2014 Compliance Recertification Application (CRA-2014)
Compliance Application Review Document (CARD for Section 194.34)
<u>Results of Performance Assessments</u>

34.0 BACKGROUND (194.34(a))

The radioactive waste disposal regulations at 40 CFR Part 191 include requirements for containment of radionuclides. The containment requirements at 40 CFR 191.13 specify that releases from a disposal system to the accessible environment must not exceed the release limits set forth in Appendix A, Table 1, of 40 CFR Part 191. Assessment of the likelihood that the Waste Isolation Pilot Plant (WIPP) will meet the Appendix A release limits is conducted through the use of a process known as a "performance assessment" (PA). The WIPP PA essentially consists of a series of computer simulations (also known as Monte Carlo simulation) that analyze the physical attributes of the repository (site's physical, chemical and biological conditions and processes that act on them, geology, waste forms and quantities, engineered features) in a manner that captures the behaviors and interactions among its various components over the 10,000-year regulatory time frame.

The PA must consider all reasonable potential release mechanisms from the repository, and it must be structured and conducted in a way that demonstrates an adequate understanding of the physical conditions at the disposal system and its surroundings and shows that the future performance of the system can be predicted with reasonable assurance. Also, it must include both undisturbed conditions and human intrusion scenarios. In addition, the PA must incorporate up-to-date scientific, defensible data for physical attributes of the repository and geochemical and radionuclide decay reactions. The results of the PA are used to demonstrate compliance with the long-term containment requirements at 40 CFR 191.13.

The containment requirements place limits on the likelihood of radionuclide releases from a disposal facility. A radionuclide release to the accessible environment is defined in terms of the location of the release and its magnitude. Any release of radioactivity to the ground surface, the atmosphere, or surface water is considered to be a release to the accessible environment. In addition, any subsurface transport of radioactivity beyond the boundary of the WIPP controlled area is also considered a release to the accessible environment.[1]

The results of the WIPP PA are to be expressed as complementary cumulative distribution functions (CCDFs). A CCDF indicates the probability of exceeding various levels of cumulative release. The CCDFs must be generated using random sampling techniques that draw upon the full range of values established for each uncertain parameter.

34.1 REQUIREMENT (194.34(a))

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[1] The "controlled area" withdrawn from public use pursuant to Section 3 of the WIPP Land Withdrawal Act extends to a depth of 6,000 feet. Therefore, the complete boundary of the WIPP controlled area is represented by the vertical plane extending from the surface boundary to a depth of 6,000 feet.

(a) "The results of performance assessments shall be assembled into complementary, cumulative distribution functions (CCDFs) that represent the probability of exceeding various levels of cumulative release caused by all significant processes and events."

34.2 1998 CERTIFICATION DECISION (194.34(a))

To meet the requirements of 194.34(a), the U.S. Environmental Protection Agency (EPA or Agency) expected the U.S. Department of Energy (DOE or Department) to demonstrate that:

1) the results of the PA were assembled into CCDFs,

2) the CCDFs represent the probability of exceeding various levels of cumulative release caused by all significant processes and events, and

3) all significant processes and events that may affect the repository over the next 10,000 years have been incorporated into the CCDFs that are presented.

EPA reviewed the features, events and processes for WIPP and the construction of the CCDFs. EPA concluded that DOE appropriately captured in the CCDFs the significant processes and events that could occur during the regulatory period and thus complied with this section.

A complete description of EPA's 1998 Certification Decision for Section 194.34 can be obtained from EPA Air Docket, A-93-02, Items V-A-1 and V-B-2.

34.3 CHANGES IN THE 2004 COMPLIANCE RECERTIFICATION APPLICATION (2004 CRA) (194.34(a))
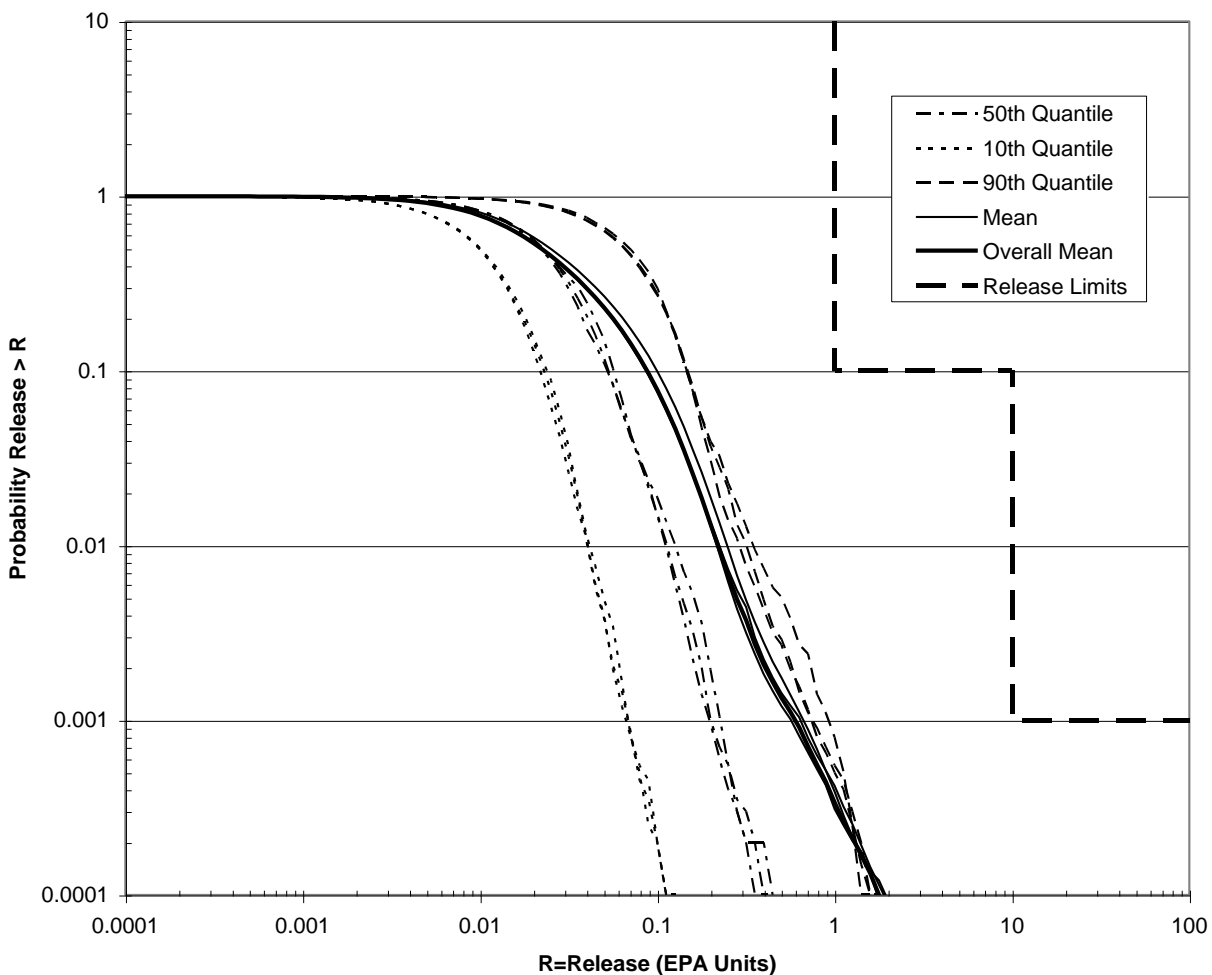
DOE developed CCDFs for the 2004 Compliance Recertification Application (2004 CRA) using a process similar to the process used in the Compliance Certification Application (CCA). Only the values represented by the CCDFs changed, reflecting changes in parameters and modeling assumptions.

34.3.1 EVALUATION OF COMPLIANCE FOR 2004 RECERTIFICATION (194.34(a))

DOE used selected computer codes and input parameters to generate estimates of radionuclides for a large number of release scenarios. In total, 300 CCDFs (100 for each of the three replicates) were constructed and presented in the Performance Assessment Baseline Calculation Report (Docket A-98-49, Item II-B2-60) for total normalized releases (Figure 34-1). Three hundred realizations were needed in order to satisfy the requirements of Section 194.34(d). Normalized release results for ten thousand future simulations were used to calculate each of the 300 CCDF curves. In addition, DOE provided CCDFs for individual pathways and by replicate. EPA's analysis (Docket A-98-49, Item II-B1-16) concluded that DOE adequately presented the PA results in CCDFs, which show the probability of exceeding various levels of cumulative releases.

