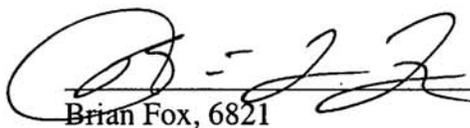


Radionuclides Expected to Dominate Potential Releases
in the Compliance Recertification Application
Supersedes ERMS# 529245

Revision 1

ERMS 531086
August 26, 2003

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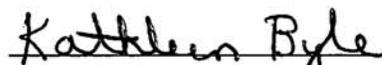
Technical Review

 8-28-03
Date

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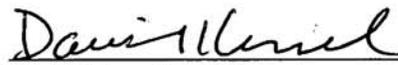
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WIPP:1.3.5.1.3.1:PA:QA-L:528009

1 of 36
Information Only

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1. INTRODUCTION

In 1996 the Department of Energy (DOE) completed a performance assessment (PA) calculation for the Waste Isolation Pilot Plant (WIPP). The PA was part of the Compliance Certification Application (CCA) submitted to the Environmental Protection Agency (EPA) to demonstrate compliance with the radiation protection regulations of 40 CFR 191 and 40 CFR 194. As required by the WIPP Land Withdrawal Act (Public Law 102-579), DOE is required to submit documentation to EPA for the recertification of the WIPP every five years in order to continue operating the site. This will require that a Compliance Recertification Application (CRA) be prepared and submitted to the EPA by November 2003.

This analysis is governed by AP-097, *Analysis Plan For Deriving Radionuclide Inventory Information for Performance Assessment Calculations: Compliance Recertification Application* which discusses the methodology that will be used by Sandia National Laboratories (SNL) to determine the WIPP repository radionuclide inventory information for use in the PA calculation for the CRA. In particular, this analysis addresses Section 2.2, Task 1 of AP-097, "Identification of Radionuclides That Dominate Release," and its associated tasks. Note the expected target dates identified in the plan are changed to the date of this package.

This analysis was performed in accordance with the SNL Quality Assurance Program and was prepared as prescribed by the SNL NWMP Procedure, NP 9-1, *Analyses*.

1.1 ACRONYMS

| | |
|---------|--|
| AP | Analysis Plan |
| CFR | Code of Federal Regulations |
| CH | Contact Handled |
| CRA | Compliance Recertification Application |
| DOE | Department of Energy |
| EPA | Environmental Protection Agency |
| ERMS | Electronic Records Management System |
| LANL-CO | Los Alamos National Laboratory – Carlsbad Operations |
| NP | NWMP Procedure |
| NWMP | Nuclear Waste Management Program |
| ORIGEN | Oak Ridge Isotope Generation and Depletion Code |
| PA | Performance Assessment |
| RH | Remote Handled |
| SNL | Sandia National Laboratory |
| TRU | Transuranic |
| WIPP | Waste Isolation Pilot Plant |

2. PROBLEM DESCRIPTION

Each potential radionuclide release mechanism modeled in performance assessment has as its source an inventory of radionuclides that (1) the DOE expects will be disposed in WIPP and (2) analysts believe will be prevalent in a release via the individual release mechanism. For the CRA, the DOE through its contractor, LANL, has been given a radionuclide inventory that it expects will be disposed in the WIPP (LANL, 2003). The radionuclide inventory contains 138 radioisotopes. However, not all of the 138 radioisotopes are necessarily important to track in a performance assessment for the WIPP repository. In addition, tracking of all 138 radioisotopes is not practical since WIPP PA involves a suite of computationally intensive codes. Therefore, the number of isotopes tracked in the WIPP PA codes must be reduced.

