03	219.57
57	6.78	0.1359	6268.02	0.00	8922378	0.4720	7.03E-03	250.44
58	11180.96	0.1460	6733.96	1.16	5812	0.4899	7.57E-03	6.63
59	123.22	0.1417	6537.39	0.01	511975	0.4825	7.35E-03	61.32
60	32.92	0.0971	4481.64	0.00	1313545	0.3899	4.80E-03	79.38

Sorted Vector	Sorted Diffusion Length (m)
14	9.43
8	9.88
86	10.42
23	10.71
46	11.95
70	12.15
80	12.93
90	13.83
69	13.88
6	17.24
93	17.41
52	17.42
84	17.72
1	19.88
11	20.16
26	22.95
62	26.01
16	29.10
74	30.51
29	31.15
43	33.18
24	35.91
71	44.61
41	47.69
44	49.21
25	50.85
47	53.58
61	54.68
59	61.32
97	71.21
39	74.29

Vector	Cumulative Flow Up Borehole (10k yrs) m³	Waste Porosity (10k yrs) (-)	Panel Pore Volume (10k yrs) (-)	Borehole Flow Rate (10k yrs) m³/yr	Residence Time yrs	Intrinsic Porosity (-)	Effective Diffusion Coefficient (m²/yr)	Diffusion Length (m)		Sorted Vector	Sorted Diffusion Length (m)
61	107.05	0.1186	5471.28	0.01	493197	0.4383	6.06E-03	54.68		60	79.38
62	489.84	0.1206	5561.97	0.05	109573	0.4423	6.17E-03	26.01		35	86.06
63	8588.80	0.1262	5823.82	0.89	6543	0.4537	6.50E-03	6.52		77	90.54
64	6.15	0.1268	5849.87	0.00	9174791	0.4548	6.53E-03	244.72		94	107.02
65	6.81	0.2249	10374.78	0.00	14701723	0.5967	1.12E-02	406.42		38	112.09
66	21488.24	0.1218	5617.10	2.23	2523	0.4448	6.24E-03	3.97		19	112.66
67	12266.73	0.1191	5495.42	1.27	4323	0.4394	6.09E-03	5.13		72	144.14
68	17.32	0.1867	8615.57	0.00	4801148	0.5513	9.59E-03	214.58		5	157.84
69	2114.23	0.1330	6136.90	0.22	28011	0.4667	6.87E-03	13.88		42	163.67
70	2275.45	0.1213	5597.82	0.24	23740	0.4439	6.22E-03	12.15		49	170.01
71	129.86	0.1074	4953.01	0.01	368071	0.4139	5.41E-03	44.61		87	177.11
72	18.84	0.1305	6022.54	0.00	3084328	0.4620	6.74E-03	144.14		95	195.79
73	6.24	0.1854	8552.09	0.00	13225200	0.5495	9.53E-03	354.96		37	198.10
74	225.38	0.0976	4503.82	0.02	192840	0.3911	4.83E-03	30.51		40	205.44
75	7.91	0.1398	6447.99	0.00	7865792	0.4790	7.24E-03	238.66		33	205.49
76	6437.11	0.1324	6109.20	0.67	9158	0.4656	6.84E-03	7.91		68	214.58
77	50.79	0.1345	6204.49	0.01	1178848	0.4694	6.95E-03	90.54		56	219.57
78	22847.74	0.1218	5617.44	2.37	2373	0.4448	6.24E-03	3.85		48	230.19
79	8806.50	0.1253	5782.39	0.91	6336	0.4519	6.45E-03	6.39		96	235.62
80	1902.83	0.1183	5456.74	0.20	27673	0.4376	6.04E-03	12.93		75	238.66
81	6.99	0.1714	7908.09	0.00	10924550	0.5300	8.86E-03	311.19		64	244.72
82	12395.68	0.1224	5647.33	1.28	4396	0.4461	6.28E-03	5.25		57	250.44
83	12180.46	0.1242	5730.55	1.26	4540	0.4497	6.38E-03	5.38		10	258.05
84	1138.41	0.1250	5765.46	0.12	48872	0.4512	6.42E-03	17.72		92	262.85
85	5.46	0.1385	6390.46	0.00	11292550	0.4768	7.17E-03	284.62		21	264.46
86	3541.73	0.1294	5968.19	0.37	16261	0.4598	6.67E-03	10.42		51	273.51
87	27.78	0.1957	9030.11	0.00	3137325	0.5629	1.00E-02	177.11		100	277.55
88	7.38	0.1616	7456.50	0.00	9752255	0.5153	8.38E-03	285.89		15	283.70
89	7868.99	0.1237	5707.87	0.82	7000	0.4487	6.35E-03	6.67		85	284.62
90	2121.72	0.1328	6127.01	0.22	27867	0.4663	6.86E-03	13.83		88	285.89
91	5.53	0.1754	8092.15	0.00	14125682	0.5357	9.06E-03	357.69		32	307.50

Vector	Cumulative Flow Up Borehole (10k yrs) m^3	Waste Porosity (10k yrs) (-)	Panel Pore Volume (10k yrs) (-)	Borehole Flow Rate (10k yrs) m^3/yr	Residence Time yrs	Intrinsic Porosity (-)	Effective Diffusion Coefficient (m^2/yr)	Diffusion Length (m)		Sorted Vector	Sorted Diffusion Length (m)
92	9.47	0.1685	7773.50	0.00	7921438	0.5257	8.72E-03	262.85		81	311.19
93	1734.27	0.1508	6959.35	0.18	38724	0.4981	7.83E-03	17.41		53	322.46
94	53.22	0.1625	7497.23	0.01	1359333	0.5167	8.42E-03	107.02		31	340.94
95	13.23	0.1481	6834.88	0.00	4986024	0.4936	7.69E-03	195.79		73	354.96
96	7.67	0.1360	6274.04	0.00	7889904	0.4722	7.04E-03	235.62		91	357.69
97	50.35	0.1068	4925.47	0.01	944042	0.4126	5.37E-03	71.21		4	360.15
98	52353.46	0.1314	6061.37	5.43	1117	0.4636	6.78E-03	2.75		65	406.42
99	3.99	0.1894	8739.83	0.00	21145638	0.5548	9.71E-03	453.22		18	439.27
100	10.99	0.1927	8891.54	0.00	7810272	0.5591	9.86E-03	277.55		99	453.22
MIN	3.86	0.0971	4481.64	0.00	320.45	0.390	4.80E-03	1.43			
MAX	173205.10	0.2249	10374.78	17.95	21145638.22	0.597	1.12E-02	453.22			
MEAN	9902.45	0.1392	6421.63	1.03	3300217.46	0.474	7.16E-03	107.54			

EPA Comment
2-C-4 Hydromagnesite Conversion Rate.

Clayton (2013) formulated the conversion reaction from hydromagnesite to magnesite for inclusion in the BRAGFLO calculations as:

$$Mg_5(CO_3)_4(OH)_2{\bullet}4H_2O(s) \rightarrow 4\ MgCO_3(s) + Mg(OH)_2(s) + 4\ H_2O(l) \qquad (5)$$

Clayton (2013) calculates a range for the hydromagnesite conversion rate based on reaction times of 100 years to 10,000 years. However, the minimum reaction time for this conversion is uncertain. SCA (2008) reviewed the available experimental and natural analogue data and concluded that hydromagnesite conversion is best represented by a range of zero conversion (only hydromagnesite remains after 10,000 years) to complete conversion (only magnesite remains after 10,000 years), with a uniform distribution across this range. Please provide an explanation as to why the specific upper and lower limits used in the PA were picked.

The effect of using zero rather than 100 years as the minimum conversion rate is likely to be less brine production in the water balance, based on equation (5). Please provide an explanation of the effects on PA if the lower limit of the hydromagnesite conversion rate is set to zero while the upper limit is decreased by a variety of plausible factors that are less than what Clayton had adopted.

References:

Clayton, D.J. 2013. Justification of Chemistry Parameters for Use in BRAGFLO for AP-164, Rev. 1. Sandia National Laboratories, ERMS 559466.

SCA (S. Cohen and Associates). 2008. Review of MgO-Related Uncertainties in the Waste Isolation Pilot Plant. Final Report prepared for the U.S. Environmental Protection Agency Office of Radiation and Indoor Air, Washington, D.C., January 24, 2008.

DOE Response

As discussed in the Justification of Chemistry Parameters for Use in BRAGFLO for AP-164, Revision 1 (Clayton 2013), the range used for the hydromagnesite conversion rate was derived from the Technical Support Document for Section 194.24: EPA's Evaluation of DOE's Actinide Source Term (EPA 1998). In section 3 of EPA (1998) the following conceptualization was given.

"*Based on a review of the literature, the Agency developed the following conceptualization of the sequence and time scales of reactions between infiltrating brine and MgO backfill in the WIPP repository:*

1. *Rapid reaction of MgO with brine to produce brucite (hours to days);*
2. *Rapid carbonation of brucite to produce nesquehonite and possibly hydromagnesite (hours to days);*
3. *Rapid conversion of nesquehonite to hydromagnesite (days to weeks);*
4. *Slow conversion of hydromagnesite to magnesite (hundreds to thousands of years).*"

In order to capture the stated reaction time range of "hundreds to thousands of years," versus tens or tens of thousands, the reaction time range of 100 to 10,000 years was used. While the range in reaction time could be bounded by 0 (instantly to magnesite) to infinity (remains as hydromagnesite), we chose to follow the conceptualization discussed in EPA (1998). In the Review of MgO-Related Uncertainties in the Waste Isolation Pilot Plant (SCA 2008), S. Cohen and Associates discuss potential reaction time ranges for the hydromagnesite conversion rate between a 73 years half-life (time required to convert half the hydromagnesite) and 6,200 years required for complete conversion. This is in line with the conceptualization discussed above. The discussion of using the bounding assumptions of all hydromagnesite or all magnesite appears to be limited to estimating the overall amount of carbon dioxide consumed by the magnesium oxide after 10,000 years.

Reducing the minimum reaction time to zero would result in an instantaneous conversion of hydromagnesite to magnesite, freeing the bound water molecules at an earlier time. This would result in an increase in the volume of brine to occur 100 years earlier, but should have a minimal effect on overall performance assessment results. The potential effects on performance assessment can be estimated by examining the impact of the sampled hydromagnesite conversion rate on the final output. In the Sensitivity of the CRA-2014 Performance Assessment Releases to Parameters (Kirchner 2013), Kirchner documents the sensitivity of releases to sampled input parameters. The parameter used to represent the hydromagnesite conversion rate (WAS_AREA:HYMAGCON) did not show any correlation with releases from the repository. Therefore, the potential effects on performance assessment with the current range of the sampled hydromagnesite conversion rate are minimal.

References:

Clayton, D.J. 2013. Justification of Chemistry Parameters for Use in BRAGFLO for AP-164, Revision 1. ERMS 559466. Sandia National Laboratories, Carlsbad, NM.

Kirchner, T. 2013. *Sensitivity of the CRA-2014 Performance Assessment Releases to Parameters.* ERMS 560043. Sandia National Laboratories, Carlsbad, NM.

S. Cohen and Associates (SCA). 2008. *Review of MgO-Related Uncertainties in the Waste Isolation Pilot Plant.* January 24, 2008. Final Report prepared for the U.S. Environmental Protection Agency Office of Radiation and Indoor Air, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1998. Technical Support Document for Section 194.24: EPA's Evaluation of DOE's Actinide Source Term. Docket A-93-02, Item V-B-17. Environmental Protection Agency Office of Radiation and Indoor Air, Washington, D.C.

EPA Comment
2-C-6 MgO Hydration Rate.

MgO has been supplied for the WIPP engineered barrier by three vendors: National Magnesia Chemicals, Premier Chemicals, and, currently, from Martin Marietta Magnesia Specialties (Martin Marietta). The majority of the MgO in the repository is from Premier Chemicals and Martin Marietta. Clayton (2013) used MgO hydration rates obtained from experiments conducted with MgO supplied by Premier Chemicals to establish the hydration rates used in PA. However, Wall (2005) performed preliminary tests with the Martin Marietta MgO and concluded that it reacted to form brucite faster than Premier MgO. Given the multiple vendors that supply MgO a summary of the following information needs to be provided;

- *The inundated and humid MgO hydration rates for MgO from the three vendors.*
- *The potential effects of the variable MgO hydration rates on repository performance.*
- *The amounts of National Magnesia Chemicals, Premier MgO and Martin Marietta MgO that will be present in the WIPP repository at the time of closure, and assumptions regarding the future* source(s) of MgO.