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessments requirements of Section 194.34.

Figure 34.1. Mean and Quantile CCDFs for Total Normalized Releases: All Replicates of the 2004 CRA PABC (from Figure 6-4, 2004 Compliance Recertification Application Performance Assessment Baseline Calculation, Docket A-98-49, Item B2-51)

34.3.2 2004 RECERTIFICATION DECISION (194.34(a))

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49), EPA determined that DOE continued to comply with the requirements for Section 194.34 for 2004 CRA.

34.4 CHANGES IN THE 2009 COMPLIANCE RECERTIFICATION APPLICATION (2009 CRA) (194.34(a))
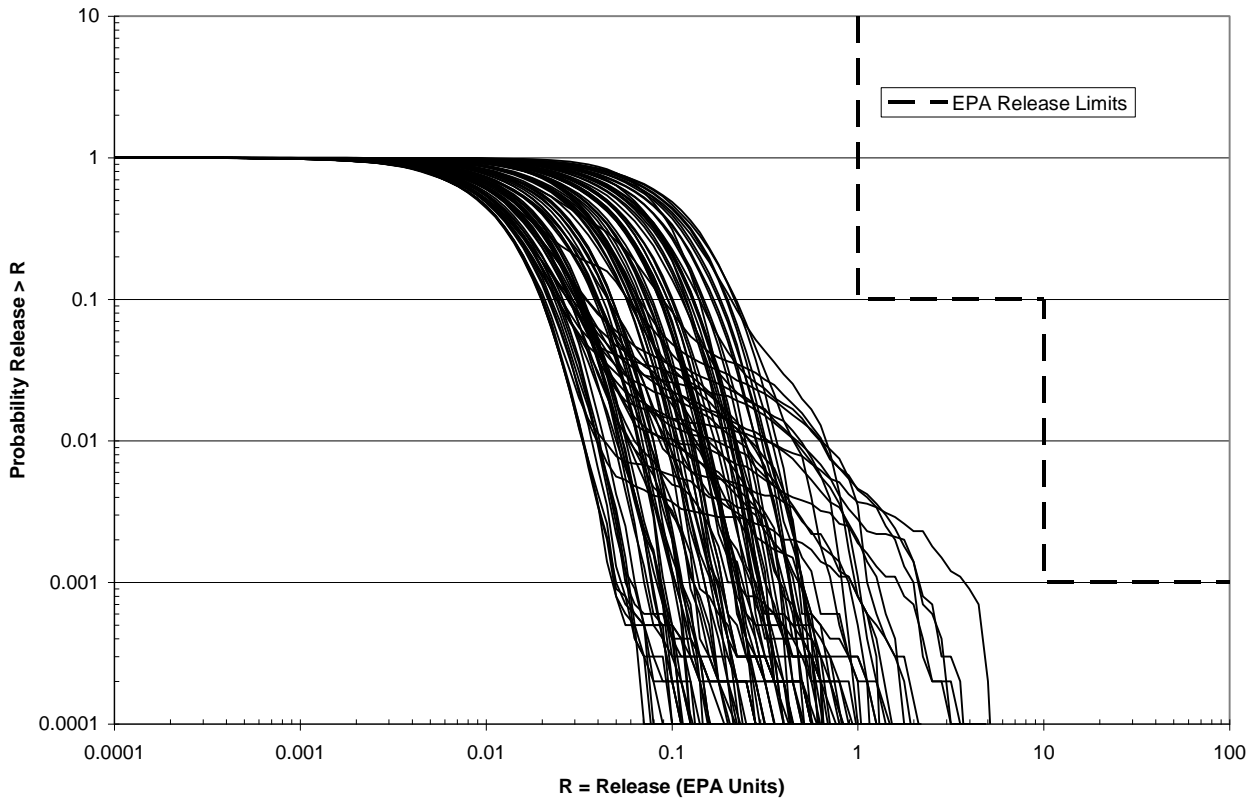
DOE developed CCDFs for the 2009 Compliance Recertification Application (2009 CRA) using the same process and CCDF computational technique as in the CCA and 2004 CRA. Only the values represented by the CCDFs changed, reflecting parameter updates, error corrections, and code improvements made since the 2004 CRA.

34.4.1 EVALUATION OF COMPLIANCE FOR 2009 RECERTIFICATION (194.34(a))

DOE continued to use selected computer codes and input parameters to generate estimates of radionuclides for a large number of release scenarios. In total, 300 CCDFs (100 for each of the three replicates) were constructed and presented in the 2009 CRA PA (2009 CRA Appendix PA-2009) and the 2009 Performance Assessment Baseline Calculation Report (2009 PABC) (Clayton et al. 2009, Camphouse 2010) for total normalized releases (Figure 34-5). Three hundred realizations were needed in order to satisfy the requirements of Section 194.34(d). Normalized release results for ten thousand future simulations were again used to calculate each of the 300 CCDF curves. In addition, DOE provided CCDFs for individual pathways and by replicate. EPA's analysis (EPA 2010b) concluded that DOE adequately presented the PA results in CCDFs, which show the probability of exceeding various levels of cumulative releases.

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessments requirements of Section 194.34.

Figure 34-2. Total Normalized Releases for 100 CCDFs of Replicate R1 of the 2004 CRA PABC (Figure 6-1, PABC Report, Docket A-98-49, Item II-B2-60).

34.4.2 2009 RECERTIFICATION DECISION (194.34(a))

Based on a review and evaluation of the 2009 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2009-0330, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.34(a) for 2009 CRA.

34.5 CHANGES IN THE 2014 COMPLIANCE RECERTIFICATION APPLICATION (2014 CRA) (194.34(a))

DOE developed CCDFs for the 2014 Compliance Recertification Application (2014 CRA) using the same process and CCDF computational technique as in the CCA and previous CRAs (2014 CRA DOE Section 34.2.7). Only the values represented by the CCDFs changed, reflecting parameter updates, error corrections, and code improvements made since the 2009 CRA.

Several EPA technical concerns regarding DOE's CRA-2014 PA were evaluated in a set of sensitivity studies. The purpose of these studies was to determine the sensitivity of the CRA-2014 PA calculations to changes in the modeling of fluid flow and geochemical processes within the WIPP underground facility with the following model changes:

- Include capillary effects and salt creep closure and healing when simulating fluid flow in the parts of the WIPP repository that do not contain waste,
- Revise the probability of encountering a Castile brine reservoir beneath the repository,
- Revise the uncertainty distributions for actinide solubilities,
- Revise the iron sulfidation reactions,
- Use a corrected shear strength distribution for degraded waste,
- Use the corrected version of the DRSPALL code, and
- Use a corrected panel closure length.

The above sensitivity studies were intended to address a subset of EPA technical issues in a timely manner. The Agency does not consider these studies as being inclusive in addressing all the technical issues identified during the CRA-2014 review. These results do demonstrate that when the aforementioned parameters are modified within the CRA-2014 PA, the releases remain below the regulatory limits. The sensitivity studies yielded the following principal results and conclusions.

- DOE's BRAGFLO fluid flow code is not capable of modeling capillary effects under conditions of changing permeability, and therefore cannot fully simulate the salt creep closure process. EPA believes this capability would improve WIPP performance modeling and recommends it be incorporated in future WIPP performance assessment (PA).

- DOE's decision to replace the concrete monolith panel closure design with a design incorporating run-of-mine (ROM) salt aggregate plugs will, upon salt creep closure and healing, likely result in much tighter, lower permeability closures that will effectively isolate the waste panels from one-another.

- Capillary effects along with low permeabilities from creep closure and healing of WIPP panel closures and non-waste area drifts effectively eliminates fluid flow among waste panels and results in slightly greater calculated releases than under the open drift assumptions of the CRA-2014 PA. As a result of the changed panel closure design, the open drift assumptions now cannot be assumed to overestimate releases. EPA encourages DOE to reevaluate this assumption for the CRA-2019 WIPP PA.