3. ANALYSIS

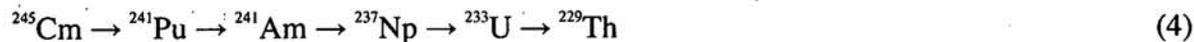
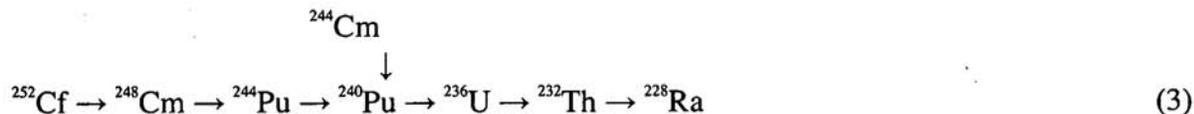
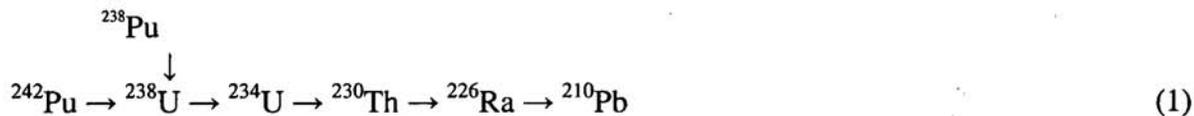
Three of the WIPP PA codes have radionuclide inventories as direct inputs: PANEL, NUTS, and CCDF_GF. The three codes are used in calculations of releases via individual release mechanisms that are modeled in WIPP PA. PANEL provides the radionuclide source for direct brine releases to the surface via a borehole (a potential short-term release mechanism), and it provides the radionuclide source for releases via a borehole to the Culebra (a potential long-term release mechanism) and to the Culebra. NUTS calculates radionuclide releases via Salado transport to the accessible boundary (a potential long-term release mechanism). CCDF_GF calculates direct solid releases to the surface due to drilling activities (a potential short-term and long-term release mechanism). The criteria for selecting important radionuclides for each of these codes (and release mechanisms) varies slightly.

The first criteria applied is a determination of importance based on the regulatory framework provided by the EPA in 40 CFR 191. Of the 138 radionuclides reported in LANL 2003, 47 are regulated by 40 CFR 191. The tables in Appendix A show the projected WIPP inventory of these isotopes in EPA units. An EPA unit is defined as the inventory of that isotope in curies divided by the EPA release limit for that isotope in curies as specified in 40 CFR 191, Appendix A, Table 1. The repository is considered to comply with the EPA regulations if there is less than a 0.1 probability that the cumulative release to the accessible environment is greater than 1 EPA unit, and less than a 0.001 probability that the cumulative release is greater than 10 EPA units.

Table 1 shows the radionuclide inventory in terms of EPA units at 0 years (2033), 100 years, 350 years, and 10,000 years. It is important to look at the contribution that is being made to the EPA units as a function of time because the contribution of radionuclides can change as they decay or build-up over time. Short-lived isotopes like ^{238}Pu decay quite rapidly, dropping to less than an EPA unit by about 1000 years, while other isotopes like ^{229}Th that initially have low EPA units grow to over an EPA unit in 10,000 years. Some isotopes at the bottom of the table have short half-lives and are not regulated by the EPA, but they also have significant curies and are the parents of regulated isotopes, so they were included in the calculations.

Of the 138 isotopes given in LANL 2003, only 24 have more than 0.001 EPA units of inventory at any time within the 10,000-year regulatory period. These are: ^{227}Ac , ^{241}Am , ^{243}Am , ^{14}C , ^{243}Cm , ^{137}Cs , ^{237}Np , ^{231}Pa , ^{210}Pb , ^{238}Pu , ^{239}Pu , ^{240}Pu , ^{242}Pu , ^{226}Ra , ^{90}Sr , ^{229}Th , ^{230}Th , ^{232}Th , ^{232}U , ^{233}U , ^{234}U , ^{235}U , ^{236}U , ^{238}U . Consequently, only these have a direct potential to affect calculated releases. In addition to those, however, there are several unregulated short-lived isotopes that (1) have significant inventory, and (2) decay to regulated isotopes. These are: ^{248}Cm , ^{245}Cm , ^{244}Pu , ^{147}Sm , ^{147}Pm , ^{228}Ra , ^{252}Cf , ^{244}Cm , ^{241}Pu and they are also included in Table 1.