References:

Clayton, D.J. 2013. Justification of Chemistry Parameters for Use in BRAGFLO for AP-164, Rev. 1. Sandia National Laboratories, ERMS 559466.

Deng, H., M. Nemer, and Y. Xiong. 2007. Experimental Study of MgO Reaction Pathways and Kinetics Rev. 1. Sandia National Laboratories TP 06-03.

Deng, H., Y. Xiong, M. Nemer and S. Johnsen. 2009. Experimental Work Conducted on MgO Long-Term Hydration. Sandia National Laboratories ERMS 551421.

Wall, N.A. 2005. Preliminary Results for the Evaluation of Potential New MgO. Sandia National Laboratories ERMS 538514.

DOE Response

As mentioned in Appendix MgO-2014 (DOE 2014), there are three vendors for the MgO in the WIPP, i.e., National Magnesia Chemicals, Premier Chemicals, and Martin Marietta Magnesia Specialties. As National Magnesia Chemicals supplied MgO for only a short time (about one year) and this source accounts for only 0.41% of the MgO in the repository (see Table 1), its hydration rates were not systematically characterized. The hydration rates for Martin Marietta MgO are faster than those for Premier MgO. As a direct comparison, for instance, Martin Marietta MgO reached complete hydration for the reactive portion of the industrial grade MgO in 43 days at 70°C in deionized (DI) water in the accelerated inundated hydration test described in Experimental Work Conducted on MgO Characterization and Hydration (Deng et al. 2009), whereas Premier MgO reached complete hydration for the reactive portion of the industrial grade MgO in 78 days under the same conditions described in Hydration of Magnesium Oxide in the Waste Isolation Plant (Snider 2002). In general, faster MgO hydration rates would reduce the amount of brine in the repository at earlier times, but would not change the total amount of brine that could be consumed by the MgO.

The experiments for MgO hydration rates at the repository temperature with Premier MgO were completed as described in Analysis of MgO Hydration Laboratory Results and Calculation of Extent of Hydration and Resulting Water Uptake versus Time under Postulated WIPP Conditions (Nowak and

Clayton 2007, and references therein), and their hydration rates were implemented in performance assessment (PA). Experiments for determination of MgO hydration rates at the repository temperature with Martin Marietta MgO have not been completed, so their hydration rate data have not been included in MgO hydration rate parameters. Using the slower hydration rates for Premier MgO for PA is a conservative assumption.

Table 1. Amounts of MgO from three vendors that were already emplaced in WIPP (from Kouba 2015)

Vendor	Amounts of MgO Procured and Emplaced in WIPP (Tons)	Percentage (%)
National Magnesia Chemicals	148	0.41
Premier Chemicals	10856.4	30.14
Martin Marietta Magnesia Specialties	25016.1	69.45

Sensitivity of the CRA-2014 Performance Assessment Releases to Parameters (Kirchner 2013) documents the sensitivity of releases to sampled input parameters (see Table 9 in Kirchner 2013). The variables used to represent the MgO hydration rates in the various brines showed that the releases from the repository are at best only weakly correlated with the MgO hydration rates over the range sampled. Therefore, the potential effects on performance assessment by changing the MgO hydration rates should be minimal.

At the time of closure, the amounts of MgO from National Magnesia Chemicals and Premier Chemicals in the WIPP listed in Table 1 will remain unchanged, but their percentages will change as the amounts of MgO from Martin Marietta Magnesia Specialties will increase. At this time, the final, exact amounts of MgO from Martin Marietta Magnesia Specialties that will be present in the WIPP at the closure are not available. The future provider of MgO is expected to be Martin Marietta Magnesia Specialties. This assumption is based on continued availability of the raw materials for their production, and the outcome of competitive procurements as required by the Federal Acquisition Regulations and the Department of Energy Acquisition Regulations.

References:

Deng, H.-R., Y.-L. Xiong, M.B. Nemer, and S. Johnsen. 2009. Experimental Work Conducted on MgO Characterization and Hydration. *Materials Res. Soc. Symp. Proc.* 1124, Q05-05 (6 pages).*

Kirchner, T. 2013. Sensitivity of the CRA-2014 Performance Assessment Releases to Parameters. ERMS 560043. Sandia National Laboratories, Carlsbad, NM.

Kouba, S. 2015. E-mail from Steve Kouba dated March 9, 2015, to Yongliang Xiong, Todd Zeitler, and Steve Wagner regarding the input for 2-C-6. ERMS 563786. Sandia National Laboratories, Carlsbad, NM.

Nowak, E.J. and D.J. Clayton. 2007. Analysis of MgO Hydration Laboratory Results and Calculation of Extent of Hydration and Resulting Water Uptake versus Time under Postulated WIPP Conditions. ERMS 546769. Sandia National Laboratories, Carlsbad, NM.

* Copyrighted reference not provided in Enclosure 2.

Snider, A.C. 2002. *Hydration of Magnesium Oxide in the Waste Isolation Plant*. SAND2002-1645P. Sandia National Laboratories, Albuquerque, NM.*

U.S. Department of Energy (DOE). 2014. Title 40 CFR Part 191 Subparts B and C Compliance Recertification Application 2014 for the Waste Isolation Pilot Plant, Appendix MgO-2014, Magnesium Oxide as an Engineered Barrier, United States Department of Energy, Waste Isolation Pilot Plant. Carlsbad Field Office, Carlsbad, NM.

EPA Comment

2-32-G1 Obsolete FEP Screening Arguments, Curtailed FEP Screening Arguments, and Completeness Considerations.

The screening arguments in the CRA-2014, Appendix SCR-2014 for many FEPs have been carried forward from past baseline reviews and do not necessarily reflect changes that have occurred in the past several years. This especially applies to information on how some FEPs are accounted for in PA. Some FEPs need to be updated to reflect current repository design and new knowledge of repository behavior. These are identified in Table FEP-1.

For some FEPs, the screening argument needs to provide a more complete discussion of the FEP and how it is determined to be screened-in or screened-out. The supporting arguments, along with documents incorporated by references, need to provide a basic understanding of how the FEP is accounted for in PA calculations, where the FEP is accounted for in the repository region and surrounding geosphere, and when in the regulatory time frame the FEP is accounted for. Those FEPs with inadequate or curtailed screening arguments are provided in Table FEP-1.

For some FEPs that DOE has reported "no change", EPA disagrees and believes that DOE should reconsider and update the FEP discussion. Table FEP-1 includes those FEPs in this category that EPA has identified, to date, as being incomplete.

DOE Response

Since the Compliance Certification Application (CCA), Appendix SCR is a screening document for individual FEPs, and therefore contains only the description, screening argument, and decision as to whether the FEP is to be included (screened-in) or excluded (screened-out) within PA scenarios. For those FEPs that are screened-in, an attempt has been made to point to the appropriate location within the compliance documentation that describes and justifies the implementation of the FEP with the appropriate model(s). Because the screening document is quite large, and because FEPs span a myriad of technical and scientific disciplines, attempting to describe the implementation of each FEP within the screening document would: 1) result in a document of unmanageable size, 2) create redundancy within the compliance documentation, and 3) create the opportunity for inconsistency and error within the compliance baseline.

The FEPs baseline is reviewed any time a change to the baseline is proposed, or any time that new data or conditions affect or relate to screening arguments or decisions. Since recertification applications are an opportunity to "roll-up" and account for any changes that have occurred since the last recertification, updates to the FEPs baseline are reflected cumulatively in Appendix SCR. Requests by the EPA to describe the implementation methodology of specific FEPs in Appendix SCR-2014 are not consistent with the current FEP program or format and content of Appendix SCR. The DOE agrees and understands that such information must be included within the compliance documentation; however, Appendix SCR is not the correct place to provide this information, rather pointers should be given to the correct source material as appropriate. Such information has historically been found within Chapter 6 of the CCA, Appendix MASS of the CCA, or their updated successor documents (Appendix PA-2004 and Attachment MASS-2004, Appendix PA-2009, Appendix PA-2014, etc.). Again, this is mostly a practical matter that has to do with managing the compliance documentation in a way that avoids duplication and inconsistency.

The DOE will continue to document any new data and information with each Compliance Recertification Application. Whenever new data or new information are available, the affected FEPs and their screening decisions will be updated. This process is consistent with EPA's comments as provided in its February 27, 2015, letter and accompanying FEPs table. In cases where we update FEPs as a result of addressing EPA's comments, we will provide updated excerpts from Appendix SCR-2014.

EPA Comment
2-32-S4 FEP H28 Enhanced Oil and Gas Production.

Please address whether enhanced production techniques are being used in the Delaware basin and in the vicinity of WIPP. Please also address the potential for these techniques to create a preferential pathway for radionuclide releases through a second well.

DOE Response

Enhanced production refers to methods used to enhance production in a well after the primary production rate becomes unsatisfactory. Enhanced production techniques employed in the Delaware Basin include water injection, waterflood, and carbon-dioxide (CO_2) miscible flooding. These techniques have been commonly used in the Delaware Basin, but only small-scale pilot injection[1] occurs near the WIPP. No unitized floods have been identified or planned[2]. As stated in Melzer (2013), carbon dioxide miscible flooding is not an attractive production enhancement technique near the WIPP due to unfavorable reservoir characteristics (channel sands). These same characteristics make widespread waterflooding unlikely as well.

In the mid-1990s, WIPP stakeholders suggested including an injection well into WIPP performance assessment scenarios. The DOE did not agree that the scenario was technically credible, and conducted very conservative analyses assuming a faulty injection well operated at extreme pressures for a very long time period located at the WIPP boundary to simulate a worse-case injection scenario. These analyses concluded that such activities do not jeopardize the ability of the WIPP to perform as expected (Stoelzel and Obrien [1996], and Stoelzel and Swift [1997]). EPA concurred with this analysis in its Technical Support Document for Section 194.32: Fluid Injection Analysis (EPA 1998) and stated, "…fluid injection was appropriately screened out of performance assessment by DOE."

EPA's question asks whether these techniques can create pathways for radionuclide releases through a second well. It is assumed that the second well is located outside the WIPP boundary and then employs enhanced recovery methods later in the life of the well. Due to the reservoir characteristics cited above, only pilot injection (single-point injection) would be employed near the WIPP, not a widespread waterflood project. In this case, water would be injected into the target formation to move oil or gas toward a neighboring producing well (not for disposal purposes). Because injection wells are permitted to pressures safely below the fracture threshold, fractures will not occur and therefore will not create any pathway that would connect the repository to the injection well. In waterflood or "pilot flood" projects such as this, exceeding the fracture threshold is not only in violation of the operating permit[3], but also detrimental to the purposes of enhancing production. Therefore, operators ensure that these threshold pressures are not exceeded. Given these limitations, it is not expected a well near the WIPP employing enhanced production techniques would create a release pathway or connection to the other wells outside the WIPP boundary or waste panels within the boundary. Scenarios where wells within the boundary that do not intersect WIPP waste are explicitly exempted from consideration of enhanced production techniques under 40 CFR 194.33(d), where it states, *"With respect to future drilling events, performance assessments need not analyze the effects of techniques used for resource recovery subsequent to the*

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[1] Note: "Pilot injection" refers to a single injection well, not an expansive, multi-injection-site waterflood project intended to influence several producing wells.
[2] Unitization provides for the development of an entire geologic structure or area by a single operator so that drilling and production may proceed in the most efficient and economic manner. Unitized waterfloods are typically designated for large, continuous reservoir types.
[3] Permits to inject are issued by the New Mexico Oil Conservation Division and limit injection pressures based on depth, fracture pressures, and other rock and reservoir characteristics.

drilling of the borehole." (See also Appendix SCR-2014 Section SCR-5.2.1.7, FEPs H60 *Liquid Waste Disposal* – Inside Boundary, and H61 *Enhanced Oil and Gas Production* – Inside Boundary.)

References:

Melzer, L.S. 2013. *An Updated Assessment of the CO2-Enhanced Oil Recovery Potential in the Vicinity of the Waste Isolation Pilot Plant (June)*. Melzer Consulting, Midland, TX.

Stoelzel, D.M., and D.G. O'Brien. 1996. *The Effects of Salt Water Disposal and Waterflooding on WIPP*. Summary Memorandum of Record for NS-7a. ERMS 240837. Sandia National Laboratories, Albuquerque, NM.

Stoelzel, D.M., and P.N. Swift. 1997. *Supplementary Analyses of the Effect of Salt Water Disposal and Waterflooding on the WIPP*. ERMS 244158. Sandia National Laboratories, Albuquerque, NM.