- Castile brine reservoir intrusions dominate the occurrence of direct brine releases (DBRs), which control lower probability but higher consequence total repository releases. EPA believes the PA modeling assumptions regarding Castile brine encounters, the DBR model and model assumption of waste panel connectivity are in need of being reevaluated and updated ensure they are in alignment with the international understanding of salt creep closure processes.

EPA analysis of these studies and their effect on overall mean total releases resulted in the following conclusions. Revising the solubility uncertainty distributions, revising the distribution of probability of the parameter used to model intersecting a Castile pressurized brine reservoir (PBRINE) and revising the iron sulfidation reaction stoichiometric coefficients significantly

increased DBRs as well as mean total low probability releases. EPA strongly encourages DOE to incorporate the above revisions or alternative revisions in upcoming CRA. Negligible effects on total mean releases were observed when DOE incorporated the corrected shear strength distribution for degraded waste, the corrected version of the computer code that models cuttings, cavings and spallings (DRSPALL) and corrected modeled panel closure length. However, the EPA also recommends these modifications be incorporated in the CRA-2019 PA.

The results indicate that modifications to the selected parameters reported in these evaluations increased calculated releases. However, the total mean releases, the upper 95% confidence limit on those means, and all individual vectors in the three replicates remained below the EPA's WIPP release limits.

However, in order to resolve many of the technical concerns identified in the Agency's review of the CRA-2014 PA, the EPA identified key concerns that the DOE can address by either incorporating revisions identified by or acceptable to the Agency or by conducting independent technical reviews on specific issues that were identified in the Agency's CRA-2014 review.

34.5.1 EVALUATION OF COMPLIANCE FOR 2014 RECERTIFICATION (194.34(a))

DOE continued to use selected computer codes and input parameters to generate estimates of radionuclides for a large number of release scenarios. (See EPA TSD *Summary of EPA's Completeness and Technical Review of DOE Changes Between the 2009 and 2014 CRA* EPA Docket EPA-HQ-OAR-2014-0609) In total, 300 CCDFs (100 for each of the three replicates) were constructed and presented in the 2014 CRA PA (2014 CRA Appendix PA-2014) calculation reports (Camphouse et al. 2013) for total normalized releases (Figure 34-3). Three hundred realizations were needed in order to satisfy the requirements of Section 194.34(d). Normalized release results for ten thousand future simulations were again used to calculate each of the 300 CCDF curves. In addition, DOE provided CCDFs for individual pathways and by replicate. EPA's analysis concluded that DOE adequately presented the PA results in CCDFs, which show the probability of exceeding various levels of cumulative releases.

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessments requirements of Section 194.34(a).
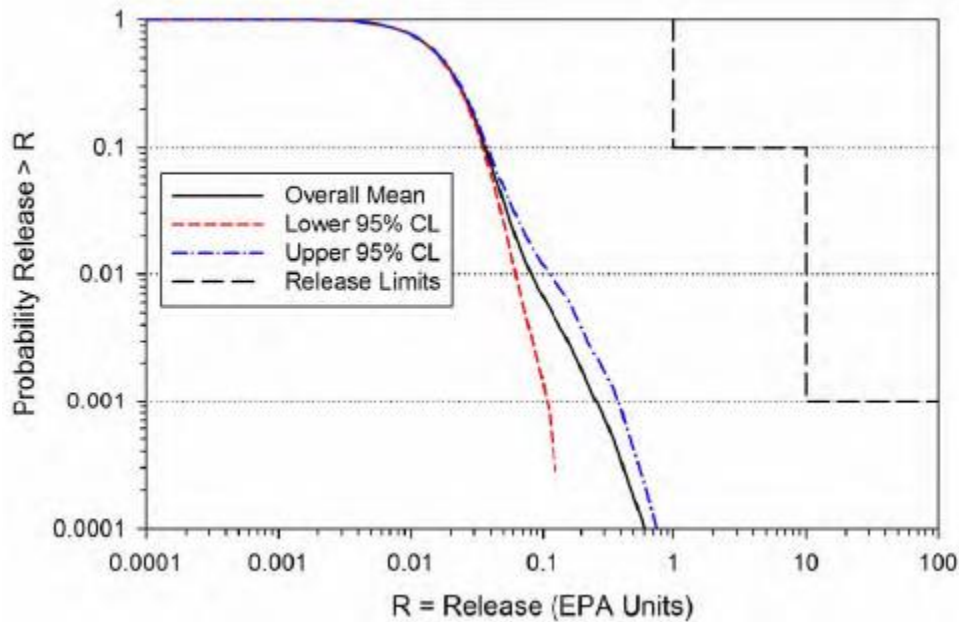
Figure 34-3. 2014 CRA PA Confidence Limits on the Overall Mean for Total Normalized Releases (Camphouse et al. 2013, Figure 6-52)

34.5.2 2014 RECERTIFICATION DECISION (194.34(a))

Based on a review and evaluation of the 2014 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2014-0609), EPA determines that DOE continues to comply with the requirements for Section 194.34(a) for 2014 CRA.

34.6 BACKGROUND (194.34(b))

The 2004 CRA WIPP performance assessment used approximately 1700 parameters and the 2009 CRA PAs continued to use approximately 1700 parameters. Many of these parameters are constants, but some are uncertain. Section 194.34 (b) addresses the need for the uncertain parameters to be sampled from a probability distribution (e.g., uniform, normal, etc.) that has been appropriately documented.

34.7 REQUIREMENT (194.34(b))

(b) "Probability distributions for uncertain disposal system parameter values used in performance assessments shall be developed and documented in any compliance application."

34.8 1998 CERTIFICATION DECISION (194.34(b))

To meet the requirements of Section 194.34(b), EPA expected DOE to:

1) discuss the sources used and the methods by which each of the probability distributions   was developed (e.g., experimental data, field data, etc.),

2) identify the functional form of the probability distribution (e.g., uniform, lognormal) used for the sampled parameters,

3) describe the statistics of each probability distribution, including the values for lower and upper ranges, mean (geometric mean when appropriate) and median,

4) Identify the importance of the sampled parameters to the final releases, and

5) Demonstrate that the data used to develop the input parameter probability distribution were qualified and controlled in accordance with Section 194.22.

EPA reviewed DOE's parameters and found that DOE adequately documented the probability distributions in CCA Appendix PAR, and discussed the data from which, and the method by which, the probability distribution of each of the 57 sampled variables was created. DOE provided general information on probability distributions, data sources for parameter distribution, forms of distributions, bounds, and importance of parameters to releases. EPA identified with some of the parameter values and probability distributions, but these were resolved for the Performance Assessment Verification Test EPA required DOE to conduct.

A complete description of EPA's 1998 Certification Decision for Section 194.34 can be obtained from EPA Air Docket, A-93-02, Items V-A-1 and V-B-2.

34.9 CHANGES IN THE 2004 CRA (194.34(b))

There were some changes in parameter values and probability distributions in the 2004 CRA PA. Many of these changes were related to inventory changes, but some were related to modeling assumption changes (See 2004 CRA CARD 23). However, the basic process that DOE used to develop the parameter information and the sampling of the parameters did not change from the CCA methodology.

34.9.1 EVALUATION OF COMPLIANCE FOR 2004 RECERTIFICATION (194.34(b))

DOE documented its selection of parameters and probability distributions for the key parameters in Chapter 6 of the 2004 CRA, 2004 CRA Appendix PA Attachment PAR, the PABC report (Docket A-98-49, Item II-B2-51) and associated references. For the 2004 CRA PA, DOE selected 75 uncertain subjective parameters whose values were obtained through random sampling in the PA. In comparison, the CCA PA sampled 57 uncertain parameters. The 2004 CRA PABC sampled 56 parameters, and there were changes to several of the parameters for the PABC (the PABC report and Kirchner, 2005 [ERMS 540279] in Docket A-98-49, Item II-B2-60). The ultimate goal of parameter sampling was to capture uncertainties in the parameters and show their effects on the CCDFs, which DOE discussed in 2004 CRA Chapter 6 sections 6.4 and 6.5 and in the PABC report section 2.9 (Docket A-98-49, Item II-B2-51).

