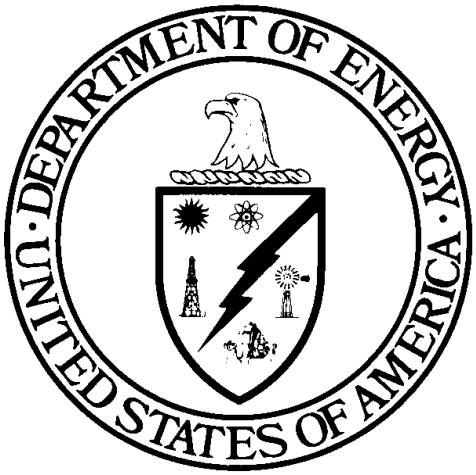
Title 40 CFR Part 191
Subparts B and C
Compliance Recertification
Application
for the
Waste Isolation Pilot Plant

Application of Release Limits
(40 CFR § 194.31)



United States Department of Energy
Waste Isolation Pilot Plant

Carlsbad Field Office
Carlsbad, New Mexico

Application of Release Limits
(40 CFR § 194.31)

Table of Contents

List of Tables

This page intentionally left blank.

Acronyms and Abbreviations

CARD	Compliance Application Review Document
CCA	Compliance Certification Application
CH-TRU	contact-handled transuranic
Ci	curies
CRA	Compliance Recertification Application
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
m^3	cubic meters
MCi	million-curie
PA	performance assessment
PABC	Performance Assessment Baseline Calculation
PAVT	Performance Assessment Verification Test
RH-TRU	remote-handled transuranic
TRU	transuranic
WIPP	Waste Isolation Pilot Plant
WUF	waste unit factor

Elements and Chemical Compounds

Am	americium
Cs	cesium
Pu	plutonium
Sr	strontium
Y	yttrium
^{137m}Ba	metastable barium-137

This page intentionally left blank.

31.0 Application of Release Limits (40 CFR § 194.31)

31.1 Requirements

> § 194.31 Application of Release Limits
>
> 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.

31.2 Background

The radioactive waste disposal regulations at 40 CFR Part 191 (U.S. Environmental Protection Agency 1993) include requirements for the 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 Part 191, Appendix A, Table 1. To calculate the applicable release limits for the Waste Isolation Pilot Plant (WIPP), information is needed on the expected total curie content in the repository. However, because the inventory estimates are updated as part of the recertification effort, and 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. Department of Energy (DOE) must establish an inventory for use in performance assessment (PA) and must determine a date for decay purposes to be used as a reference point for calculating the curie content of waste. 40 CFR § 194.31 (U.S. Environmental Protection Agency 1996) specifies that release limits should be calculated based on the curie content at the time of disposal (that is, after the end of the operational period, when the shafts of the repository have been backfilled and sealed). This approach was used by DOE in all previous compliance applications and is also being used for the 2009 Compliance Recertification Application (CRA-2009). The inventory for the CRA-2009 PA is the same inventory used for the CRA-2004 PABC. Since the CRA-2004 PABC was completed, the *Annual Transuranic Waste Inventory Report–2007* (U.S. Department of Energy 2008) was published and provides updated inventory information. The DOE anticipates this inventory update will have only a small impact on normalized releases relative to the CRA-2009 PA, and will not be significant for compliance. Therefore, the DOE is in compliance with section 194.24(a) (U.S. Environmental Protection Agency 1994).

31.3 1998 Certification Decision

The U.S. Environmental Protection Agency (EPA) stated in Compliance Application Review Document (CARD) 31 (U.S. Environmental Protection Agency 1998) that they expected the Compliance Certification Application (CCA) (U.S. Department of Energy 1996) 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. The EPA later determined as part of their compliance determination that the CCA PA and the EPA-mandated Performance Assessment Verification Test (PAVT) were calculated using release limits developed in accordance with Part 1, Appendix A.

A complete description of EPA's 1998 Certification Decision for compliance with section 194.31 can be obtained from CARD 31 (U.S. Environmental Protection Agency 1998).