U.S. Environmental Protection Agency (EPA). 1998. *Technical Support Document for Section 193.32: Fluid Injection Analysis* (May). Environmental Protection Agency Office of Radiation and Indoor Air, Washington, D.C.

EPA Comment
2-32-S5 FEP H58 Solution Mining.

This FEP is screened out partially on the basis that solution mining will not occur in low ambient temperature conditions. However, solution mining is occurring in the nearby Eddy mine under similar conditions that exist in the vicinity of WIPP. Please provide text that reconciles the basis of the screening argument and the conditions at the Eddy mine where solution mining is taking place.

DOE Response

The official screening decision for this FEP, as stated in Appendix SCR-2014, is based on regulatory grounds under the "future states assumption" found in 40 CFR 194.25. That is, from a strictly *regulatory-based* perspective, the solution mining project currently underway by Intrepid Mining can be screened out because it is located geographically outside of the Delaware Basin boundary, and regulatory guidance is clear that areas outside the basin boundary are, by definition, not in the vicinity of WIPP and therefore not to be considered in compliance applications due to their geographic and geologic differences from the WIPP site. This position is supported by the EPA in its Response to Comments, Section 8, Issue GG (EPA 1998d):

> *"...However, the Agency emphasizes that, in accordance with the WIPP compliance criteria, solution mining does not need to be included in the PA. As previously discussed, potash solution mining is not an ongoing activity in the Delaware Basin. Section 194.32(b) of the rule limits assessment of mining effects to excavation mining. Thus the solution mining scenarios proposed are excluded on regulatory grounds after repository closure. Prior to or soon after disposal, solution mining is an activity that could be considered under Section 194.32(c). However, DOE found that potash solution mining is not an ongoing activity in the Delaware Basin; and one pilot project examining solution mining in the Basin is not substantive evidence that such mining is expected to occur in the near future."*

For many FEPs within WIPP's baseline, screening can sometimes be accomplished based on more than one screening criterion. In such cases, the DOE often opts for the regulatory screening, if appropriate. Such is the case for H58. However, in the interest of completeness and comprehensiveness, the DOE felt it worthwhile to discuss the Intrepid solution mining project in Appendix SCR-2009. The DOE again updated this project's progress in Appendix SCR-2014. DOE has followed the development of this project from its inception, and has verified that the solution mining activity remains outside the Delaware Basin boundary, thus supporting the screening decision of SO-R (screened-out, based on regulatory grounds).

While the screening decision of SO-R is the "decision of record," a technical discussion is also presented about both the probability and consequence of solution mining for potash at the WIPP within Appendix SCR-2014. The DOE feels that while these arguments are not the basis of the current screening decision, they are valuable in understanding the nature and impact of this activity should it occur at or near the WIPP in the future. Appendix SCR-2014 provides additional information regarding the possible consequences of solution mining near the WIPP, however this information does not affect the current screening decision.

References:

U.S. Environmental Protection Agency (EPA). 1998. *Response to Comments: Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations* (May). Environmental Protection Agency Office of Radiation and Indoor Air, Washington, D.C.

EPA Comment
2-32-S7 FEP W3 Heterogeneity of Waste Forms.

The screening argument citation of the CCA as the source of information on the heterogeneity of waste forms ignores changes that have occurred in the past 15 years, including supercompacted waste and mingling RH waste in shielded containers with CH waste. Please update the information to reflect current waste forms.

DOE Response

The screening argument for W3 Heterogeneity of Waste Forms has been revised to reflect new information regarding the variety of waste forms and types that are approved for disposal. However, the details regarding the implementation of the waste inventory and waste heterogeneity are presented elsewhere within the compliance documentation, and are referenced in the revised Appendix SCR text. Waste heterogeneity from an activity standpoint is accounted for in disturbed performance scenarios (see Appendix PA-2014, Section PA-3.8). Any new information related to the heterogeneity of wastes and variations to their physical form has been updated with each CRA as appropriate. These variations have been discussed historically in other areas of the CCA and subsequent CRAs, as appropriate. This information continues to be represented within the compliance baseline, as all previous compliance submittals and correspondence remain part of the certification basis.

With regard to EPA's specific request about current waste forms, Hansen et al. (2004) discusses the effects of supercompacted waste and heterogeneous waste emplacement on repository performance. In that report, the DOE "assessed the baseline features, events and processes (FEPs) to identify specific components of performance assessment that could be affected by supercompacted waste." The DOE found that "no changes to the waste-related FEPs were warranted in the new performance assessment." The results of that assessment have not been superseded, so the DOE continues to support that finding, and no changes to the waste-related FEPs based on supercompacted waste and heterogeneous waste emplacement are currently warranted. The EPA's review (EPA 2004) and approval (Marcinowski 2004) of this analysis concurred with DOE's findings that these wastes are suitable for disposal in WIPP and are adequately represented within performance assessment.

More recently, the approval to dispose shielded RH containers was granted by EPA in Edwards (2013). This approval was based, in part, upon a bounding analysis (Dunagan et al. 2007) that evaluated the effects of 1) disposing all of the RH waste in the walls as originally assumed; 2) disposing all of the RH waste in shielded containers on the room floors, and 3) disposing half of the RH waste in shielded containers and the other half in the walls. The bounding analysis concludes that the packaging and emplacement of RH waste in shielded containers has no discernible impact to all release pathways (i.e., cuttings, cavings, spallings, direct brine releases, groundwater releases, and total releases).

SCR-6.1.2.1.2 Summary of New Information

The waste inventory used for the CRA-2014 PA calculations has been updated as provided in Kicker and Zeitler (2013). Since these FEPs are accounted for in PA, inventory-related parameters may differ from those used in previous PAs; however, the screening decisions have not changed and these FEPs are represented in PA calculations. The EPA approved the use of the shielded RH container as an allowable disposal container in WIPP (Edwards 2013). The impacts of this container upon WIPP performance were evaluated in Dunagan et al. (2007).

SCR-6.1.2.1.3 Screening Argument

Waste characteristics, comprising the waste inventory and heterogeneity of waste forms, are described in the CCA, Appendix BIR. The waste inventory is accounted for in PA calculations in deriving the dissolved actinide source term and gas generation rates. The distribution of contact-handled transuranic (CH-TRU) and remote-handled transuranic (RH-TRU) waste within the repository leads to room-scale heterogeneity of the waste forms, which is accounted for in PA calculations when considering the potential activity of waste material encountered during inadvertent borehole intrusion (Appendix PA-2014, Section PA-3.8). The DOE implements waste heterogeneity in waste forms through the assumption of random placement of TRU waste in the repository. This assumption includes all waste container forms and types. Details regarding the implementation of this assumption are provided in the CRA-2009, Appendix MASS-2009, Section MASS-21.0. This implementation methodology has not changed as a result of the addition of the shielded RH-waste container.

This change has been added to Enclosure 4, *CRA-2014 Errata Tracking.*

References:

Dunagan, S.C., G.T. Roselle, E.D. Vugrin, and J.T. Long. 2007. *Analysis Report for Shielded Container Performance Assessment.* ERMS 547197. October 31, 2007. Sandia National Laboratories, Carlsbad, NM.

Edwards, J.D. 2013. Letter to J. Franco, Carlsbad Field Office, approving the disposal of the shielded container assembly. September 3, 2013. U.S. Environmental Protection Agency, Washington, D.C.

Hansen, C.W., L.H. Brush, M.B. Gross, F.D. Hansen, B.Y. Park, J.S. Stein and T. W. Thompson. 2004. *Effects of Supercompacted Waste and Heterogeneous Waste Emplacement on Repository Performance*. ERMS 533551.

Marcinowski, F. 2004. Letter to R. P. Detwiler, Carlsbad Field Office, approving the disposal of compressed waste from the Idaho National Environmental and Engineering Laboratory's Advanced Mixed Waste Treatment Facility at the Waste Isolation Pilot Plant. March 26, 2004. U.S. Environmental Protection Agency, Washington, D.C.

Trinity Engineering Associates. 2004. *Review of Effects of Supercompacted Waste and Heterogeneous Waste Emplacement on WIPP Repository Performance, Final Report.* March 17, 2004. U.S. Environmental Protection Agency, Washington, D.C.

EPA Comment
2-32-S8 FEP W5 Container Material Inventory.

Please supplement the screening argument with an explanation of the implementation in PA of the material inventory of shielded containers containing RH waste.

DOE Response

Appendix SCR is not intended to provide comprehensive explanations on how a FEP is represented in PA models, but does provide pointers to other compliance documents that contain this information. The implementation and impact of the addition of shielded containers to the inventory was discussed in the CRA-2009, Section 15.6.4.3, and with more recent information in Section 15.8.4.3 of the CRA-2014. Analyses evaluating shielded containers on WIPP performance are found in Dunagan et al. (2007). The masses of shielded container material parameters are represented in PA the same way as for other RH containers. Changes to Appendix SCR-2014 text that points to the implementation details of waste containers within performance assessment has been made and is provided in the revised text below.

SCR-6.1.3.2 FEP Number: W5

FEP Title: Container Material Inventory

SCR-6.1.3.2.1 Screening Decision: UP

The Container Material Inventory is accounted for in PA calculations.

SCR-6.1.3.2.2 Summary of New Information

The masses of container materials associated with the waste inventory for the CRA-2014 have been updated as detailed in Van Soest (2012). The EPA approved the use of the shielded RH container as an allowable disposal container in WIPP (Edwards 2013). The impacts of this container upon WIPP performance were evaluated in Dunagan et al. (2007).

SCR-6.1.3.2.3 Screening Argument

The container material inventory is described in Van Soest (2012) and is accounted for in PA calculations through the estimation of gas generation rates (see Appendix PA-2014, Section PA-4.2.5). In the CCA, Appendix WCL, a minimum quantity of metallic Fe was specified to ensure sufficient reactants to reduce radionuclides to lower and less soluble oxidation states. This requirement is met as long as there are no substantial changes in container materials. The inventory used for the CRA-2014 contains 3.69 x 107 kg of steel in packaging (includes containers) materials. This value is up slightly from 3.59 x 107 kg reported in 2008 (Van Soest 2012). Modeling assumptions related to the implementation of waste container materials can be found in Appendix MASS-2014, Table MASS-5.

This change has been added to Enclosure 4, *CRA-2014 Errata Tracking*.

Reference:

Dunagan, S.C., G.T. Roselle, E.D. Vugrin, and J.T. Long. 2007. *Analysis Report for Shielded Container Performance Assessment*. ERMS 547197. October 31, 2007. Sandia National Laboratories, Carlsbad, NM.

EPA Comment
2-32-S9 FEP W18 Disturbed Rock Zone (DRZ).

The screening argument for this FEP states "This excavation-induced, host-rock fracturing is accounted for in PA calculations (the CCA, Chapter 6.0, Section 6.4.5.3)." The cited CCA text indicates that the DRZ is modeled in the same way around all repository excavations. However, the DRZ is now expected to vary spatially. Provide an updated description of the DRZ in the waste and non-waste locations of the repository.

2-32-S10 FEP W19 Excavation-Induced Changes in Stress. *Screening argument was combined with that for W18 Disturbed Rock Zone (DRZ); please see comments for FEP W18.*

DOE Response

FEPs W18 and W19 have been screened in since the CCA (Chapter 6.0, Section 6.4.5.3). The status of these FEPs did not change for CRA-2014, and host-rock fracturing resulting from excavation-induced changes in stress has always been included in PA calculations. Its detailed implementation in PA calculations is discussed in other parts of WIPP compliance documentation, as described below. The screening argument for these FEPs (Appendix SCR-2014) refers to the CCA (Chapter 6.0, Section 6.4.5.3) to note that excavation-induced, host-rock fracturing has been included in PA calculations (as a disturbed rock zone, DRZ), but does not describe the specific details of how this fracturing has been implemented in PA calculations. In the "Summary of New Information" for these FEPs (Appendix SCR-2014), AP-164 (Camphouse 2013) is cited as providing a description of the DRZ, including the DRZ in both the waste and non-waste locations of the repository and in locations beyond the panel closures (i.e., operational and experimental areas). Further, Camphouse (2013) describes how the spatial variation in the DRZ is implemented in different parameter values for the DRZ in the waste locations (material DRZ_1) and in the non-waste locations around the ROMPCS (material DRZ_PCS):

> *For the first 200 years post-closure, the disturbed rock zone (DRZ) above and below the ROMPCS maintained the same properties as specified to the DRZ surrounding the disposal rooms (PA material DRZ_1). After 200 years, the DRZ above and below the ROMPCS was modeled as having healed, and was represented by material DRZ_PCS.*

And also:

> *It is expected that healing of the DRZ region above and below the ROMPCS after 200 years will not yield an increase in permeability when compared to the damaged DRZ. A relationship will be implemented in the CRA-2014 PA to enforce that the permeability of material DRZ_PCS is never greater than the permeability of material DRZ_1.*

Although there is an updated implementation and updated parameters for the DRZ, there is no change to the screening argument or screening decision for these FEPs. Consistent with the DOE's response to EPA comment 2-32-G1, this type of information is best left in the supporting documentation, rather than within the screening document.

