Recertification CARD No. 31
Application of Release Limits

BACKGROUND

The radioactive waste disposal regulations at 40 CFR Part 191 include requirements for containment of radionuclides. The containment requirements 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 Part 191. To calculate the applicable release limits for the Waste Isolation Pilot Plant (WIPP), information is needed on the potential total curie content in the repository. However, because the curie content of the waste inventory in the repository will change over time as a result of natural decay and in-growth of radionuclides, the U.S. Environmental Protection Agency (EPA or Agency) must establish when the curie content of waste should be fixed for purposes of calculating the release limits. Section 194.31 specifies that release limits should be calculated based on the curie content at time of disposal (that is, after the end of operational period, when the shafts of the repository has been backfilled and sealed). This CARD describes EPA's evaluation of the U.S. Department of Energy's (DOE or Department) calculation of release limits in the 2004 Compliance Recertification Application (2004 CRA).

REQUIREMENT

"The release limits shall be calculated according to part 191, appendix A of this chapter, using the total activity, in curies, that will exist in the disposal system at the time of disposal."

1998 CERTIFICATION DECISION

EPA expected the Compliance Certification Application (CCA) to estimate curies of each radionuclide in the disposal system at the time of disposal, and provide sample calculations of release limits, including, the relative contribution of each radionuclide to the normalized releases. EPA determined that the CCA performance assessment and the EPA-mandated Performance Assessment Verification Test (PAVT) were calculated using release limits according to Appendix A of 40 CFR 191.

CHANGES IN THE CRA

DOE used the updated versions of the same computer codes to decay the radionuclide inventory and calculate EPA units per cubic meter. During the 2004 CRA review, EPA reviewed the codes and they adequately performed the decay calculations. Thus, the only change of note was the 2004 CRA inventory, which is discussed in 2004 CRA CARD 24.

A complete description of EPA's 1998 Certification Decision for Section 194.31 can be obtained from Docket A-93-02, Items V-A-1 and V-B-2.

EVALUATION OF COMPLIANCE FOR RECERTIFICATION

EPA reviewed the information collected by DOE related to the waste inventory for the 2004 CRA PA and the PABC; EPA conducted verification calculations on the data used by DOE in the 2004 CRA PA (see 2004 CRA CARD 24 and the Technical Support Document (TSD) for Section 24: Review of the Baseline Inventory Used in the Compliance Recertification Application and the Performance Assessment Baseline Calculation, Docket A-98-49, Item II-B1-9). DOE discusses the waste unit factor calculations and the radionuclides that are important to the calculations and other items EPA expected in 2004 CRA, Appendix TRU Waste, and the PABC Inventory Report (TRU Waste Inventory for the 2004 Compliance Recertification Application Performance Assessment Baseline Calculation (Docket A-98-49, Item II-B2-60)).

Since the radioactivity in each waste stream is not measured at the same time, the waste stream activities are decay-corrected to December 31, 2001, using the ORIGEN2 Version 2.2 computer code. The radioactivity based on scaled contact-handled, transuranic (CH-TRU) waste volumes of each radionuclide in each waste stream is summed over all the waste streams to give the total CH-TRU waste activity for each nuclide. This activity is divided by the allowable CH-TRU waste volume of 168,485 m^3 to determine the activity concentration in Ci/m^3. The process is duplicated for remote-handled, transuranic (RH-TRU) waste using a volume limit of 7,079 m^3. The total radioactivity associated with CH-TRU waste in the 2004 CRA is 5.33×10^6 Ci (decayed to December 31, 2001), as compared to 6.42×10^6 Ci (decayed to December 31, 1995) in the CCA/PAVT (2004 CRA Appendix DATA, Attachment F, Annex B, Table DATA-F-B-27). As shown in Table 31-1, the five most significant radionuclides in the waste—Am-241, Pu-238, Pu-239, Pu-240, and Pu-241—contribute 97.2% of the total CH-TRU waste activity in the 2004 CRA and 99.0% in the CCA/PAVT.

Table 31-1. Most Important Radionuclides in CH-TRU Waste Inventory

Radionuclide	Radioactivity in CCA/PAVT[1] (Ci)	Radioactivity in CRA[2] (Ci)
Am-241	4.42×10^5	4.01×10^5
Pu-238	2.61×10^6	1.61×10^6
Pu-239	7.85×10^5	6.60×10^5
Pu-240	2.10×10^5	2.40×10^6
Pu-241	2.31×10^6	5.18×10^6
Fraction of Total Inventory	99.0%	97.2%

[1] Decayed through 1995
[2] Decayed through 2001

Similar information on the five most significant radionuclides in RH-TRU waste is presented in Table 31-2 (Appendix DATA, Attachment F, Annex B, Table DATA-F-B-28). The total RH-TRU waste inventory in the CCA/PAVT is 1.02×10^6 Ci while that in the 2004 CRA is 1.33×10^6 Ci. These values are substantially lower than the RH-TRU waste limit of 5.1 million

curies specified in the WIPP LWA (PL102-579).