EPA reviewed DOE's parameter selection and probability distributions in several Technical Support Documents (TSD) related to computer codes (Docket A-98-49, Items II-B1-7, II-B1-8), parameters (Docket A-98-49, Items II-B1-3, II-B1-6, II-B1-9), and chemistry (Docket A-98-49, Items II-B1-3, II-B1-9, II-B1-16). The Agency found that DOE adequately documented the probability distributions and discussed the data from which, and the method by which, the probability distribution of each of the sampled variables was created.

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessments requirements of Section 194.34(b) for 2004 CRA.

34.9.2 2004 RECERTIFICATION DECISION (194.34(b))

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49), EPA determined that DOE continued to comply with the requirements for Section 194.34(b) for 2004 CRA.

34.10 CHANGES IN THE 2009 COMPLIANCE RECERTIFICATION APPLICATION (2009 CRA) (194.34(b))

There were some changes in parameter values and probability distributions in the 2009 CRA; 15 parameters were modified and 90 were added for the 2009 CRA PA (Fox 2008, Table 6). Most of these changes are related to inventory changes, but some are related to modeling assumption changes (See 2009 CRA CARD 23). The 2009 PABC had 19 hand-coded parameters added to the parameter database and 130 parameters were modified mainly because of inventory changes (Clayton 2010b). However, the basic process that DOE used to develop the parameter information and the sampling of the parameters did not change from the methodology documented in the CCA or 2004 CRA (DOE 2009 CRA Section 34).

34.10.1 EVALUATION OF COMPLIANCE FOR 2009 RECERTIFICATION (194.34(b))

DOE documented its selection of parameters and probability distributions for the key parameters in Fox 2008, Table 6, 2009 CRA Appendix PA-2009, the 2009 2009 PABC report (Clayton et al. 2009) and associated references. The 2009 PABC also sampled 75 parameters and there were changes to several of the parameters for the 2009 PABC (Clayton et al 2009, Clayton 2010b). The ultimate goal of parameter sampling continues to be to capture uncertainties in the parameters and show their effects on the CCDFs, which DOE discussed in (Fox 2008, Clayton et al. 2009, Clayton 2010b).

EPA reviewed DOE's parameter selection and probability distributions in several Technical Support Documents (TSD) related to computer codes (EPA 2010e), parameters (EPA 2010g), and chemistry (EPA 2010a). The Agency found that DOE continued to adequately document the probability distributions and discussed the data from which, and the method by which, the probability distribution of each of the sampled variables was created.

EPA did not receive any public comments on DOE's continued compliance with the

results of performance assessments requirements of Section 194.34(b) during 2009 CRA.

34.10.2 2009 RECERTIFICATION DECISION (194.34(b))

Based on a review and evaluation of the 2009 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2009-0330, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.34(b) for 2009 CRA.

34.11 CHANGES IN THE 2014 COMPLIANCE RECERTIFICATION APPLICATION (2014 CRA) (194.34(b))

Some parameter values and probability distributions changed in the 2014 CRA. There were 105 parameters modified and 90 parameters were added to the 2014 CRA PA (2014 CRA DOE Section 34.3.7 and Kicker and Herrick 2013, Table 3). Most of these changes were related to inventory, the panel closure redesign and solubility changes, but some were related to modeling assumption changes (see 2014 CRA CARD 23 and 2014 CRA Appendix PA). The basic process that DOE used to develop the parameter information and the sampling of the parameters did not change from the methodology documented in the CCA or previous CRAs (2014 CRA DOE Section 34.3.7).

34.11.1 EVALUATION OF COMPLIANCE FOR 2014 RECERTIFICATION (194.34(b))

DOE documented its selection of parameters and probability distributions for the key parameters in Kicker and Herrick 2013, Table 1, 2014 CRA Appendix PA-2014, the 2014 CRA summary (Camphouse 2013) and associated references. The Agency believes that the sensitivity studies, coupled with DOE's documentation, provide a reasonable expectation that WIPP complies with the radioactive waste disposal regulations at 40 CFR parts 191 and 194.

The ultimate goal of parameter sampling continues to be to capture uncertainties in the parameters and show their effects on the CCDFs, which DOE discussed in (Kicker and Herrick 2013, Camphouse 2013).

EPA reviewed DOE's parameter selection and probability distributions in several Technical Support Documents (TSD) related to computer codes (EPA 2015, 2017a, b) parameters (EPA 2017c, Appendix B of EPA 2017a), and chemistry (EPA 2014d). During the completeness review, EPA identified issues with parameters or approaches used by DOE in the calculations. In order to fully address our questions on multiple topics, the Agency requested DOE conduct additional calculations so EPA could better understand how alternative parameter values would affect repository performance. These calculations, or sensitivity studies as they have been referred to, are summarized below and are the subject of a technical support document [EPA 2017e].

The Agency found that DOE continued to adequately document the probability distributions and discussed the data from which, and the method by which the probability distribution of each of the sampled variables was created.

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessments requirements of Section 194.34(b) during the 2014 CRA.

34.11.2 2014 RECERTIFICATION DECISION (194.34(b))

Based on a review and evaluation of the 2014 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2014-0609), EPA determines that DOE continues to comply with the requirements for Section 194.34(b) for 2014 CRA.

34.12 BACKGROUND (194.34(c))

In section 194.34(c), EPA's intent was to ensure that the sampled parameters were appropriately selected for use in performance assessment. DOE chose to use the Latin Hypercube Sampling (LHS) methodology to sample the probabilistic parameters.

34.13 REQUIREMENT (194.34(c))

(c) "Computational techniques, which draw random samples from across the entire range of the probability distributions developed pursuant to paragraph (b) of this section, shall be used in generating CCDFs and shall be documented in any compliance application."

34.14 1998 CERTIFICATION COMPLIANCE DECISION (194.34(c))

To demonstrate compliance with Section 194.34(c), EPA expected DOE to:

1) discuss the computational techniques used for random sampling, and

2) demonstrate that sampling occurred across the entire range of each parameter.

EPA agreed that it was appropriate to use the LHS method for the 57 sampled parameters described in CCA Appendix PAR. The CCDFGF code also sampled stochastic variables with Monto Carlo sampling for each realization. EPA concluded that DOE adequately discussed the computational techniques and the sampling ranges.

A complete description of EPA's 1998 Certification Decision for Section 194.34(c) can be obtained from EPA Air Docket, A-93-02, Items V-A-1 and V-B-2.

34.15 CHANGES IN THE 2004 COMPLIANCE RECERTIFICATION APPLICATION (2004 CRA) (194.34(c))

Like in the CCA, DOE used the LHS methodology for sampling uncertain parameters. There is no change in the methodology for the 2004 CRA.

34.15.1 EVALUATION OF COMPLIANCE FOR 2004 RECERTIFICATION (194.34(c))

EPA determined in the CCA that this method ensures that parameter values will be selected from the entire range of the probability distributions because LHS stratifies the probability distributions into a number (100, in this case) of equal-probability regions and then samples one value from each region. EPA noted that the LHS sampling is appropriate for generating random samples.

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessments requirements of Section 194.34(c) for 2004 CRA.

34.15.2 2004 RECERTIFICATION DECISION (194.34(c))

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49), EPA determined that DOE continued to comply with the requirements for Section 194.34(c) for 2004 CRA.

34.16 CHANGES IN THE 2009 COMPLIANCE RECERTIFICATION APPLICATION (2009 CRA) (194.34(c))

DOE continued to use the LHS methodology for sampling uncertain parameters for the 2009 CRA PAs. There is no change in the methodology for the CRA.

34.16.1 EVALUATION OF COMPLIANCE FOR 2009 RECERTIFICATION (194.34(c))

EPA determined in the CCA and 2004 CRA that this method ensures that parameter values will be selected from the entire range of the probability distributions because LHS stratifies the probability distributions into a number (100, in this case) of equal-probability regions and then samples one value from each region. EPA notes that the LHS sampling continues to be appropriate for generating random samples in the 2009 PAs.

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessments requirements of Section 194.34(c) for 2009 CRA.