31.4 Changes in the CRA-2004

In the CRA-2004, the DOE used updated versions of the same computer codes as those used in the CCA and CCA PAVT to decay the radionuclide inventory and calculate EPA units per cubic meter of waste (Fox 2003). The only change of note was the CRA-2004 inventory, which is discussed in the CRA-2004, Appendix DATA, Attachment F, the CRA-2004, Appendix TRU WASTE, and in CARD 24 (U.S. Environmental Protection Agency 2006a).

Since the radioactivity in each waste stream is not measured at the same time, the waste stream activities were decay-corrected to December 31, 2001, using the computer code ORIGEN2 Version 2.2 (Oak Ridge National Laboratory 2002). The total radioactivity in the repository is based on contact-handled (CH) transuranic (TRU) (CH-TRU) waste volumes of each radionuclide and then scaled to WIPP's maximum allowable CH-TRU volume (168,485 cubic meters (m^3)). The scaling factor for each type of waste is calculated by subtracting the stored and emplaced waste volumes from the disposal limit value (for disposal volumes of CH-TRU waste [168,485 m^3] and remote-handled (RH) transuranic (TRU) (RH-TRU) waste [7,079 m^3]) and dividing this value by the projected waste volume.

The total radioactivity associated with CH-TRU and RH-TRU wastes from the CCA PAVT, CRA-2004, and CRA-2004 PABC are shown in Table 31-1. These RH-TRU waste values are substantially lower than the RH-TRU waste limit of 5.1 million-curie (MCi) specified in the WIPP Land Withdrawal Act (PL102-579).

Table 31-2 shows that the 5 radionuclides with the highest activity in the waste—Americium (Am)-241, Plutonium (Pu)-238, ^{239}Pu, ^{240}Pu, and ^{241}Pu—contribute 97% of the total CH-TRU waste activity in the CRA-2004 PABC, 97% in the CRA-2004, and 99% in the CCA PAVT.

Similar information on the five radionuclides with the highest activity in the RH-TRU waste is presented in Table 31-3.

For use in the PA, these inventories are decayed using the computer code to the year 2033, the assumed closure date for the WIPP, and to various dates up to 10,000 years after closure to obtain the radioactivity profiles as a function of time (e.g., see the CRA-2004, Appendix PA, Attachment PAR, Table PAR-50).

Table 31-1. Total Radioactivity Associated with CH-TRU and RH-TRU Wastes

Analysis	CH-TRU Waste Total Activity (Ci)	RH-TRU Waste Total Activity (Ci)
CCA PAVT[a,c]	6.4×10^6	1.0×10^6
CRA-2004[b,c]	5.3×10^6	1.3×10^6
CRA-2004 PABC[b,d]	4.7×10^6	1.6×10^6

[a] Decayed through 1995
[b] Decayed through 2001
[c] Values from the CRA-2004, Appendix DATA, Attachment F, Annex B, Table DATA-F-B-27
[d] Values from Transuranic Waste Baseline Inventory Report 2004, Table B.1-27 (U.S. Department of Energy 2006).

Table 31-2. Radionuclides with Highest Activity in the CH-TRU Waste Inventory

Radionuclide	Radioactivity in CCA PAVT[a,c] (Ci)	Radioactivity in CRA-2004[b,c] (Ci)	Radioactivity in CRA-2004 PABC[b,d] (Ci)
^{241}Am	4.4×10^5	4.0×10^5	4.8×10^5
^{238}Pu	2.6×10^6	1.6×10^6	1.5×10^6
^{239}Pu	7.9×10^5	6.6×10^5	5.8×10^5
^{240}Pu	2.1×10^5	(1.1×10^5)[e]	9.4×10^4
^{241}Pu	2.3×10^6	(2.4×10^6)[f]	2.0×10^6
Fraction of Total Inventory	99%	97%	97%

[a] Decayed through 1995
[b] Decayed through 2001
[c] Values directly from the CRA-2004, Appendix DATA, Attachment F, Annex B, Table DATA-F-B-27
[d] Values directly from Transuranic Waste Baseline Inventory Report 2004, Table B.1-27 (U.S. Department of Energy 2006).
[e] Value incorrectly reported in CARD 31 as 2.40×10^6 (U.S. Environmental Protection Agency 2006b).
[f] Value incorrectly reported in CARD 31 as 5.18×10^6 (U.S. Environmental Protection Agency 2006b).