Reference:

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

EPA Comment
2-32-S15 FEP W28 Nuclear Explosions.

Please modify the screening argument to address whether, in addition to "a reduction of TRU radionuclides from previous estimates", the quantities of fissile radionuclides have also been reduced.

DOE Response

This screening argument is based on the lack of a mechanism for rapid compression of fissile mass to a high density; this remains true. It would be reasonable to assume, however, that since the overall TRU inventory has declined, the fissile radionuclide inventory has also declined. In response to the EPA's comment, we have taken the fissile radionuclides as identified in the WIPP TRAMPAC (DOE 2012) as having a fissile gram equivalent of greater than 0.00,[1] and summed the total curies (CH and RH) for these radionuclides from the Performance Assessment Inventory Report-2008 (PAIR)[2] (Crawford et al. 2008) used in the 2009 PABC, and then compared them to the same curie totals[3] from the PAIR-2012 (Van Soest 2012) used in the CRA-2014. Fissile radionuclides have indeed reduced from approximately 3.1 million curies for the PABC-2009 to 2.7 million curies for the CRA-2014. The Appendix SCR-2014 text has been updated with this information and is provided below.

SCR-6.3.3.2 FEP Number: W28

FEP Title: *Nuclear Explosions*

SCR-6.3.3.2.1 Screening Decision: SO-P

Nuclear explosions have been eliminated from PA calculations on the basis of low probability of occurrence over 10,000 yrs.

SCR-6.3.3.2.2 Summary of New Information

This FEP has been updated to include the most recent inventory information as presented in Kicker and Zeitler (2013). This new information does not change the screening argument or decision for this FEP.

SCR-6.3.3.2.3 Screening Argument

Nuclear explosions have been eliminated from PA calculations on the basis of low probability of occurrence over 10,000 yrs. For a nuclear explosion to occur, a critical mass of Pu would have to undergo rapid compression to a high density. Even if a critical mass of Pu could form in the system, there is no mechanism for rapid compression. Inventory information used for the CRA-2014 is presented in Kicker and Zeitler (2013). The updated inventory information for the CRA-2014 shows a reduction of TRU radionuclides from previous estimates. Fissile radionuclides have reduced from approximately 3.1 million curies for the PABC-2009 to 2.7 million curies for the CRA-2014. Thus, current criticality screening arguments are conservatively bounded by the previous CCA screening arguments (Rechard et al. 1996, 2000, and 2001).

This change has been added to Enclosure 4, *CRA-2014 Errata Tracking*.

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[1] See the WIPP TRUPACT Authorized Methods of Payload Control (TRAMPAC), Table 3.1-2.
[2] Data from Table A 4 (decayed to 2033) from the PAIR-2008 was used.
[3] Data from Table 5-3 and 5-4 (decayed to 2033) from the PAIR-2012 was used.

References:

Crawford, B.A., D. Guerin, S. Lott, B. McInroy, J. McTaggart, G. Van Soest. 2008. *Performance Assessment Inventory Report*, INV-PA-08, Revision 0. LA-UR-09-02260. Los Alamos National Laboratory, Carlsbad, NM

U.S. DOE (Department of Energy). 2012. *Contact-Handled Transuranic Waste Authorized Methods for Payload Control* (CH-TRAMPAC), Revision 4. December 2012. U.S. Department of Energy Carlsbad Field Office, Carlsbad, NM.

Van Soest, G.D. 2012. *Performance Assessment Inventory Report*, Revision 0, LA-UR-12-26643. Los Alamos National Laboratory Carlsbad Operations, Carlsbad, NM.

EPA Comment
2-32-S16 FEP W40 Brine Inflow.

Please supplement the screening argument with information on the impacts of changes in GLOBAL:PBRINE and the PCS on brine inflow.

DOE Response

Consistent with the DOE's response to EPA comment 2-32-G1, this type of information is best left in the supporting documentation, rather than within the screening document. The change in the PA parameter distribution for PBRINE does not affect the screening argument or decision for this FEP. The parameter distribution has changed, however the implementation of PBRINE within PA models has not changed. Therefore, no changes have been made to the screening argument or decision for this FEP.

The impacts on repository performance due to implementation of the PCS were discussed in the DOE's planned change request documentation (DOE 2011) and were specifically approved by EPA (per condition 1 of 40 CFR 194) in its October 8, 2014, Federal Register notice (EPA 2014). Furthermore, EPA agreed with the way DOE addressed FEPs in the PCS change notice in its TSD, which stated,

> *"The Agency agrees that for screened-in FEPs, the details of conceptual and numerical implementation and parameterization can be considered modeling issues, and can be documented and justified in analysis plans and reports. (S. Cohen and Associates 2013)"*

Details regarding the overall impacts of the PCS to WIPP performance can be found at:

http://www.epa.gov/radiation/news/wipp-news.html#panelclosure.

References:

S. Cohen and Associates. 2013. *Review of DOE's Planned Change Request to Modify the WIPP Panel Closure System*. November 2013. Vienna, VA.

U.S. Department of Energy (DOE). 2011. Transmittal of Planned Change Request to Panel Closures Redesign, E. Ziemianski, DOE Interim Manager, to J. Edwards, EPA ORIA. September 8, 2011.

U.S. Environmental Protection Agency (EPA). 2014. Title 40 CFR Part 194: Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance With the Disposal Regulations; Panel Closure Redesign. Federal Register, vol. 79 (October 8, 2014): 60750-756.

EPA Comment
2-32-S17 FEP W42 Fluid Flow Due to Gas Production.

Please supplement the screening argument with information on the impacts of changes in GLOBAL:PBRINE and the PCS on the availability of brine in the waste panels.

DOE Response

Consistent with the DOE's response to EPA comment 2-32-G1, this type of information is best left in the supporting documentation, rather than within the screening document. Also, as discussed in the DOE's response to comment 2-32-S16, the change in the PA parameter PBRINE does not affect the screening argument or decision for this FEP. Implementation of PBRINE within PA models has not changed. Therefore, no changes have been made to the screening argument or decision for this FEP.

Information on the impacts of the PCS implementation on Salado flow modeling can be found at: http://www.epa.gov/radiation/news/wipp-news.html#panelclosure.

EPA Comment
2-32-S18 FEP W44 Degradation of Organic Material.

Please supplement the screening argument with an expanded discussion of the importance of the availability of brine on the degradation of organic material. Changes that affect the availability of brine in a waste panel, such as the water balance implementation, the revised value of GLOBAL:PBRINE, and the properties of the ROMPCS and associated DRZ, will affect this FEP.

DOE Response

Consistent with the DOE's response to EPA comment 2-32-G1, this type of information is best left in the supporting documentation, rather than within the screening document. While changes in the availability of brine to support the degradation processes of organic material will indeed affect the amount of gases generated, these processes are already accounted for in PA calculations. However, the screening argument and decision are not affected by these changes. The implementation of the chemical models that represent these processes is described elsewhere within the compliance documentation and PCS documentation (see Appendix PA-2014, Section PA-4.2.5).

EPA Comment
2-32-S19 FEP W45 Effects of Temperature on Microbial Gas Generation.

Please modify the screening argument to acknowledge the reduced thermal impact of seal concrete hydration because of the elimination of additional explosion walls and the Option D monolith.

DOE Response

This is a revision to Appendix SCR-2014, Section SCR-6.5.1.1.3.1. The revised text has been changed to read:

> This thermal rise is considered bounding due to the elimination of concrete from the panel closure systems. Because the new panel closures will be constructed of mined salt, the overall mass of concrete emplaced within the repository will be significantly decreased. More importantly, the emplacement of any constructed element (e.g., shaft seals) of the repository will be done at or before repository closure. Therefore, any increase in temperature due to concrete hydration will have abated by the time AICs are assumed to no longer prevent drilling into the repository.

The revised text has been added to Enclosure 4, *CRA-2014 Errata Tracking.*

EPA Comment
2-32-S20 FEP W53 Radiolysis of Cellulose.

The reported reason for the screening argument update is not consistent between Table SCR-1, where the update is due to new radionuclide inventory, and Section SCR-6.5.1.7.2 where the update is due to new cellulose inventory. The screening argument in Section SCR-6.5.1.7.3 refers only to the new radionuclide inventory. Please reconcile the information.

DOE Response

This is a revision to Appendix SCR-2014. The revised text of Section SCR-6.5.1.7.2 has been changed to read:

> **SCR-6.5.1.7.2 Summary of New Information**
>
> This FEP has been updated with new waste inventory data. Decreasing waste inventory values lower the overall activity for all TRU radionuclides which indicate that radiolysis of cellulose will not be a significant process. The screening argument and decision are not affected by this change in inventory information.

This change has been added to Enclosure 4, *CRA-2014 Errata Tracking.*

EPA Comment
2-32-S23 FEP W110 Panel Closure Physical Properties.

Please update the screening argument to provide a description of the as-emplaced properties of the ROM salt now that in situ testing has been completed.

DOE Response

Consistent with the DOE's response to EPA comment 2-32-G1, this type of information is best left in the supporting documentation, rather than within the screening document. The results of in situ testing have not been documented at this time. At this point, the screening argument and decision remain unchanged.

EPA Comment
2-32-S25 FEP W113 Consolidation of Panel Closures.

Please supplement the screening argument with information on consolidation specific to the ROM salt in the ROMPCS. Such a discussion can be found in Camphouse et al. (2012, Section 2.0. ERMS 557396).

DOE Response

Consistent with the DOE's response to EPA comment 2-32-G1, this type of information is best left in the supporting documentation, rather than within the screening document. The screening argument in Appendix SCR-2014 states in Section SCR-6.3.5.1.3: "Consolidation of shaft seals, consolidation of the ROM salt PCS, mechanical degradation of shaft seals, and mechanical degradation of panel closures are accounted for in PA calculations through the permeability ranges assumed for the seal and closure systems (Appendix PA-2014, Section PA-4.2.7 and Section PA-4.2.8)." Appendix PA, Section PA-4.2.8 then cites Camphouse et al. (2012) for more discussion on the ROMPCS consolidation.

Status Report of DOE Responses to EPA Completeness Questions			
Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
EPA's Completeness Questions Received December 17, 2014			
40 CFR 194.15(A)(2) MONITORING **1-15-1 Water Level Fluctuations in SNL-13.** DOE/WIPP-12-3489 p. 143 states "SNL-13 was also excluded [from the Culebra groundwater analysis] due to a sudden rise and then sudden stabilization following the drilling of a new oil or gas well nearby." Please address the following: 1. Identify and provide the location, depth, and purpose of the 'new' nearby wells. 2. What activities took place at the nearby wells during the time of the changes in SNL-13, such as fluid injection? Provide pressure histories, volumes and fluid types, fluid enhancements (e.g. fracking fluids or proppants). 3. Provide a chronological history of the activities in the nearby wells compared to the "sudden" changes in adjusted freshwater heads recorded in SNL-13. 4. Were water levels in other monitoring wells influenced by activities at nearby wells?		✓	
40 CFR 194.15(A)(2) MONITORING **1-15-2 Shaft Extensometers Not Taking Recordings.** DOE is not replacing the failed monitoring instruments in the shaft. However, EPA Section 42, Monitoring requirements expects, " *...extent of deformation ..." and "...brittle deformation...* " to be monitored. Please provide a justification to discontinue measuring these characteristics in the WIPP shafts as these measurements are used to calibrate numerical models and predict closure rates. Additionally, identify how this requested information will be addressed in the future.		✓	