All of the radionuclides in Table 1 except ^{14}C , ^{137}Cs , ^{147}Pm , ^{147}Sm , and ^{233}U belong to the following decay chains:



These decay chains were simplified by leaving out the many very short-lived and therefore unregulated intermediates. Leaving out short-lived intermediates that lie between regulated isotopes does not affect the rate of decay and ingrowth of the remaining long-lived isotopes.

Table 1: Thirty-three Isotopes Considered for Modeling in the CRA PA

| Radionuclide | Half-life ^b (years) | EPA Units ^a | | | | |
|--------------|-----------------------------------|------------------------|-----------|-----------|--------------|----------|
| | | 0 Years | 100 Years | 350 Years | 10,000 Years | Maxium |
| Pu-238 | 87.7 a | 5.04E+03 | 2.29E+03 | 3.18E+02 | 2.61E-23 | 5.04E+03 |
| Pu-239 | 2.41E+04 a | 2.68E+03 | 2.67E+03 | 2.65E+03 | 2.01E+03 | 2.68E+03 |
| Am-241 | 432.7 a | 1.84E+03 | 1.63E+03 | 1.09E+03 | 2.48E-04 | 1.84E+03 |
| Pu-240 | 6.56E+03 a | 4.36E+02 | 4.31E+02 | 4.20E+02 | 1.51E+02 | 4.36E+02 |
| Cs-137 | 30.17 a | 7.19E+01 | 7.13E+00 | 2.21E-02 | 0.00E+00 | 7.19E+01 |
| Sr-90 | 29.1 a | 5.71E+01 | 5.29E+00 | 1.38E-02 | 0.00E+00 | 5.71E+01 |
| U-233 | 1.592E+05 a | 5.12E+00 | 5.11E+00 | 5.11E+00 | 4.91E+00 | 5.12E+00 |
| Th-229 | 7.3E+03 a | 2.17E-02 | 6.92E-02 | 1.86E-01 | 3.04E+00 | 3.04E+00 |
| U-234 | 2.46E+05 a | 1.28E+00 | 2.27E+00 | 2.98E+00 | 3.03E+00 | 3.03E+00 |
| Th-230 | 7.54E+04 a | 7.07E-03 | 2.36E-02 | 8.50E-02 | 2.64E+00 | 2.64E+00 |
| U-238 | 4.47E+09 a | 6.21E-01 | 6.21E-01 | 6.21E-01 | 6.21E-01 | 6.21E-01 |
| Np-237 | 2.14E+06 a | 4.06E-02 | 9.75E-02 | 2.09E-01 | 4.27E-01 | 4.27E-01 |
| Th-232 | 1.4E+10 a | 2.75E-01 | 2.75E-01 | 2.75E-01 | 2.75E-01 | 2.75E-01 |
| Ra-226 | 1.60E+03 a | 2.53E-02 | 2.43E-02 | 2.23E-02 | 2.07E-01 | 2.07E-01 |
| Pb-210 | 22.3 a | 1.99E-02 | 2.43E-02 | 2.23E-02 | 2.07E-01 | 2.07E-01 |
| Pu-242 | 3.75E+05 a | 1.09E-01 | 1.09E-01 | 1.09E-01 | 1.07E-01 | 1.09E-01 |
| Am-243 | 7.37E+03 a | 8.75E-02 | 8.70E-02 | 8.59E-02 | 5.74E-02 | 8.75E-02 |
| U-236 | 2.342E+07 a | 6.66E-03 | 7.94E-03 | 1.11E-02 | 8.62E-02 | 8.62E-02 |
| U-235 | 7.04E+08 a | 9.18E-03 | 9.45E-03 | 1.01E-02 | 3.21E-02 | 3.21E-02 |
| C-14 | 5730 a | 1.31E-02 | 1.29E-02 | 1.25E-02 | 3.90E-03 | 1.31E-02 |
| U-232 | 70 a | 1.23E-02 | 4.71E-03 | 4.24E-04 | 0.00E+00 | 1.23E-02 |
| Ac-227 | 21.77 a | 3.85E-03 | 4.84E-03 | 4.92E-03 | 8.06E-03 | 8.06E-03 |
| Pa-231 | 3.28E+04 a | 4.88E-03 | 4.89E-03 | 4.91E-03 | 8.06E-03 | 8.06E-03 |
| Cm-243 | 29.1 a | 1.64E-03 | 1.44E-04 | 3.29E-07 | 0.00E+00 | 1.64E-03 |
| Cm-248 | 3.48E+05 a | 3.75E-04 | 3.75E-04 | 3.75E-04 | 3.68E-04 | 3.75E-04 |
| Cm-245 | 8.5E+03 a | 7.72E-05 | 7.88E-05 | 8.10E-05 | 3.97E-05 | 8.10E-05 |
| Pu-244 | 8.0E+07 a | 4.44E-06 | 4.44E-06 | 4.44E-06 | 4.47E-06 | 4.47E-06 |
| Sm-147 | 1.06E+11 a | 6.44E-11 | 6.44E-11 | 6.44E-11 | 6.44E-11 | 6.44E-11 |
| Pm-147 | 2.6234 a | --- | --- | --- | --- | --- |
| Ra-228 | 5.76 a | --- | --- | --- | --- | --- |
| Cf-252 | 2.638 a | --- | --- | --- | --- | --- |
| Cm-244 | 18.1 a | --- | --- | --- | --- | --- |
| Pu-241 | 14.4 a | --- | --- | --- | --- | --- |