34.16.2 2009 RECERTIFICATION DECISION (194.34(c))

Based on a review and evaluation of the 2009 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2009-0330, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.34(c) for 2009 CRA.

34.17 CHANGES IN THE 2014 COMPLIANCE RECERTIFICATION APPLICATION (2014 CRA) (194.34(c))

DOE continued to use the Latin Hypercube Sample (LHS) methodology for sampling uncertain parameters for the 2014 CRA PAs (2014 CRA DOE Section 34.4.7 and Kirchner 2013a). There is no change in the methodology for the 2014 CRA.

34.17.1 EVALUATION OF COMPLIANCE FOR 2014 RECERTIFICATION (194.34(c))

EPA determined in the CCA and previous CRAs that the LHS sampling method ensures that parameter values will be selected from the entire range of the probability distributions because LHS stratifies the probability distributions into a number (100, in this case) of equal-probability regions and then samples one value from each region. EPA notes that LHS sampling continues to be appropriate for generating random samples in the 2014 PAs (Kicker and Herrick 2013, Table 4 and Kirchner 2013a, Section 1).

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessments requirements of Section 194.34(c) for 2014 CRA.

34.17.2 2014 RECERTIFICATION DECISION (194.34(c))

Based on a review and evaluation of the 2014 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2014-0609), EPA determines that DOE continues to comply with the requirements for Section 194.34(c) for 2014 CRA.

34.18 BACKGROUND (194.34(d))

In Section 194.34(d), EPA's intent was to ensure that PA modeling appropriately sampled uncertain parameters and future scenarios were appropriately used in performance assessment. In the CCA and the recertification analyses, DOE generated 300 CCDFs in order to meet this requirement.

34.19 REQUIREMENT (194.34(d))

(d) "The number of CCDFs generated shall be large enough such that, at cumulative releases of 1 and 10, the maximum CCDF generated exceeds the 99th percentile of the population of CCDFs with at least a 0.95 probability. Values of cumulative release shall be calculated according to Note 6 of Table 1, Appendix A of Part 191 of this chapter."

34.20 <u>1998 CERTIFICATION COMPLIANCE DECISION (194.34(d))</u>

To demonstrate compliance with Section 194.34(d), EPA expected DOE to:

1) Identify the number of CCDFs generated,

2) Discuss how DOE determined the number of CCDFs to be generated,

3) List the probabilities of exceeding cumulative releases of 1 and 10 for each CCDF generated, and

4) Demonstrate that the maximum CCDF generated, at cumulative normalized releases of 1 and 10, exceeds the 99th percentile with at least a 0.95 probability with a discussion that includes examples of calculations.

EPA found the analysis presented in CCA Chapter 8 sufficient to show that 298 CCDF curves would satisfy the statistical criterion. EPA's independent analysis also verified that the 300 CCDF curves computed and presented in the CCA were sufficient (CCA CARD 34). DOE correctly interpreted the definition of the 99th percentile value, and applied standard mathematical expressions for deriving the probability of an outcome of multiple events (i.e., the generation of multiple CCDF curves). The probabilistic analysis was found to be appropriate for sampling with the LHS method, which achieves better coverage than non-stratified random sampling of parameter ranges

A complete description of EPA's 1998 Certification Decision for Section 194.34(d) can be obtained from EPA Air Docket, A-93-02, Items V-A-1 and V-B-2.

34.21 CHANGES IN THE 2004 COMPLIANCE RECERTIFICATION APPLICATION (2004 CRA) (194.34(d))

As in the CCA, DOE generated 300 CCDFs in three sets (replicates) of 100. There was no change in the methodology for the 2004 CRA.

34.21.1 EVALUATION OF COMPLIANCE FOR 2004 RECERTIFICATION (194.34(d))

DOE generated three sets of 100 CCDFs each and discussed the statistical confidence levels for the set of CCDFs. Based on the analysis in the CCA and the fact that DOE used the same approach in the CRA, EPA concurred with DOE's CRA analyses.

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessments requirements of Section 194.34(d).

34.21.2 2004 RECERTIFICATION DECISION (194.34(d))

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49), EPA determined that DOE continued to comply with the requirements for Section 194.34(d) for 2004 CRA.

34.22 CHANGES IN THE 2009 COMPLIANCE RECERTIFICATION APPLICATION (2009 CRA) (194.34(d))

DOE continued to generate 300 CCDFs in three sets (replicates) of 100 for the 2009 CRA PAs. There is no change in the methodology for the 2009 CRA.

34.22.1 EVALUATION OF COMPLIANCE FOR 2009 RECERTIFICATION (194.34(d))

DOE generated three sets of 100 CCDFs each and discussed the statistical confidence levels for the set of CCDFs (Clayton et al. 2009, Camphouse 2010). Based on the analysis in the 2009 CRA and the fact that DOE used the same approach in the 2009 CRA as in the CCA and 2004 CRA PAs, EPA concurs with DOE's CRA analyses.

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessments requirements of Section 194.34(d) for 2009 CRA.

34.22.2 2009 RECERTIFICATION DECISION (194.34(d))

Based on a review and evaluation of the 2009 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2009-0330, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.34(d) for 2009 CRA.

34.23 CHANGES IN THE 2014 COMPLIANCE RECERTIFICATION APPLICATION (2014 CRA) (194.34(d))

DOE continued to generate 300 CCDFs in three sets (replicates) of 100 for the 2014 CRA PAs (see 2014 CRA Appendix PA, Section PA-2.2). There is no change in the methodology for the 2014 CRA.

34.23.1 EVALUATION OF COMPLIANCE FOR 2014 RECERTIFICATION (194.34(d))

DOE generated three sets of 100 CCDFs each and discussed the statistical confidence levels for the set of CCDFs (2014 CRA Appendix PA, Section PA-2-2, Kirchner 2011, Camphouse et al., 2013). Based on the analysis in the 2014 CRA and the fact that DOE used the same approach in the 2014 CRA as in the CCA and previous CRA PAs, EPA concurs with DOE's CRA analyses.

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessments requirements of Section 194.34(d) for 2014 CRA.

34.23.2 2014 RECERTIFICATION DECISION (194.34(d))

Based on a review and evaluation of the 2014 CRA and supplemental information provided by DOE (Docket ID No. EPA-HQ-OAR-2014-0609), EPA determines that DOE continues to comply with the requirements for Section 194.34(d) for 2014 CRA.

34.24 BACKGROUND (194.34(e))

In section 194.34(e), DOE was required to show the full range of CCDFs in order to provide an indication of the nature of the releases.

34.25 REQUIREMENT (194.34(e))

(e) "Any compliance application shall display the full range of CCDFs generated."

34.26 1998 CERTIFICATION DECISION (194.34(e))

To demonstrate compliance with Section 194.34(e), EPA expected DOE to:

1) display the full range of CCDFs generated,

2) present the appropriate information so that EPA may confirm DOE's PA analysis, including steps used to arrive at the result and data values that are represented by the CCDFs, and

3) include descriptive statistics such as the range, mean, median, etc., for the estimated CCDFs at cumulative releases of 1 and 10.

DOE employed LHS to create three independent replicates of 100 realizations each, yielding 300 CCDF curves. The range of normalized release values indicated on the horizontal axis extends from below one in a million (10^{-6}) to values above 1 (10^0) and 10 (10^1). The CCDF probability values on the vertical axis range from 10^{-4} up to the highest possible probability value of 1 (see Figure 34-1). DOE concluded that the requirement of Section 194.34(e) was met. EPA concurred with this conclusion.

A complete description of EPA's 1998 Certification Decision for Section 194.34(e) can be obtained from EPA Air Docket, A-93-02, Items V-A-1 and V-B-2.

34.27 CHANGES IN THE 2004 COMPLIANCE RECERTIFICATION APPLICATION (2004 CRA) (194.34(e))

There were no changes to the approached used by DOE in the 2004 CRA PA and 2004 PABC.