Table 31-2. Most Important Radionuclides in RH TRU Waste Inventory

Radionuclide	Radioactivity in CCA/PAVT[1] (Ci)	Radioactivity in CRA[2] (Ci)
Ba-137m	2.04×10^5	3.36×10^5
Cs-137	2.16×10^5	3.65×10^5
Pu-241	1.42×10^5	1.12×10^5
Sr-90	2.09×10^5	2.46×10^5
Y-90	2.09×10^5	2.43×10^5
Fraction of Total Inventory	96.1%	97.6%

[1] Decayed through 1995
[2] Decayed through 2001

For use in PA, these inventories are decayed using the ORIGEN2 Version 2.2 computer code to 2033, the assumed closure date for the WIPP, and to various dates up to 10,000 years to assess the effects of various intrusion times on disturbed repository performance scenarios (e.g., see 2004 CRA, Appendix PA, Attachment PAR, Table PAR-50).

Isotopic Decay Calculation Checks

To verify whether the ORIGEN2 Version 2.2 decay calculations were performed correctly, selected isotopes from the 2004 CRA PA were decayed independently using this code. Results of these decay calculations are presented in Attachment B to the Inventory TSD (Docket A-98-49, Item II-B1-9). Decay calculations show that, on a spot-check basis, the ORIGEN2 values derived by DOE and used in EPAUNI[8] were done correctly.

In addition, spreadsheets were developed to assess the decay of Np-237 with respect to the potential need for inclusion in PA. Results of this analysis are also presented in Attachment B of the Inventory TSD (Docket A-98-49, Item II-B1-9), based on the three spreadsheet comparisons. The first spreadsheet presents the calculation of activity for Pu-241, Am-241, and Np-237 using a three-isotope Bateman equation formulation. Values were calculated at 100-year intervals to 10,000 years, with initial values taken from Table 4-7 of the 2004 CRA, which provides the repository inventories at closure (defined as 2033). The second spreadsheet presents a set of validation calculations on the formulation to ensure the expected conservation of atoms. The third spreadsheet provides a summary of the results. As expected and based on a 14.4-year half-life, the Pu-241 is effectively gone within 100 years, and the Np-237 builds up to a relatively small, almost equilibrium value of about 100 curies. For perspective, the total radioactivity in the 2004 CH-TRU waste inventory after 10,000 years is about 5.3×10^5 curies (2004 CRA Appendix PA, Attachment PAR, Table PAR-60).

According to Table 1 (Note 1e) in Appendix A of 40 CFR Part 191, release limits for the

[8] EPAUNI is a computer code that calculates the activity per m^3 for each waste stream at a discrete set of times.

radionuclides specified in the rule are based on "an amount of transuranic (TRU) waste containing one million curies of alpha-emitting transuranic radionuclides with half-lives greater than 20 years." To obtain release limits for use in PA, the release limits per 10^6 curies specified in Table 1 of Appendix A must be multiplied by a factor which defines the number of millions of TRU curies in the waste. For PA purposes, this factor, defined as the waste unit factor (WUF) or unit of waste, is expressed as:

$$f_w = \frac{\sum W_f}{10^6 \, Ci}$$

where f_w is the waste unit factor and W_f is the inventory in curies of each alpha-emitting TRU radionuclide with a half-life of 20 years or more. DOE identified a total of 138 radionuclides expected to be present in the waste based on the PABC inventory. Of these, 17 meet the definition of TRU waste in 40 CFR 191, Appendix A, Table 1 for calculating the waste unit factor. Table 2 of Leigh and Trone 2005 (Docket A-98-49, Item II-B2-60) identifies these nuclides and determines that they contribute 2.32 x 10^6 Ci at closure resulting in a WUF of 2.32 in the PABC.

The methodology for calculating the waste unit factor and release limits in the PABC is unchanged from that used in the CCA and the 2004 CRA and is appropriate and acceptable for PA.

EPA did not receive any public comments on DOE's continued compliance with the application of release limits requirements of Section 194.31.

RECERTIFICATION DECISION

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 determines that DOE continues to comply with the requirements for Section 194.31.