Status Report of DOE Responses to EPA Completeness Questions			
Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
40 CFR 194.15(A)(2) MONITORING **1-15-3 Derivation of Annual Culebra Water Level Map.** CRA-2014 Section 42.8 *Changes or New Information Since the CRA-2009* discusses changes to the process used to derive the Culebra groundwater flow parameters that is used to prepare the annual water level map. Please address the following: 1. For each yearly calculation (ERMS 558589, Section 2.3.2.2), if the monitored freshwater heads have changed, do the 100 calibrated T-Fields need to be recalculated? If not, why? 2. ERMS 557633 Section 2.1 states, "The PA MODFLOW model T (transmissivity), A (anisotropy) and R (recharge) input fields are appropriately averaged across 100 realizations, producing a single average MODFLOW flow model." Provide information as to how averaging is done with examples. 3. For the averaged MODFLOW model, T (transmissivity), A (anisotropy) and R (recharge) are fixed while a subset of the boundary conditions is modified (ERMS 557633, Section 2.1). Please describe how the new boundary conditions are determined and implemented. If this simply involves raising or lowering the heads along the boundaries to best match the observed water levels within the modeled area, describe how well the assigned boundaries honor the water levels in the nearest monitoring wells both inside and outside the model area. 4. If the step-by-step creation of the annual Culebra water level map is the same as that provided during 2012 and 2013 inspections, please denote as such. If generating the annual water level map differs from what has been provided during inspections, please provide these steps.		✓	

Status Report of DOE Responses to EPA Completeness Questions			
Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
40 CFR 194. 23 MODELS AND COMPUTER CODES **1-23-1 Continuing Validity of Kds.** CRA-2014 Appendix PA, Table PA-1 states that the Culebra Matrix Partition Coefficients (Kds) are, " *Carried over from CRA-2009 PABC* ." Please provide the rationale for the assumption that the CRA 2014 Kds can be same as those used in the CRA-2009 despite the changes in the organic ligand content and the 2012 inventory since the last PA. Additionally, provide a discussion of the potential impacts of the organic kitty litter added to the LANL waste on the Culebra Kds.	✓ Note: The discussion of the potential impacts of the organic kitty litter added to the LANL waste on the Culebra Kds is addressed in the response to 1-C-1	✓ Note: The discussion of the rationale for the assumption that the CRA-2014 Kds can be the same as those used in the CRA-2009 is addressed in DOE's second response submittal on 3/18/15	
40 CFR 194. 23 MODELS AND COMPUTER CODES **1-23-2 Continuing Validity of T-Fields.** CRA-2014 Appendix PA, Table PA-1 states that the Culebra Transmissivity Fields are, " *Carried over from CRA-2009 PABC* ." It appears that the last update to the geologic well data analysis was performed in 2007 (Powers 2007a and Powers 2007b). Specific questions and requests the Agency has related to the T-Fields are listed below. 1. Have changes in the Culebra well data during the past seven years changed the T-Field derivation in any way? 2. Has any additional hydraulic testing been performed that could be used for additional calibration of the T-Fields? 3. Has the saturated thickness of the Culebra remained constant since the original derivation of the T-Fields? 4. Provide justification that new well information and water level changes since the 2009 PABC do not need to be included in the T-Field derivation and that the 2009 T-Fields are still valid for use in the CRA-2014 PA. 5. Provide justification for the continued use of the CRA-2009 T-fields.		✓	

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Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
40 CFR 194. 23 MODELS AND COMPUTER CODES **1-23-3 REGION ROMPCS** The Agency agreed to the adopted parameter values used for the panel closure change request to isolate the effects and facilitate a comparison of the proposed panel closure design on the baseline PA and, at the time of the planned changed request, there was uncertainty in the emplacement technique to be used. The Agency would like DOE to address the following comments on several parameters related to the panel closures: 1. Identify and technically justify that ranges of porosity and permeability for the ROM salt PCS during the time period 0 to 100 years (material PCS_T1) are consistent with initial emplacement of the ROM salt material without wetting or compaction. 2. Provide technical justification for applying a capillary pressure model that assumes zero threshold pressure to region ROMPCS during time periods 100 to 10,000 years (T2 and T3). 3. Provide a technical justification for selecting the ranges for the residual brine and gas saturations (SAT_RBRN and SAT_RGAS) during time periods T2 and T3; the justification should include adopting a zero value as the low end. 4. Provide technical justification for using the same value for the bulk compressibility of ROM salt during the T1, T2 and T3 time periods (from 0 to 100, 100 to 200, and 200 to 10,000 years).		✓	
40 CFR 194. 23 MODELS AND COMPUTER CODES **1-23-4 REGION DRZ PCS** The Agency would like DOE to address the following comments related to the parameter values adopted for the DRZ_PCS: 1. Provide technical justification for assigning the same sampled value of porosity to the material in DRZ_PCS region for both early and late time periods (T2 and T3) when the DRZ is undergoing consolidation and healing. 2. Provide technical justification for the apparent discrepancy created by independently sampling the permeability of material DRZ_PCS, representing a healed DRZ, from a distribution that can provide a sampled permeability as much as seven orders of magnitude higher than the permeability of intact halite. 3. Provide technical justifications for assigning zero values to the residual brine and gas saturations (SAT_RBRN and SAT_RGAS) in CRA-2014 for the region DRZ_PCS during the T3 time period (200 to 10,000 years). 4. Provide technical justification for applying a capillary pressure model that assumes zero threshold pressure in region DRZ_PCS during the T3 time period (200 to 10,000 years). 5. Provide technical justification for the value of the bulk compressibility of the DRZ_PCS region, and applying that same value during both early and late time periods (T2 and T3) when the material in that region is undergoing consolidation.		✓	

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Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
40 CFR 194. 23 MODELS AND COMPUTER CODES **1-23-5 Waste Shear Strength.** Please address the following: 1. Provide horsetail plots of the remaining fraction of uncorroded iron in the repository throughout the 10,000-year regulatory time frame from the CRA-2009 PABC from each of the three replicates and each scenario. 2. Provide horsetail plots of the remaining fraction of undegraded CPR in the repository throughout the 10,000-year regulatory time frame from the CRA-2009 PABC from each of the three replicates and each scenario. 3. Provide and justify the criteria used in advancing the surrogate waste samples during the shear strength tests when the eroded sample face was not smooth but irregular. 4. Identify and justify the consequences of using the proposed uniform distribution rather than the currently approved log-uniform distribution for TAUFAIL. 5. Provide the quality control procedures used during the shear strength tests and provide evidence that the tests were performed consistent with those procedures.		✓	

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Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
40 CFR 194. 23 MODELS AND COMPUTER CODES **1-23-6 Probability of Encountering a Castile Brine Pocket.** Please address the following comments: 1. TDEM results are site specific and indicate the presence of potentially large volumes of brine beneath some waste panels. Explain why TDEM data is not used in DOE's proposed approach for estimating PBRINE. 2. DOE's approach ignored the presence of high electrical conductivity zones identified beneath four of the ten WIPP waste panels. Please explain how this omission affected the comparison of the TDEM approach with DOE's newly derived drilling data approach. 3. ERMS 558724 asserts that brine encounters of sufficient size to impact the repository would be noticed and logged by a driller. The approach does not acknowledge the potential of encountering a low yield and high volume brine pocket which would not be noticed by the driller in calculating PBRINE. Please address the basis for not considering the low yield, high volume brine pockets. 4. DOE reported the same count of 34 brine intrusions out of 678 Castile wells in 2008. It is unclear whether 2008 was the last time a brine intrusion was observed at the time of collecting data for the CRA-2014 or if 2008 was the cut-off date for recoding a brine intrusion. Please clarify. 5. The circular regions in Figure 5 of ERMS 558724 were selected to include a known brine pocket encounter. Please provide information as to whether this radius would bias the results and the sensitivity of the results to the radius size. 6. Provide information as to how the well depths, for each well that did and did not encounter a brine pocket, were incorporated into the drilling data analysis. 7. The ratios in Table 2 of ERMS 558724 include double-counting of many wells. Please provide information as to how this affected the results. 8. ERMS 558724 states that pressurized brine is associated with near-vertical fractures. However, WIPP-12 yielded large volumes of brine that is assumed to have been stored and transmitted through the extensive and primarily interconnected horizontal to sub-horizontal fractures. Please provide an explanation as to how the near-vertical fracture model adopted by DOE's modified PBRINE parameter is consistent with evidence that WIPP-12 releases are attributed to horizontal and sub-horizontal fractures.		✓	
40 CFR 194. 23 MODELS AND COMPUTER CODES **1-23-7. Volume of Repository Operations and Experimental Areas.** Please address the following: 1. Explain how DOE arrived at a volume of 148,011 m^3 for the underground. 2. In the diagram of repository ventilation during recovery (see attached, labeled *Phase 2B Underground Map*, dated March/17/2014) a large portion of the north experimental area is denoted as 'backfilled'. Please provide information of the material properties of these backfilled areas and how they are modeled during the 10,000 year regulatory period in the CRA-2014 PA.		✓	

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Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
40 CFR 194.23 MODELS AND COMPUTER CODES **1-23-8 Fluid Flow in Repository Operations and Experimental Areas.** There have been numerous refinements of conceptual and numerical models of repository fluid flow since the 1994-95 time frame as well as changes to the panel closure system that may also change repository fluid flow. Please provide updated technical justifications for the following parameter values adopted for the experimental and operations areas: 1. Setting the permeability of the operations and experimental rooms to a constant value of value 10^{-11} m^2 throughout the modeled period. 2. Setting the porosity of the operations and experimental rooms to a constant 18% throughout the modeled period. 3. Setting the porosity and permeability of the DRZ adjacent to the operations and experimental room to the same sampled value as the DRZ surrounding a waste panel throughout the modeled period.		✓	
40 CFR 194.23 MODELS AND COMPUTER CODES **1-23-11 EQ3/6 and Supporting Files.** Please provide the following computer files related to the actinide source term modeling calculations and the determination of the cumulative distribution functions for the actinide solubilities: 1. The EQ3/6 database file DATA0.FM1 used for the CRA-2014 solubility calculations, (also known as DATA0.FMT.R2). 2. EQ3/6 input and output files used for calculating actinide solubilities for the actinide source term at different brine volumes (1x, 2x, 3x, 4x, 5x minimum brine volumes). 3. The Excel macro GetEQData.xls and all Excel spreadsheets that contain the output extracted with GetEQData.xls. 4. EQ3/6 input and output files used for calculating actinide solubilities for the +III and +IV actinide uncertainty analysis calculations. 5. Excel macros GetEQData_v101e.xls and GetEQData_v101f.xls; and 6. Excel files Thorium_Uncertainty_Results_2014_PA.xls and Americium_Uncertainty_Results_2014_PA.xls.		✓	
40 CFR 194.23 MODELS AND COMPUTER CODES **1-23-12 WIPP-Specific Organic Complexation Data.** Appendix SOTERM Section 3.8.2 provides a description and four graphs (Figure SOTERM-21) that relate to WIPP-specific experiments designed to evaluate the effects of organic chelating agents on +III and +IV actinide solubility in WIPP brines. 1. Please provide supporting documentation for these data, including a summary of the experimental approach, materials and analytical methods used to produce the data. 2. Please provide any available characterization data for the solid phases present in these experiments.		✓	

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Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
40 CFR 194.23 MODELS AND COMPUTER CODES **1-23-13 Missing Reference.** Appendix SOTERM, Figure SOTERM-7 caption cites Altmaier (2011) but this reference is missing from the reference list. Please provide this reference.		✓	
40 CFR 194.24 WASTE CHARACTERIZATION- PERFORMANCE ASSESSMENT INVENTORY **1-24-1 Shielded Container Lead Inventory** 1. Please provide information as to how lead shielding on RH shielded containers is included in the performance assessment.		✓	
40 CFR 194.24 WASTE CHARACTER IZATION- PERFORMANCE ASSESSMENT INVENTORY **1-24-2 Inventory Report Text Unclear.** Please address the following: 1. Provide information as to how the "projected-to-stored volume ratio" is derived for both RH and CH waste. Please provide an example of this derivation. 2. Provide information of the RH waste volume that has been and will be placed in the leaded containers on the waste panels floors. 3. Provide information that specifies how potential waste inventory listed in the inventory report estimate is used in the CRA-2014 performance assessment.		✓	
40 CFR 194.24 WASTE CHARACTER IZATION- PERFORMANCE ASSESSMENT INVENTORY **1-24-3 Emplaced Inventory Chemical Constituents** 1. In the ATWIR 2012, Section 2.3, it is stated that, "Chemical constituents are not reported in the emplaced inventory". In the PAIR 2012 report, Section 4.3, it is indicated that "two additional analysis" were performed for chemical and other important constituents. It is unclear how the chemical constituents of emplaced inventory, identified in the PAIR report, are derived and calculated for the CRA-2014 PA, provide clarification.		✓	