34.27.1 EVALUATION OF COMPLIANCE FOR 2004 RECERTIFICATION (194.34(e))
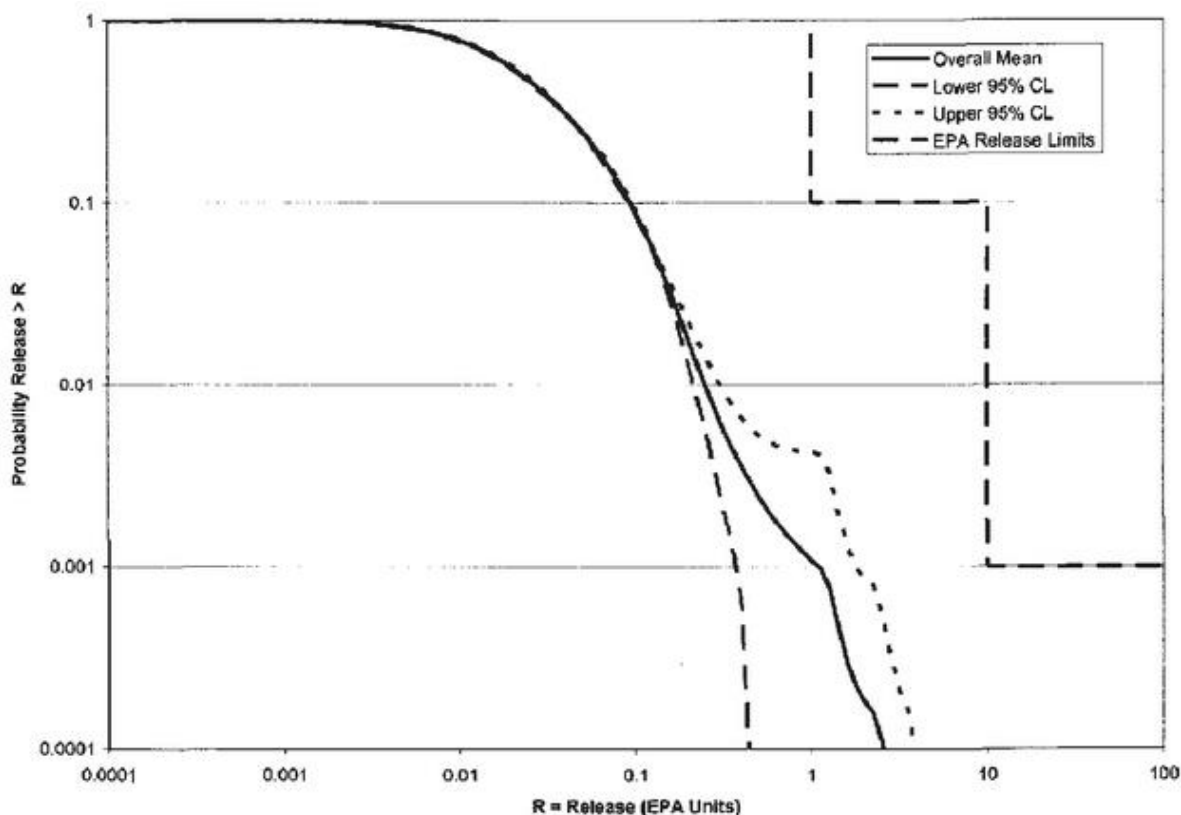
DOE presented and discussed the results of the performance assessment analysis in the 2004 CRA, Chapter 6 and the PABC report, Chapter 6 (Docket A-98-49, Item II-B2-60). Figure 34-2 shows the releases from replicate R1 of the 2004 CRA PABC.

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessment requirements of Section 194.34(e) for 2004 CRA.

34.27.2 2004 RECERTIFICATION DECISION (194.34(e))

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49) and the fact that DOE included the full range of CCDFs as required by this section, EPA determined that DOE continued to comply with the requirements for Section 194.34(e) for 2004 CRA.

Figure 34-4. PABC-2009 Confidence Limits on Overall Mean for Total Normalized Releases (Camphouse 2010, Figure 3-33).

34.28 CHANGES IN THE 2009 RECERTIFICATION (194.34(e))

There were no changes to the approached used by DOE in the 2009 CRA PAs.

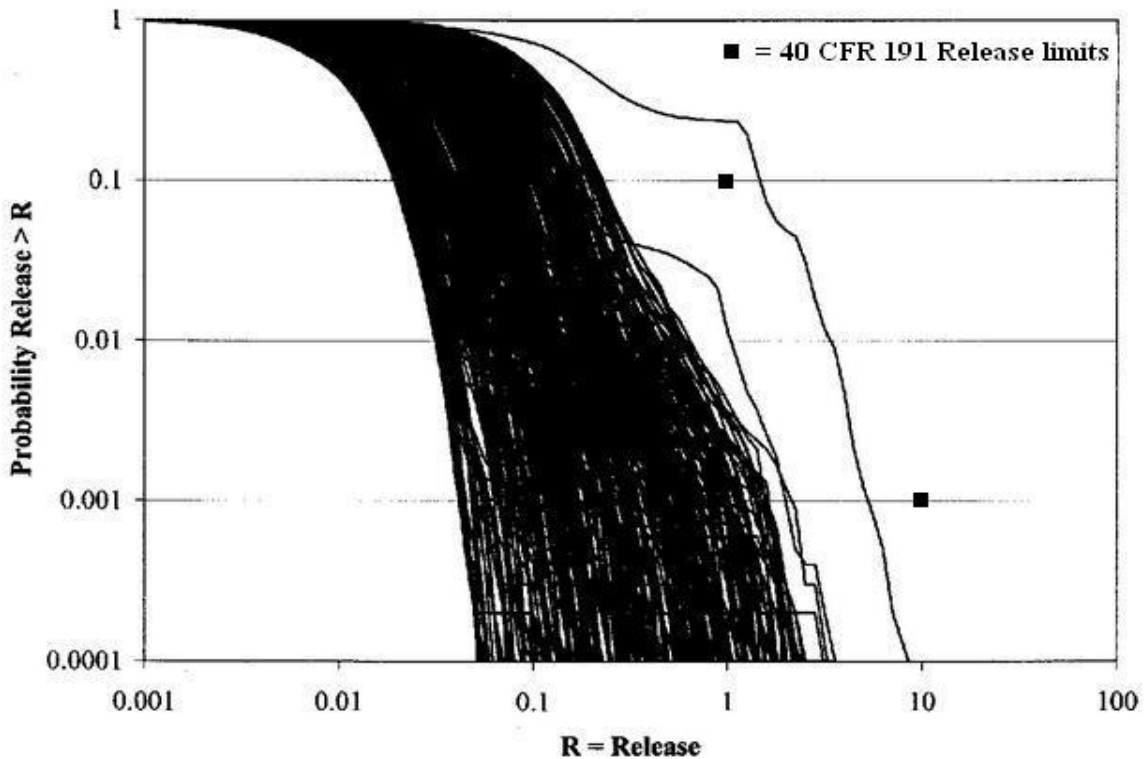**34.28.1 EVALUATION OF COMPLIANCE FOR 2009 RECERTIFICATION (194.34(e))**

DOE presented and discussed the results of the performance assessment analysis in the 2009 CRA Section 34 and the 2009 PABC report (Clayton et al. 2009). Figure 34-5 shows the 300 CCDFs (100 for each of the 3 replicates) for total normalized releases were constructed and presented in 2009 PABC (Clayton et al. 2009). It is discussed further in Section 34.34.1 of this CARD.

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessment requirements of Section 194.34(e) for the 2009 CRA.

34.28.2 2009 RECERTIFICATION DECISION (194.34(e))

Based on a review and evaluation of the 2009 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2009-0330, Air Docket A-98-49) and the fact that DOE included the full range of CCDFs as required by this section, EPA determines that DOE continues to comply with the requirements for Section 194.34(e) for 2009 CRA.

Figure 34-5. 2009 PABC-Total Normalized Releases in EPA Units Replicates R1, R2, and R3 (Adapted from Clayton et al. 2009, Figure 6-6)

34.29 CHANGES IN THE 2014 RECERTIFICATION (194.34(e))

There were no changes to the approached used by DOE in the 2014 CRA PAs. DOE generated the full range of CCDFs for the 2014 CRA PAs.