Table 31-3. Radionuclides with Highest Activity in the RH-TRU Waste Inventory

Radionuclide	Radioactivity in CCA PAVT[a,c] (Ci)	Radioactivity in CRA-2004[b,c] (Ci)	Radioactivity in CRA-2004 PABC[b,d] (Ci)
^{137m}Ba	2.0×10^5	3.4×10^5	3.9×10^5
^{137}Cs	2.2×10^5	3.7×10^5	4.3×10^5
^{241}Pu	1.4×10^5	1.1×10^5	1.3×10^5
^{90}Sr	2.1×10^5	2.5×10^5	3.2×10^5
^{90}Y	2.1×10^5	2.4×10^5	3.2×10^5
Fraction of Total Inventory	96%	98%	98%

[a] Decayed through 1995
[b] Decayed through 2001
[c] Values directly from the CRA-2004, Appendix DATA, Attachment F, Annex B, Table DATA-F-B-28
[d] Values directly from Transuranic Waste Baseline Inventory Report 2004, Table B.1-28 (U.S. Department of Energy 2006).

According to Part 1, Appendix A, Table 1 (Note 1e), release limits for the radionuclides specified in the rule are based on "an amount of TRU waste containing one million curies of alpha-emitting TRU radionuclides with half-lives greater than 20 years." To obtain release limits for use in the PA, the release limits per MCi specified in Part 191, Appendix A, Table 1 must be multiplied by a factor that defines the number of MCi of TRU radionuclides in the inventory. For PA purposes, this factor, defined as the WUF or unit of waste, is expressed as

$$f_w = \frac{\sum W_f}{10^6 Ci} \qquad \text{(Eq. 31.1)}$$

where f_w is the WUF and W_f is the WIPP-scale inventory in curies of each alpha-emitting TRU radionuclide with a half-life of 20 years or more. The DOE identified a total of 138 radionuclides expected to be present in the waste based on the CRA-2004 PABC inventory. Of these, 17 meet the definition of TRU waste in Part 191, Appendix A, Table 1 for calculating the WUF. Table 2 of Leigh and Trone (2005) identify these nuclides and determine that they contribute 2.32×10^6 Ci at closure, resulting in a WUF of 2.32 in the CRA-2004 PABC. CRA-2004, Appendix TRU WASTE, and the CRA-2004 PABC Inventory Report (Leigh, Trone, and Fox 2005) discuss in detail the waste unit factor (WUF) calculations and the radionuclides important to the calculations.

31.5 EPA's Evaluation of Compliance for the 2004 Recertification

The CRA-2004 PABC Inventory Report (U.S. Department of Energy 2006) was completed following the submittal of the CRA-2004 and was used in the CRA-2004 PABC calculations. Though this inventory was issued following the CRA-2004, it was included in the EPA's evaluation of the CRA-2004. The EPA reviewed the information collected by the DOE related to the waste inventory for the CRA-2004 PA and the CRA-2004 PABC, and conducted verification calculations on the data used by the DOE in the CRA-2004 PA (CARD 24, U.S. Environmental Protection Agency 2006a, and U.S. Environmental Protection Agency 2006c, Sections 3.4 and 4.4). The methodologies for calculating the WUF and release limits in the CRA-2004 PABC were unchanged from those used in the CCA and the CRA-2004, and the EPA determined that the approach used was appropriate and acceptable for the CRA-2004 PA (U.S. Environmental Protection Agency 2006d).

To verify whether the ORIGEN2 Version 2.2 decay calculations were performed correctly, the EPA carried out independent calculations of the decay of the inventory. These calculations showed that, on a spot-check basis, the ORIGEN2 values derived by the DOE and used in EPAUNI[1] (Sandia National Laboratories 2003) were correct (CARD 31, U.S. Environmental Protection Agency 2006b). During the CRA-2004 review, the EPA reviewed the codes and determined that they adequately performed the decay calculations. The EPA determined that the approach used by the DOE was appropriate and acceptable for the CRA-2004 PA (U.S. Environmental Protection Agency 2006a).