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40 CFR 194.24 WASTE CHARACTER IZATION- PERFORMANCE ASSESSMENT INVENTORY **1-24-4 Missing References.** Please provide the following references: French, D. 2009. *Analysis of Container Material Masses* , INV-SAR-19. Los Alamos National Laboratory - Carlsbad Operations, Carlsbad, NM. Los Alamos National Laboratory - Carlsbad Operations (LANL-CO) 2010. *Analyses* , LCOQP9 - Los Alamos National Laboratory - Carlsbad Operations, Carlsbad, NM. Los Alamos National Laboratory - Carlsbad Operations (LANL-CO) 2011a. *Data Collection, Data Management, and Control for the Comprehensive Inventory* , INV-SP-01. Los Alamos National Laboratory - Carlsbad Operations, Carlsbad, NM. Los Alamos National Laboratory - Carlsbad Operations (LANL-CO) 2011b. *Entry, Verification, and Validation of inventory Information in the Comprehensive Inventory Database* , INV-SP-02. Los Alamos National Laboratory - Carlsbad Operations, Carlsbad, NM. Los Alamos National Laboratory - Carlsbad Operations (LANL-CO) 2011c. *LANL-CO Software Quality Assurance Plan* , LCO-QPD-02. Los Alamos National Laboratory - Carlsbad Operations, Carlsbad, NM. Los Alamos National Laboratory- Carlsbad Operations (LANL-CO) 2011d. *Software Quality Assurance* , LCO-QP19-1. Los Alamos National Laboratory - Carlsbad Operations, Carlsbad, NM. Los Alamos National Laboratory - Carlsbad Operations (LANL-CO) 2011e. *Comprehensive Inventory Database* , Version 2.0, Schema Version S2.00, Data Version D.10.01. Los Alamos National Laboratory - Carlsbad Operations, Carlsbad, NM. Los Alamos National Laboratory - Carlsbad Operations (LANL-CO) 2012. *Comprehensive Inventory Database* , Version 2.01, Schema Version S2.01, Data Version D.11.00. Los Alamos National Laboratory - Carlsbad Operations, Carlsbad, NM. *Chemical and Cement Components 2011 Inventory Estimates* . LANL-CO. INV-SAR-28, Revision 0, November 1, 2012. LANL-CO Record ID# INV-1211-01-01-01. *Estimation of Cellulose, Plastic, and Rubber Emplacement Materials in the Waste Isolation Pilot Plant (WIPP)* . LANL-CO. INV-SAR-27, Revision 0, November 5, 2012. LANL-CO Record ID# INV-1211-02-01-01.		✓	
GENERAL: CRA-2014 DOCUMENTATION **1-G-1 Reference Appendix QAPD-2014 Not Provided.** CRA-2014 Section 23, Models and Computer Codes, Section 23.5.7 states, "The DOE's quality assurance program, as applied to the CRA-2014, is contained in Appendix QAPD-2014." The appendix has not been provided. Please provide this document.		✓	

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GENERAL: CRA-2014 DOCUMENTATION **1-G-2 Codes IDs Do Not Include Source Code Listing.** CRA-2014 Section 23, Models and Computer Codes, Section 23.8.7 states, "The IDs include source-code listings..." EPA examined a number of code Implementation Documents; they include a reference to the location of the source-code listing, but not the actual listing of the code. Please provide the source-code listing for the following CRA-2014 codes: BRAGFLO 6.02, MATSET 9.20, CCDFGF 6.0.		✓	
GENERAL: CRA-2014 DOCUMENTATION **1-G-3 New Codes EQ3/6 and JAS3D Documentation Incomplete.** DOE states in CRA-2014 Section 23, 23.7.7, "The documentation for the new codes EQ3/6 and JAS3D may be found in their respective UM, AP, VD, ID, and RD/VVP." It does not appear that this documentation has been included in CRA-2014. Please provide this documentation.		✓	
CHEMISTRY COMMENTS **1-C-1 LANL Waste Stream With Added Cellulosic Material.** Organic kitty litter was used as an absorbent for nitrate salts for Waste Stream LA-MIN02-V.001 (NMED 2014) and 349 drums of this waste were placed in Panels 6 and 7 (Wallace 2014). Please address the following: 1. Provide a complete waste profile for the kitty litter; including; cellulosic content and other ingredients; emplaced volume and mass. 2. Specify the number of drums with kitty litter placed in either Panel 6 or 7. 3. Identify the type of waste emplaced in the drums with the kitty litter. 4. Indicate whether this cellulosic kitty litter has been used in other waste streams and whether the corresponding waste profile reports adequately describe the waste material parameters. 5. Describe the effects of omitting the organic kitty litter in the waste stream(s) on the CPR inventory and consequent effects on gas generation rates calculated for the CRA-2014 PA. 6. Provide information of the quantities of soluble organics, such as organic ligands or surfactants that could affect actinide solubilities when this material is leached.	✓		
EPA's Completeness Questions Received February 27, 2015			
194.23 MODELS AND COMPUTER CODES **2-23-1 ROM Salt Panel Closures Locations.** Please provide the WIPP configuration layout (a plan view) used for the 2014 CRA that includes all locations where the ROM salt panel closures are to be placed. Provide text that provides the exact location, dimensions and properties for the set of panel closures that lie furthest north in the repository.	✓		

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Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
194.23 MODELS AND COMPUTER CODES **2-23-2 Provide An Update of the Derivation of the Shaft Properties at the Repository Horizon.** In the BRAGFLO grid for the 2004 and 2009 CRA Performance Assessments (PAs), the modeled lower portion of the shaft included an effective permeability that incorporated both the concrete portion of the shaft (at the repository horizon level) and the furthest north panel closures located just south of the waste and exhaust shafts. The material properties of the modeled shaft (the concrete monolith segment) were combinations of the shaft properties and the Option D panel closure properties (Camphouse and Clayton 2011, ERMS 555204). Now, however, there is a new panel closure system that uses run of mine salt instead of the Option D design, and the properties of new panel closure system are different than that of the concrete portion in the lower shaft. In the CRA 2014 PA, however, it appears the material properties of the shaft at the repository horizon have not been updated to reflect the change. Please confirm this and identify how the properties would change to reflect the change in the panel closure design.	✓		
194.33 FUTURE DRILLING **2-33-1 Future Drilling Into Nitrate Waste.** Please provide the probability and describe the potential consequence(s) to PA calculations of drilling into the nitrate waste.	✓		
194.43 PASSIVE INSTITUTIONAL CONTROLS **2-43-1 Changes in Passive Institutional Controls (PICs).** Recent Nuclear Energy Agency and International Atomic Energy Agency reports describe changes and developments in international approaches to PICs. These are referenced in INIS-US-13-WM-13145 which states "The DOE/CBFO WIPP PIC's program in place today meets the regulatory criteria, but complete feasibility of implementation is questionable, and may not be in conformance with the international guidance being developed." Please explain this feasibility concern. Please also provide the complete INIS-US-WM-13145 report (the Web link only provides an Abstract) and any other recent studies or reports that may impact PICs planning in the future. Reference: INIS-US-13-WM-13145, "The Revised WIPP Passive International Controls Program – A Conceptual Plan – 13145, Dated 2013-07-01, Web link: http://www.osti.gov/scitech/biblio/22225507		✓	

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Completeness Question	Included in This Submittal	Previously Submitted	Pending
194.44 ENGINEERED BARRIERS **2-44-1 MgO Physical Segregation.** In Franco (2012) DOE notified EPA that MgO emplacement has been modified by placing a 3,000 pound supersack of MgO on every other waste stack or on each waste stack in every other row. In the Franco 2012 letter the "effective diffusion penetration length of CO2" was considered but the information on physical segregation is limited. Please provide updated documentation to more explicitly and clearly address whether the larger lateral separation distance still allows sufficient reactions between MgO and CO2. References: Franco, J.R. 2012. Letter to A. Perrin (Subject: "Planned Change Notice for Placement of MgO Supersacks," with enclosure (Analysis of an alternative placement scheme for MgO supersacks). February 14, 2012. Carlsbad, NM: U.S. Department of Energy Carlsbad Field Office. U.S. Department of Energy (DOE). 2009. Title 40 CFR Part 191 Subparts B and C Compliance Recertification Application for the Waste Isolation Pilot Plant, Appendix MgO-2009. *Magnesium Oxide as an Engineered Barrie* r. DOE/WIPP 09-3424. Carlsbad, NM: Carlsbad Field Office. Vugrin, E.D., M.B. Nemer, and S.W. Wagner. 2006. *Uncertainties Affecting MgO Effectiveness and Calculation of the MgO Effective Excess Factor* (Rev. 0, November 17). ERMS 544781. Carlsbad, NM: Sandia National Laboratories.	✓		

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Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
194.46 REMOVAL OF WASTE **2-46-1 CCA Appendix WRAC Waste Removal Documentation Needs Updating.** The cited removal plan is basically the same as that given during the 1996 CCA and does not reflect updates and modifications to the repository design and waste characteristics. The Agency found discrepancies between what was used as the removal plan listed in 1996 CCA Appendix WRAC, "Waste Removal after Closure," with the current 2014 repository design, waste, and container characteristics. These are listed below. Please update the waste retrieval plan to address these discrepancies. Please assure that 40 CFR 194.46 requirements "Removal of Waste" still comply and are aligned with expected repository conditions at the time of closure, and that removal of waste remains feasible. The repository is no longer mined on one contiguous level [CCA Appendix WRAC page WRAC-7], the southern portion of the mine was moved up to the Clay Seam G level. The waste containers have changed. The CCA assumed two principal types of containers (55-gallon drums and standard waste boxes) [CCA Appendix WRAC, page WRAC-8] but with the introduction of large waste boxes, shielded RH-TRU containers, pipe over packs, and super-compacted waste, these assumptions are no longer valid. The waste characteristics have changed with the introduction of nitrate waste potentially subject to exothermic reactions. The run-of-mine salt panel closure replaced the original concrete-based Option D panel closure design, which can no longer be used "as markers for locating panels and drifts" [CCA Appendix WRAC, Section WRAC.6.4]. Given the use of shielded containers CH and RH wastes no longer must be segregated in the waste panels [CCA Appendix WRAC, Sections WRAC.4.3, WRAC.6, WRAC.6.4] and can no longer be removed using separate retrieval operations where the RH shielded containers are comingled with CH waste containers. CCA Appendix WRAC refers to performance assessment (PA) modeling to predict future characteristics of repository waste rooms. The PA assumptions, models, parameters, and inventory have changed since the CCA. Please include these changes in the waste removal reevaluation. CCA Appendix WRAC, Section WRAC.4.3 takes credit for the effectiveness of active and passive controls to deter human intrusion for up to 700 years after closure. However, this credit was denied by EPA because of difficulty predicting the future. This should be removed from the waste removal reevaluation. References: U.S. Department of Energy (DOE). 1996. Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant (October). CCA Appendix WRAC, Waste Removal After Closure". DOE/CAO-1996-2184. Carlsbad, NM: Carlsbad Area Office. U.S. Department of Energy (DOE). 1996. Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant (October). CCA Chapter 7.0, "Assurance Requirements". DOE/CAO-1996-2184. Carlsbad, NM: Carlsbad Area Office. U.S. Department of Energy (DOE). 2004. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant (March). CRA-2004 Chapter 7.0, "Assurance Requirements". DOE/WIPP 2004-3231. Carlsbad, NM: Carlsbad Field Office. U.S. Department of Energy (DOE). 2009. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant (March). CRA-2009 Section 46, "Removal of Waste" DOE 09-2434. Carlsbad, NM: Carlsbad Field Office.			✓