34.29.1 EVALUATION OF COMPLIANCE FOR 2014 RECERTIFICATION (194.34(e))

DOE presented and discussed the results of the performance assessment analysis in the 2014 CRA DOE Section 34, 2014 CRA Appendix PA-2014 and the 2014 CRA summary report (Camphouse et al. 2013). Figure 34-6 shows the 300 CCDFs (100 for each of the 3 replicates)

for total normalized releases were constructed and presented in 2014 CRA summary report (Camphouse et al. 2013).

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessment requirements of Section 194.34(e) for the 2014 CRA.

34.29.2 2014 RECERTIFICATION DECISION (194.34(e))

Based on a review and evaluation of the 2014 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2014-0609) and the fact that DOE included the full range of CCDFs as required by this section, EPA determines that DOE continues to comply with the requirements for Section 194.34(e) for 2014 CRA.

Figure 34-6. 2014 PA-Total Normalized Releases in EPA Units Replicates R1, R2, and R3 (Adapted from Camphouse et al. 2013, Figure 6-51)
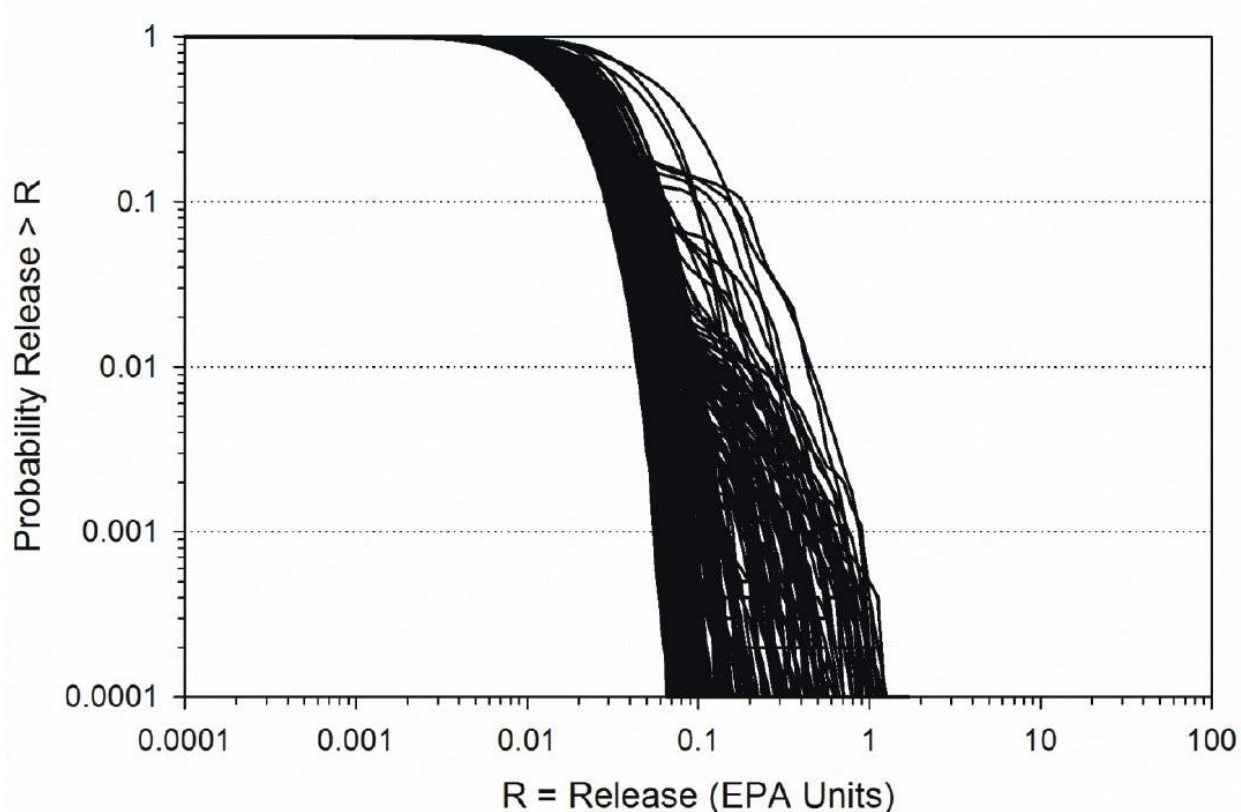
34.30 BACKGROUND (194.34(f))

Because of the unique nature of the WIPP, EPA must ensure that the data used could adequately support a certification decision. To this end, EPA required DOE to demonstrate compliance with a high statistical confidence. DOE must show, in effect, that the mean of its 300 CCDF curves, and the 95th percentile upper confidence limit of the mean of the population for the cumulative releases at 1 and 10 EPA units.

34.31 REQUIREMENT (194.34(f))

(f) "Any compliance application shall provide information which demonstrates that there is at least a 95 percent level of statistical confidence that the mean of the population of CCDFs meets the containment requirements of 40 CFR 191.13."

34.32 1998 CERTIFICATION DECISION (194.34(f))

To demonstrate compliance with Section 194.34(f), EPA expected DOE to:

1) present the appropriate information, including steps used to arrive at the result and the data used in the analysis, so that EPA can confirm that the mean of the population of

CCDFs meets the containment requirements of Section 191.13 with a 95 percent level of statistical confidence,

2) identify the mean of the sample of CCDFs generated for the cumulative releases at 1 and 10 as specified in Section 191.13, and

3) identify the values of the CCDFs associated with a 95 percent level of statistical confidence of the mean of the population for the cumulative releases at 1 and 10 as specified in Section 191.13 (CAG, p. 52).

The CCA PAVT results yielded CCDFs with 100 percent of the curves lying below the limit of resolution at R=10, and over 90 percent of the CCDFs below the limit of resolution at R=1. The estimated mean CCDF for the PAVT was also below the limit of resolution at R=1 and R=10. The PAVT results also demonstrated that the level of statistical confidence is significantly greater than 95 percent and that the mean of the CCDFs meets the Section 191.13 containment requirements. Therefore, EPA concluded that the final result of the PAVT was in compliance with the containment requirements of Section 191.13 and that the results were presented in accordance with Section 194.34(f).

A complete description of EPA's 1998 Certification Decision for Section 194.34(f) can be obtained from EPA Air Docket, A-93-02, Items V-A-1 and V-B-2.

34.33 CHANGES IN THE 2004 COMPLIANCE RECERTIFICATION APPLICATION (2004 CRA) (194.34(f))

In the 2004 CRA, DOE used the same general approach to calculating the statistical confidence for release limits as was used for the CCA. However, there were some modeling implementation errors that EPA identified would cause the performance assessment results to possibly be out of compliance with this requirement. Thus, EPA required DOE to conduct an additional performance assessment.

34.33.1 EVALUATION OF COMPLIANCE FOR 2004 RECERTIFICATION (194.34(f))

DOE provided the CCDFs and uncertainty information in the 2004 CRA documentation. EPA's and DOE's review of the 2004 CRA identified that there were several errors that possibly affected the 2004 CRA PA's compliance with section 194.34 (f) (March 4, 2005, letter from EPA to DOE, Docket A-98-49, Item II-B3-80 and DOE's responses in Docket A-98-49, Items II-B2-39 and II-B2-40). Incorrect LHS transfer files were used as input to PRECCDFGF for replicates 2 and 3, thus some of the same parameter inputs were used multiple times instead of being appropriately sampled for each replicate; however, they were minor. EPA believed that this was essentially equivalent to using the same parameter values instead of being adequately sampled as required. A spallings release calculation for the volume fraction of contact-handled waste was omitted from CCDFGF. Also, there was an error in the input control file for the computer code SUMMARIZE that affected spallings results. Finally, only 50 vectors for DRSPALL calculations were run for the 2004 CRA performance assessment instead of a full set of 100 vectors, thus potentially reducing the range of spallings releases.

Because of these problems, EPA required DOE to run a full set of DRSPALL vectors and correct the problem with LHS transfer files. DOE conducted another performance assessment, called the 2004 Performance Assessment Baseline Calculations (2004 PABC). The results of the 2004 PABC are provided in DOE's 2004 PABC report (Docket A-98-49, Item II-B2-60). Table 6-1 of that report, reproduced here in Table 34-1, lists the mean total normalized releases at the compliance probabilities of 0.1 and 0.001, along with the upper and lower 95% confidence limits. EPA's review of the 2004 PABC identified that the errors were corrected.