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

31.6 Changes or New Information since the 2004 Recertification

The CRA-2009 PA maintains the same inventory and WUF values that were used in the CRA-2004 PABC (Leigh, Trone, and Fox 2005) and previously accepted by the EPA. The CRA-2004 PABC inventory was the last published inventory at the time the PA calculation for the CRA-2009 commenced. Since the CRA-2004 PABC was completed, the *Annual Transuranic Waste Inventory Report–2007* (U.S. Department of Energy 2008) was published and provides updated inventory information. The DOE anticipates this inventory update will have only a small impact on normalized releases relative to the CRA-2009 PA, and will not be significant for compliance. The DOE's approach to demonstrating compliance with the application of release limits has not changed from that used in the CRA-2004 and CRA-2004 PABC, and therefore continues to comply with section 194.31.

31.7 References

Fox, B. 2003. *Analysis of EPA Unit Loading Calculation, Compliance Recertification Application* (Superceded ERMS 530304, Revision 1). ERMS 531582. Carlsbad, NM: Sandia National Laboratories.

Leigh, C., and J. Trone. 2005. *Calculation of the Waste Unit Factor for the Performance Assessment Baseline Calculation* (Revision 0). ERMS 539613. Carlsbad, NM: Sandia National Laboratories.

Leigh, C., J. Trone, and B. Fox. 2005. *TRU Waste Inventory for the 2004 Compliance Recertification Application Performance Assessment Baseline Calculation* (Revision 0). ERMS 541118. Carlsbad, NM: Sandia National Laboratories.

Oak Ridge National Laboratory (ORNL). 2002. *RSICC Computer Code Collection ORIGEN 2.2* (June). CCC371 ORIGEN 2.2. ERMS 525791. Oak Ridge, TN: Radiation Safety Information Computational Center.

Sandia National Laboratories (SNL). 2003. *User's Manual for EPAUNI, Version 1.15A.* ERMS 530203. Carlsbad, NM: Sandia National Laboratories.

U.S. Department of Energy (DOE). 1996. *Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant* (October). 21 vols. 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). 10 vols. DOE/WIPP 2004-3231. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2006. *Transuranic Waste Baseline Inventory Report–2004*. DOE/TRU 2006-3344. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2008. *Annual Transuranic Waste Inventory Report—2007* (Revision 1). DOE/TRU 2008-3379. Carlsbad, NM: Carlsbad Field Office.

U.S. Environmental Protection Agency (EPA). 1993. "40 CFR Part 191: Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes; Final Rule." *Federal Register,* vol. 58 (December 20, 1993): 66398–416.

U.S. Environmental Protection Agency (EPA). 1996. "40 CFR Part 194: Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations; Final Rule." *Federal Register*, vol. 61 (February 9, 1996): 5223–45.

U.S. Environmental Protection Agency (EPA). 1998. "CARD No. 31: Application of Release Limits." *Compliance Application Review Documents for the Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR 191 Disposal Regulations: Final Certification Decision* (May) (pp. 31-1 through 31-20). Washington, DC: Office of Radiation and Indoor Air.

U.S. Environmental Protection Agency (EPA). 2004. "40 CFR Part 194: Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance With the Disposal Regulations; Alternative Provisions" (Final Rule). *Federal Register*, vol. 69 (July 16, 2004): 42571–583.

U.S. Environmental Protection Agency (EPA). 2006a. "Recertification CARD No. 24: Waste Characterization." *Compliance Application Review Documents for the Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations: Final Recertification Decision* (March) (pp. 24-1 through 24-50). Washington, DC: Office of Radiation and Indoor Air.

U.S. Environmental Protection Agency (EPA). 2006b. "Recertification CARD No. 31: Application of Release Limits." *Compliance Application Review Documents for the Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations: Final Recertification Decision* (March) (pp. 31-1 through 31-4). Washington, DC: Office of Radiation and Indoor Air.

U.S. Environmental Protection Agency (EPA). 2006c. *Technical Support Document for Section 194.24: Review of the Baseline Inventory Used in the Compliance Recertification Application and the Performance Assessment Baseline Calculation* (March). Washington, DC: Office of Radiation and Indoor Air.

U.S. Environmental Protection Agency (EPA). 2006d. *Technical Support Document for Section 194.23: Review of WIPP Recertification Performance Assessment Computer Codes* (March). CRA Code Review. Washington, DC: Office of Radiation and Indoor Air.