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Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
194.55 RESULTS OF COMPLIANCE ASSESSMENTS **2-55-1 Incorrect Reference.** Appendix IGP-2014, Section IGP-2.1 makes reference to 194.55(b)(1), should this be 194.54(b)(1) "Existing boreholes…"?		✓	
CHEMISTRY COMMENTS **2-C-3 Data Supporting Water Balance Assumptions.** The CRA-2014 PA calculations include the effects of MgO hydration, microbial degradation of CPR and iron sulfide formation on repository water balance. For PA, it is assumed that hydrogen sulfide created by CPR degradation preferentially reacts with iron hydroxide versus metallic iron (CRA-2014 Appendix MASS, page MASS-57). These hydrogen-sulfide reactions are: $Fe(OH)_2(s) + H_2S(g) \rightarrow FeS(s) + H_2O(l)$ (1) $Fe(s) + H_2S(g) \rightarrow FeS(s) + H_2(g)$ (2) The assumption that hydrogen sulfide preferentially reacts with iron hydroxide increases brine production and decreases gas production compared to the assumption that all or some of the hydrogen sulfide reacts with metallic iron. It is also assumed for PA that carbon dioxide preferentially reacts with brucite instead of unreacted MgO. The carbonation reactions are: $1.25\ Mg(OH)_2(s) + CO_2(g,aq) \rightarrow 0.25\ Mg_5(CO_3)_4(OH)_2{\cdot}4H_2O(s)$ (3) $1.25\ MgO(s) + CO_2(g,aq) + 1.25\ H_2O(l) \rightarrow 0.25\ Mg_5(CO_3)_4(OH)_2{\cdot}4H_2O(s)$ (4) The assumption that carbon dioxide preferentially reacts with brucite increases brine production in the repository. Please provide supporting data for these water-balance assumptions and evaluate the potential magnitude of the effects of these assumptions on the water balance.			✓
CHEMISTRY COMMENTS **2-C-4 Hydromagnesite Conversion Rate.** Clayton (2013) formulated the conversion reaction from hydromagnesite to magnesite for inclusion in the BRAGFLO calculations as: $Mg_5(CO_3)_4(OH)_2{\cdot}4H_2O(s) \rightarrow 4\ MgCO_3(s) + Mg(OH)_2(s) + 4\ H_2O(l)$ (5) Clayton (2013) calculates a range for the hydromagnesite conversion rate based on reaction times of 100 years to 10,000 years. However, the minimum reaction time for this conversion is uncertain. SCA (2008) reviewed the available experimental and natural analogue data and concluded that hydromagnesite conversion is best represented by a range of zero conversion (only hydromagnesite remains after 10,000 years) to complete conversion (only magnesite remains after 10,000 years), with a uniform distribution across this range. Please provide an explanation as to why the specific upper and lower limits used in the PA were picked. The effect of using zero rather than 100 years as the minimum conversion rate is likely to be less brine production in the water balance, based on equation (5). Please provide an explanation of the effects on PA if the lower limit of the hydromagnesite conversion rate is set to zero while the upper limit is decreased by a variety of plausible factors that are less than what Clayton had adopted. References: Clayton, D.J. 2013. Justification of Chemistry Parameters for Use in BRAGFLO for AP-164, Rev. 1. Sandia National Laboratories, ERMS 559466. SCA (S. Cohen and Associates). 2008. Review of MgO-Related Uncertainties in the Waste Isolation Pilot Plant. Final Report prepared for the U.S. Environmental Protection Agency Office of Radiation and Indoor Air, Washington, D.C., January 24, 2008.	✓		

Status Report of DOE Responses to EPA Completeness Questions			
Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
CHEMISTRY COMMENTS **2-C-5 Cumulative Effects of Water Balance Assumptions on PA.** The result of several water balance assumptions is to increase brine production from waste reactions in the repository. These assumptions include that hydrogen sulfide will preferentially react with iron hydroxide instead of metallic iron (Comment 2-C-3); that carbon dioxide will preferentially react with brucite instead of MgO (Comment 2-C-3); and that the minimum rate of hydromagnesite conversion to magnesite is greater than zero (Comment 2-C-4). Please provide a description of the cumulative effects of these assumptions on the water balance calculations for the CRA-2014 PA.			✓
CHEMISTRY COMMENTS **2-C-6 MgO Hydration Rate.** MgO has been supplied for the WIPP engineered barrier by three vendors: National Magnesia Chemicals, Premier Chemicals, and, currently, from Martin Marietta Magnesia Specialties (Martin Marietta). The majority of the MgO in the repository is from Premier Chemicals and Martin Marietta. Clayton (2013) used MgO hydration rates obtained from experiments conducted with MgO supplied by Premier Chemicals to establish the hydration rates used in PA. However, Wall (2005) performed preliminary tests with the Martin Marietta MgO and concluded that it reacted to form brucite faster than Premier MgO. Given the multiple vendors that supply MgO a summary of the following information needs to be provided; The inundated and humid MgO hydration rates for MgO from the three vendors. The potential effects of the variable MgO hydration rates on repository performance. The amounts of National Magnesia Chemicals, Premier MgO and Martin Marietta MgO that will be present in the WIPP repository at the time of closure, and assumptions regarding the future source(s) of MgO. References: Clayton, D.J. 2013. Justification of Chemistry Parameters for Use in BRAGFLO for AP-164, Rev. 1. Sandia National Laboratories, ERMS 559466. Deng, H., M. Nemer, and Y. Xiong. 2007. Experimental Study of MgO Reaction Pathways and Kinetics Rev. 1. Sandia National Laboratories TP 06-03.Deng, H., Y. Xiong, M. Nemer and S. Johnsen. 2009. Experimental Work Conducted on MgO Long-Term Hydration. Sandia National Laboratories ERMS 551421. Wall, N.A. 2005. Preliminary Results for the Evaluation of Potential New MgO. Sandia National Laboratories ERMS 538514.	✓		
CHEMISTRY COMMENTS **2-C-7 MgO Hydration Rate Data File.** Please provide a copy of the Microsoft Excel file "hydration kinetics Q & HY2 & HH djc 5-1-07.xls" used by Nowak and Clayton (2007) to calculate the MgO hydration rates. References: Nowak, E.J. and D. Clayton. 2007. Analysis of MgO Hydration Laboratory Results and Calculation of Extent of Hydration and Resulting Water Uptake versus Time under Postulated WIPP Conditions. Sandia National Laboratories ERMS 546769.		✓	

Status Report of DOE Responses to EPA Completeness Questions			
Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
CHEMISTRY COMMENTS **2-C-8 Iron and Lead Corrosion Rate Data.** Please provide spreadsheets containing the iron and lead corrosion data listed in Appendix A, Tables A-1 and A-2 from Roselle (2013). References: Roselle, G.T. 2013. Determination of Corrosion Rates from Iron/Lead Corrosion Experiments to be Used for Gas Generation Calculations. Sandia National Laboratories ERMS 559077.		✓	
194.32 SCOPE OF PERFORMANCE ASSESSMENT Since the original certification decision changes have been made to the repository, it is our observation that, for many of the features, events, and processes (FEPs) we have reviewed, DOE has not fully considered all of the relevant changes to the repository. Additionally, DOE has not fully considered updates relevant to activities within the WIPP vicinity. Table FEP-1 lists our comments on specific FEPS; immediately below we discuss general FEP screening issues that need further attention. **2-32-G1 Obsolete FEP Screening Arguments, Curtailed FEP Screening Arguments, and Completeness Considerations.** The screening arguments in the CRA-2014, Appendix SCR- 2014 for many FEPs have been carried forward from past baseline reviews and do not necessarily reflect changes that have occurred in the past several years. This especially applies to information on how some FEPs are accounted for in PA. Some FEPs need to be updated to reflect current repository design and new knowledge of repository behavior. These are identified in Table FEP-1. For some FEPs, the screening argument needs to provide a more complete discussion of the FEP and how it is determined to be screened-in or screened-out. The supporting arguments, along with documents incorporated by references, need to provide a basic understanding of how the FEP is accounted for in PA calculations, where the FEP is accounted for in the repository region and surrounding geosphere, and when in the regulatory time frame the FEP is accounted for. Those FEPs with inadequate or curtailed screening arguments are provided in Table FEP-1. For some FEPs that DOE has reported "no change", EPA disagrees and believes that DOE should reconsider and update the FEP discussion. Table FEP-1 includes those FEPs in this category that EPA has identified, to date, as being incomplete.	✓		
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S1**. Screening argument considers only boreholes intersecting the waste region. Please supplement the argument with a discussion of boreholes that intersect the non-waste regions and the consequence to PA calculations. Provide references and specific information as to whether boreholes penetrating non-waste regions could result in the transport of radionuclides between the waste and non-waste regions, to overlying units, or to the surface. Provide information, either directly or by reference, as to how deep boreholes penetrating the non-waste and waste regions of the repository are accounted for in the PA.			✓

Status Report of DOE Responses to EPA Completeness Questions			
Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S2.** The screening argument considers flow into the repository from boreholes that intercept pressurized fluid in underlying formations but only for boreholes intersecting the waste region. In the current BRAGLO model gas and brine readily flow between the waste and non-waste regions. A discussion and analysis of boreholes that could intersect the non-waste regions and their impact on the PA needs to be provided.			✓
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S3.** Screening argument considers only boreholes intersecting the waste region and also pressurized Castile brine. In the current BRAGLO model gas and brine readily flow between the waste and non-waste regions . Please supplement the argument with a discussion and analysis of boreholes that could intersect the non-waste regions on the PA.			✓
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S4.** Please address whether enhanced production techniques are being used in the Delaware basin and in the vicinity of WIPP. Please also address the potential for these techniques to create a preferential pathway for radionuclide releases through a second well.	✓		
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S5.** This FEP is screened out partially on the basis that solution mining will not occur in low ambient temperature conditions. However, solution mining is occurring in the nearby Eddy mine under similar conditions that exist in the vicinity of WIPP. Please provide text that reconciles the basis of the screening argument and the conditions at the Eddy mine where solution mining is taking place.	✓		
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S6.** In the screening argument please provide evidence that the modeled excavated volume is the expected mined volume of the underground workings at the time of closure.			✓
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S7.** The screening argument citation of the CCA as the source of information on the Heterogeneity of waste forms ignores changes that have occurred in the past 15 years, including supercompacted waste and mingling RH waste in shielded containers with CH waste. Please update the information to reflect current waste forms.	✓		

Status Report of DOE Responses to EPA Completeness Questions			
Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S8.** Please supplement the screening argument with an explanation of the implementation in PA of the material inventory of shielded containers containing RH waste.	✓		
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S9**. The screening argument for this FEP states "This excavation-induced, host-rock fracturing is accounted for in PA calculations (the CCA, Chapter 6.0, Section 6.4.5.3)." The cited CCA text indicates that the DRZ is modeled in the same way around all repository excavations. However, the DRZ is now expected to vary spatially. Provide an updated description of the DRZ in the waste and non-waste locations of the repository.	✓		
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S10.** Screening argument was combined with that for W18 *Disturbed Rock Zone(DRZ); please see comments for FEP W18.*	✓		
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S11.** Please supplement the screening argument with a discussion of salt creep and consolidation specific to the ROM salt in the ROMPCS, and healing of the adjacent DRZ. Such a discussion can be found in Camphouse et al. (2012, Section 2.0. ERMS 557396). The screening argument for this FEP states that "Salt creep in the Salado is accounted for in PA calculations (the CCA, Chapter 6.0, Section 6.4.3.1)." The cited CCA section discusses these FEPs only in the context of the waste region. In addition, this is the only FEP that addresses DRZ healing, which is expected to vary spatially.			✓
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S12.** Screening argument was combined with that for W20 *Salt Creep*; please see comments for FEP W20. Additionally, please supplement the screening argument with discussions of 1) the coupling between consolidation of the ROM salt in the ROMPCS and healing of the adjacent DRZ (DRZ healing cannot occur until the ROM salt is consolidated and applies a back stress sufficient to compress and heal the DRZ); and 2) lateral extrusion of the ROM salt when under compressive stress from drift creep closure.			✓
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S13**. Please supplement the screening argument with a discussion of the potential for high waste panel gas pressures to delay the consolidation of the ROM salt, thereby maintaining a higher permeability in the PCS for a longer period of time.			✓

Status Report of DOE Responses to EPA Completeness Questions			
Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S14.** Please update the screening argument to reflect the LANL inventory with nitrates and added organic matter that resulted in an exothermic reaction.			✓
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S15**. Please modify the screening argument to address whether, in addition to "a reduction of TRU radionuclides from previous estimates", the quantities of fissile radionuclides have also been reduced.	✓		
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S16**. Please supplement the screening argument with information on the impacts of changes in GLOBAL:PBRINE and the PCS on brine inflow.	✓		
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S17.** Please supplement the screening argument with information on the impacts of changes in GLOBAL:PBRINE and the PCS on the availability of brine in the waste panels.	✓		
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S18.** Please supplement the screening argument with an expanded discussion of the importance of the availability of brine on the degradation of organic material. Changes that affect the availability of brine in a waste panel, such as the water balance implementation, the revised value of GLOBAL:PBRINE, and the properties of the ROMPCS and associated DRZ, will affect this FEP.	✓		
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S19.** Please modify the screening argument to acknowledge the reduced thermal impact of seal concrete hydration because of the elimination of additional explosion walls and the Option D monolith.	✓		
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S20**. The reported reason for the screening argument update is not consistent between Table SCR-1, where the update is due to new radionuclide inventory, and Section SCR-6.5.1.7.2 where the update is due to new cellulose inventory. The screening argument in Section SCR-6.5.1.7.3 refers only to the new radionuclide inventory. Please reconcile the information.	✓		