Table 34-1. CCA PAVT, CRAs 2004 PAs-and 2004 PABC- -Statistics on the Overall Mean for Total Normalized Releases (in EPA Units) at Probabilities of 0.1 and 0.001, All Replicates Pooled.

Probability	PA Analysis	Mean Total Release	90th Quantile Total Release	Lower 95% CL	Upper 95% CL
0.1	CCA PAVT	1.237E-1	1.916E-1	1.231E-1	1.373E-1
	2004 CRA	9.565E-2	1.571E-1	8.070E-2	1.104E-1
	2004 PABC	8.770E-2	1.480E-1	8.471E-2	9.072E-2
0.001	CCA PAVT	3.819E-1	3.907E-1	2.809E-1	4.357E-1
	2004 CRA	5.070E-1	8.582E-1	2.778E-1	5.518E-1
	PABC-2004	6.006E-1	8.092E-1	5.175E-1	6.807E-1

CL = Confidence Limit

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessments requirements of Section 194.34(f) for 2004 CRA.

34.3328.2 2004 RECERTIFICATION DECISION (194.34(f))

Table 34-1 shows that the 2004 PABC demonstrates at least a 95% level of statistical confidence that the mean of the population of CCDFs met the containment regulations of 40 CFR 191.13.

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49), EPA determined that DOE continued to comply with the requirements for Section 194.34(f) for 2004 CRA.

34.3429 CHANGES IN THE 2009 COMPLIANCE RECERTIFICATION APPLICATION (2009 CRA) (194.34(f))

In the 2009 CRA DOE used the same general approach to calculate the statistical confidence for release limits as used in the CCA and 2004 CRA.

34.34.1 EVALUATION OF COMPLIANCE FOR 2009 RECERTIFICATION (194.34(f))

DOE shows the overall mean of the total normalized for the 300 CCDFs, along with the 95% confidence levels about the overall mean for the total normalized releases of the 2009 PABC, in Figure 34-3.

As seen in Figure 34-5, one vector differed considerably from the other 299, and exceeded the compliance release limit at a probability of 0.1. The vector in question is dominated by direct brine releases, or DBR (Clayton et al. 2009). Increases in radionuclide solubilities as a result of inventory changes in the PABC-09 led to greater amounts of mobilized radionuclides calculated by the PANEL code and available for DBR (Garner 2010). DBR releases may be pessimistic, because the volume of brine used in PANEL to calculate mobilized radionuclides per brine volume does not limit the volume of brine available for DBR in CCDFGF. EPA examined this vector and determined that it does not affect facility compliance, which is determined by the mean of the 300 vectors.

Table 34-2 shows the overall mean total normalized release CCDF values for the 2009 CRA PA and 2009 PABC at the compliance probabilities of 0.1 and 0.001 and the upper and lower 95% confidence values. These are compared to the CCA and 2004 CRA PAs. EPA examined the 2009 CRA Section 34, 2009 CRA Appendix PA-2009, and the 2009 PABC report (Clayton et al. 2009) to verify that there is at least a 95 percent level of statistical confidence that the mean of the population of CCDFs meet the containment requirements of 40 CFR 191.13.

EPA did not receive any public comments on DOE's continued compliance with the results of performance assessments requirements of Section 194.34(f) during 2009 CRA.

Table 34-2. CCA PAVT, CRAs 2004, 2009 PAs-and the 2004 and 2009 PABC- Statistics on the Overall Mean for Total Normalized Releases (in EPA Units) at Probabilities of 0.1 and 0.001, All Replicates Pooled.

Probability	PA Analysis	Mean Total Release	90th Quantile Total Release	Lower 95% CL	Upper 95% CL
0.1	CCA PAVT	1.237E-1	1.916E-1	1.231E-1	1.373E-1
	2004 CRA	9.565E-2	1.571E-1	8.070E-2	1.104E-1
	2004 PABC	8.770E-2	1.480E-1	8.471E-2	9.072E-2
	2009 CRA	1.000E-1	1.700E-1	1.000E-1	1.100E-1
	2009 PABC	9.000E-2	1.600E-1	9.000E-2	1.100E-1
0.001	CCA PAVT	3.819E-1	3.907E-1	2.809E-1	4.357E-1
	2004 CRA	5.070E-1	8.582E-1	2.778E-1	5.518E-1
	PABC-2004	6.006E-1	8.092E-1	5.175E-1	6.807E-1
	2009 CRA	7.200E-1	8.100E-1	4.800E-1	9.200E-1
	2009 PABC	1.100E+0	1.000E+0	3.700E-1	1.77E+0

CL = Confidence Limit

34.34.2 2009 RECERTIFICATION DECISION (194.34(f))

Table 34-2 shows that 2009 CRA PA and the 2009 PABC demonstrates at least a 95% level of statistical confidence that the mean of the population of CCDFs meets the containment regulations of 40 CFR 191.13.

Based on a review and evaluation of the 2009 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2009-0330, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.34(f) for 2009 CRA.

34.35 CHANGES IN THE 2014 COMPLIANCE RECERTIFICATION APPLICATION (2014 CRA) (194.34(f))

In the 2014 CRA DOE used the same general approach to calculate the statistical confidence for release limits as used in the CCA and previous CRAs (2014 CRA DOE Section 34.7.7).

34.35.1 EVALUATION OF COMPLIANCE FOR 2014 RECERTIFICATION (194.34(f))

DOE shows the overall mean of the total normalized releases for the 300 CCDFs, along with the 95% confidence levels about the overall mean for the total normalized releases of the 2014 PA in Figure 34-3.

Table 34-3 shows the overall mean total normalized release CCDF values for the 2014 CRA PA at the compliance probabilities of 0.1 and 0.001 and the upper and lower 95% confidence values. These are compared to the CCA and previous CRA PAs. EPA examined the 2014 CRA DOE Section 34, 2014 CRA Appendix PA-2014, the 2014 CRA summary report (Camphouse et al. 2013) to verify that there is at least a 95 percent level of statistical confidence that the mean of the population of CCDFs meet the containment requirements of 40 CFR 191.13.

34.35.2 2014 RECERTIFICATION DECISION (194.34(f))

Table 34-3 shows that 2014 CRA PA demonstrates at least a 95% level of statistical confidence that the mean of the population of CCDFs meets the containment regulations of 40 CFR 191.13.

Based on a review and evaluation of the 2014 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2014-0609), EPA determines that DOE continues to comply with the requirements for Section 194.34(f) for 2014 CRA.

Table 34-3. For the CCA PAVT, CRAs 2004, 2009, 2014 PAs-and the 2004 and 2009 PABC -Statistics on the Overall Mean for Total Normalized Releases (in EPA Units) at Probabilities of 0.1 and 0.001, All Replicates Pooled.

Probability	PA Analysis	Mean Total Release	90th Quantile Total Release	Lower 95% CL	Upper 95% CL
0.1	CCA PAVT	1.237E-1	1.916E-1	1.231E-1	1.373E-1
	2004 CRA	9.565E-2	1.571E-1	8.070E-2	1.104E-1
	2004 PABC	8.770E-2	1.480E-1	8.471E-2	9.072E-2
	2009 CRA	1.000E-1	1.700E-1	1.000E-1	1.100E-1
	2009 PABC	9.000E-2	1.600E-1	9.000E-2	1.100E-1
	2014 CRA	3.670E-2		3.840E-2	9.000E-2
	2014 PABC				
0.001	CCA PAVT	3.819E-1	3.907E-1	2.809E-1	4.357E-1
	2004 CRA	5.070E-1	8.582E-1	2.778E-1	5.518E-1
	PABC-2004	6.006E-1	8.092E-1	5.175E-1	6.807E-1
	2009 CRA	7.200E-1	8.100E-1	4.800E-1	9.200E-1
	2009 PABC	1.100E+0	1.000E+0	3.700E-1	1.77E+0
	2014 CRA	2.610E-1		1.090E-1	3.840E-1
	2014 PABC				

CL = Confidence Limit

References

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