Status Report of DOE Responses to EPA Completeness Questions			
Completeness Question	**Included in This Submittal**	**Previously Submitted**	**Pending**
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S21.** Please supplement the screening argument with a discussion of the impact of exothermic reactions in the waste panels.			✓
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S22.** Please supplement the screening argument with a discussion of the impact on the PA based on a reduced concrete inventory due to DOE now not using the Option D concrete monoliths in the panel closure system. Update the analysis to include where explosion walls are or will be installed.			✓
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S23**. Please update the screening argument to provide a description of the as-emplaced properties of the ROM salt now that *in situ* testing has been completed.	✓		
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S24**. Please update the screening argument to include the chemical composition of the steel bulkheads that are part of the panel closure design.			✓
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S25**. Please supplement the screening argument with information on consolidation specific to the ROM salt in the ROMPCS. Such a discussion can be found in Camphouse et al. (2012, Section 2.0. ERMS 557396).	✓		
194.32 SCOPE OF PERFORMANCE ASSESSMENT **2-32-S26**. The screening decision for this FEP was changed from UP (screened in) to SO-P (screened out – low probability). Please supplement the screening argument with a discussion of the chemical degradation of the steel bulkheads, which are part of the ROM salt panel closure system. Please also provide technical justification for the changed screening decision in light of the presence of the bulkheads.			✓

CRA-2014 Errata Tracking						
Error #	Error Description	Correction	Originator	Responsibility	Status	Date of Completion
1	EPA Comment 1-23-13 Missing Reference. Appendix SOTERM, Figure SOTERM-7 caption cites Altmaier (2011) but this reference is missing from the reference list. Please provide this reference.	This is a typographical error in Appendix SOTERM. The text will be corrected to read "Altmaier et al., 2008" which is already included as a reference in Appendix SOTERM, given below. The requested reference is included in Enclosure 2. Figure SOTERM-7 is based on Figure 5 in this reference and shows the highest three CaCl2 concentrations shown in the published Figure. This typographical error has been added to Enclosure 4, *CRA-2014 Errata Tracking*. Reference: Altmaier M., Neck, V., Fanghänel, T., "Solubility of Zr(IV), Th(IV) and Pu(IV) hydrous oxides in CaCl2 solutions and the formation of ternary Ca-M-OH complexes," Radiochimica Acta 96, (2008).	EPA	LANL-D. Reed	Included in first response submittal to EPA	Submitted to EPA in first response, 1/28/15
2	EPA Comment 1-G-1 Reference Appendix QAPD-2014 Not Provided. CRA-2014 Section 23, Models and Computer Codes, Section 23.5.7 states, "The DOE's quality assurance program, as applied to the CRA-2014, is contained in Appendix QAPD-2014." The appendix has not been provided. Please provide this document.	There was not an Appendix QAPD-2014 in the CRA-2014; therefore, the statement above is a typographical error in CRA-2014 Section 23.5.7. The reference to Quality Assurance Program Document (QAPD) will be added to Section 23 References and the text will be corrected to read, "The DOE's quality assurance program, as applied to the CRA-2014, is contained in the Quality Assurance Program Document (U.S. DOE 2010)." The QAPD is already included as a reference in the CRA-2014; however, a copy of the QAPD is included in Enclosure 2. This typographical error has been added to Enclosure 4, *CRA-2014 Errata Tracking*.	EPA	SNL-G. Safley	Included in first response submittal to EPA	Submitted to EPA in first response, 1/28/15
3	EPA Comment 2-55-1 Incorrect Reference. IGP-2014, Section IGP-2.1 makes reference to 194.55(b)(1), should this be 194.54(b)(1) "Existing boreholes…"?	This is a typographical error in Appendix IGP-2014. The text will be corrected to read "Existing boreholes, as required by 40 CFR § 194.54(b)(1)…". This typographical error has been added to Enclosure 4, *CRA-2014 Errata Tracking*.	EPA	SNL-S. Wagner	Included in third response submittal to EPA	Submitted to EPA in third response, 4/8/15

CRA-2014 Errata Tracking						
Error #	**Error Description**	**Correction**	**Originator**	**Responsibility**	**Status**	**Date of Completion**
4	EPA Comment 2-23-2 Provide an Update of the Derivation of the Shaft Properties at the Repository Horizon. "...In the CRA 2014 PA, however, it appears the material properties of the shaft at the repository horizon have not been updated to reflect the change. Please confirm this and identify how the properties would change to reflect the change in the panel closure design."	The corrected length of the northernmost set of panel closures will be implemented in future PA calculations and will be tracked in Enclosure 4, *CRA-2014 Errata Tracking* .	EPA	SNL-T. Zeitler	Included in fourth response submittal to EPA	Submitted to EPA in fourth response

CRA-2014 Errata Tracking						
Error #	**Error Description**	**Correction**	**Originator**	**Responsibility**	**Status**	**Date of Completion**
5	EPA Comment 2-32-S7 FEP W3 Heterogeneity of Waste Forms. The screening argument citation of the CCA as the source of information on the heterogeneity of waste forms ignores changes that have occurred in the past 15 years, including supercompacted waste and mingling RH waste in shielded containers with CH waste. Please update the information to reflect current waste forms.	SCR-6.1.2.1.2 Summary of New Information The waste inventory used for the CRA-2014 PA calculations has been updated as provided in Kicker and Zeitler (2013). Since these FEPs are accounted for in PA, inventory-related parameters may differ from those used in previous PAs; however, the screening decisions have not changed and these FEPs are represented in PA calculations. The EPA approved the use of the shielded RH container as an allowable disposal container in WIPP (Edwards 2013). The impacts of this container upon WIPP performance were evaluated in Dunagan et al. (2007). SCR-6.1.2.1.3 Screening Argument Waste characteristics, comprising the waste inventory and heterogeneity of waste forms, are described in the CCA, Appendix BIR. The waste inventory is accounted for in PA calculations in deriving the dissolved actinide source term and gas generation rates. The distribution of contact-handled transuranic (CH-TRU) and remote-handled transuranic (RH-TRU) waste within the repository leads to room-scale heterogeneity of the waste forms, which is accounted for in PA calculations when considering the potential activity of waste material encountered during inadvertent borehole intrusion (Appendix PA-2014, Section PA-3.8). The DOE implements waste heterogeneity in waste forms through the assumption of random placement of TRU waste in the repository. This assumption includes all waste container forms and types. Details regarding the implementation of this assumption are provided in the CRA-2009, Appendix MASS-2009, Section MASS-21.0. This implementation methodology has not changed as a result of the addition of the shielded RH-waste container. This change has been added to Enclosure 4, *CRA-2014 Errata Tracking*.	EPA	SNL/PIRU-R.Kirkes	Included in fourth response submittal to EPA	Submitted to EPA in fourth response

CRA-2014 Errata Tracking						
Error #	Error Description	Correction	Originator	Responsibility	Status	Date of Completion
6	EPA Comment 2-32-S8 FEP W5 Container Material Inventory. Please supplement the screening argument with an explanation of the implementation in PA of the material inventory of shielded containers containing RH waste.	SCR-6.1.3.2 FEP Number: W5 FEP Title: Container Material Inventory SCR-6.1.3.2.1 Screening Decision: UP The Container Material Inventory is accounted for in PA calculations. SCR-6.1.3.2.2 Summary of New Information The masses of container materials associated with the waste inventory for the CRA-2014 have been updated as detailed in Van Soest (2012). The EPA approved the use of the shielded RH container as an allowable disposal container in WIPP (Edwards 2013). The impacts of this container upon WIPP performance were evaluated in Dunagan et al. (2007). SCR-6.1.3.2.3 Screening Argument The container material inventory is described in Van Soest (2012) and is accounted for in PA calculations through the estimation of gas generation rates (see Appendix PA-2014, Section PA-4.2.5). In the CCA, Appendix WCL, a minimum quantity of metallic Fe was specified to ensure sufficient reactants to reduce radionuclides to lower and less soluble oxidation states. This requirement is met as long as there are no substantial changes in container materials. The inventory used for the CRA-2014 contains 3.69 x 107 kg of steel in packaging (includes containers) materials. This value is up slightly from 3.59 x 107 kg reported in 2008 (Van Soest 2012). Modeling assumptions related to the implementation of waste container materials can be found in Appendix MASS-2014, Table MASS-5. This change has been added to Enclosure 4, *CRA-2014 Errata Tracking*.	EPA	SNL/PIRU-R.Kirkes	Included in fourth response submittal to EPA	Submitted to EPA in fourth response

CRA-2014 Errata Tracking						
Error #	**Error Description**	**Correction**	**Originator**	**Responsibility**	**Status**	**Date of Completion**
7	EPA Comment 2-32-S15 FEP W28 Nuclear Explosions. Please modify the screening argument to address whether, in addition to "a reduction of TRU radionuclides from previous estimates", the quantities of fissile radionuclides have also been reduced.	SCR-6.3.3.2 FEP Number: W28 FEP Title: Nuclear Explosions SCR-6.3.3.2.1 Screening Decision: SO-P Nuclear Explosions have been eliminated from PA calculations on the basis of low probability of occurrence over 10,000 yrs. SCR-6.3.3.2.2 Summary of New Information This FEP has been updated to include the most recent inventory information as presented in Kicker and Zeitler (2013). This new information does not change the screening argument or decision for this FEP. SCR-6.3.3.2.3 Screening Argument Nuclear explosions have been eliminated from PA calculations on the basis of low probability of occurrence over 10,000 yrs. For a nuclear explosion to occur, a critical mass of Pu would have to undergo rapid compression to a high density. Even if a critical mass of Pu could form in the system, there is no mechanism for rapid compression. Inventory information used for the CRA-2014 is presented in Kicker and Zeitler (2013). The updated inventory information for the CRA-2014 shows a reduction of TRU radionuclides from previous estimates. Fissile radionuclides have reduced from approximately 3.1 million curies for the PABC-2009 to 2.7 million curies for the CRA-2014. Thus, current criticality screening arguments are conservatively bounded by the previous CCA screening arguments (Rechard et al. 1996, 2000, and 2001). This change has been added to Enclosure 4, *CRA-2014 Errata Tracking*.	EPA	SNL/PIRU-R.Kirkes	Included in fourth response submittal to EPA	Submitted to EPA in fourth response

CRA-2014 Errata Tracking						
Error #	**Error Description**	**Correction**	**Originator**	**Responsibility**	**Status**	**Date of Completion**
8	EPA Comment 2-32-S19 FEP W45 Effects of Temperature on Microbial Gas Generation. Please modify the screening argument to acknowledge the reduced thermal impact of seal concrete hydration because of the elimination of additional explosion walls and the Option D monolith.	This is a revision to Appendix SCR-2014, Section SCR-6.5.1.1.3.1. The revised text has been changed to read: This thermal rise is considered bounding due to the elimination of concrete from the panel closure systems. Because the new panel closures will be constructed of mined salt, the overall mass of concrete emplaced within the repository will be significantly decreased. More importantly, the emplacement of any constructed element (e.g., shaft seals) of the repository will be done at or before repository closure. Therefore, any increase in temperature due to concrete hydration will have abated by the time AICs are assumed to no longer prevent drilling into the repository. The revised text has been added to Enclosure 4, CRA-2014 Errata Tracking.	EPA	SNL/PIRU-R.Kirkes	Included in fourth response submittal to EPA	Submitted to EPA in fourth response
9	EPA Comment 2-32-S20 FEP W53 Radiolysis of Cellulose. The reported reason for the screening argument update is not consistent between Table SCR-1, where the update is due to new radionuclide inventory, and Section SCR-6.5.1.7.2 where the update is due to new cellulose inventory. The screening argument in Section SCR-6.5.1.7.3 refers only to the new radionuclide inventory. Please reconcile the information.	This is a revision to Appendix SCR-2014. The revised text of Section SCR-6.5.1.7.2 has been changed to read: SCR-6.5.1.7.2 Summary of New Information This FEP has been updated with new waste inventory data. Decreasing waste inventory values lower the overall activity for all TRU radionuclides which indicate that radiolysis of cellulose will not be a significant process. The screening argument and decision are not affected by this change in inventory information. This change has been added to Enclosure 4, *CRA-2014 Errata Tracking*.	EPA	SNL/PIRU-R.Kirkes	Included in fourth response submittal to EPA	Submitted to EPA in fourth response
End of CRA-2014 Errata Tracking						