(a) EPA Units Taken from Tables A-1 through A-7 in Appendix A

(b) Decay mode and half-life information taken from *Nuclides and Isotopes* (also called the "Chart of the Nuclides"), 14th Ed. (General Electric 1989).

3.1 IMPORTANT RADIONUCLIDES FOR PANEL

30 radioisotopes have traditionally been modeled in PANEL calculations. Those radioisotopes are: ^{241}Am , ^{243}Am , ^{243}Cm , ^{137}Cs , ^{237}Np , ^{231}Pa , ^{210}Pb , ^{238}Pu , ^{239}Pu , ^{240}Pu , ^{242}Pu , ^{226}Ra , ^{90}Sr , ^{229}Th , ^{230}Th , ^{232}Th , ^{233}U , ^{234}U , ^{235}U , ^{236}U , ^{238}U , ^{248}Cm , ^{245}Cm , ^{244}Pu , ^{147}Sm , ^{147}Pm , ^{228}Ra , ^{252}Cf , ^{244}Cm , and ^{241}Pu . The list of radioisotopes traditionally modeled in PANEL encompasses all radioisotopes that could affect regulated releases directly or indirectly. Since PANEL is a fairly fast-running code, there is no need to reduce the number of radionuclides modeled in the PANEL calculations for the CRA.

3.2 IMPORTANT RADIONUCLIDES FOR NUTS

The number of isotopes has to be reduced for NUTS since it is a computationally intensive code and each isotope that is included increases the calculation time. Table 1 indicates that ^{238}Pu , ^{239}Pu , ^{241}Am , ^{240}Pu , ^{137}Cs , ^{90}Sr , ^{233}U , ^{229}Th , ^{234}U and ^{230}Th have EPA units over unity at some time during the 10,000 year regulatory period.

^{137}Cs and ^{90}Sr are excluded from the NUTS calculation even though they have EPA units over unity at early times because they are short-lived radionuclides that will no longer be contributors to the EPA units by the time radioactive material is transported via the Salado transport pathway to the accessible boundary. Table 2 indicates that including ^{238}Pu , ^{239}Pu , ^{241}Am , ^{240}Pu , ^{233}U , ^{229}Th , ^{234}U and ^{230}Th accounts for 98.7% of the EPA units at the time of repository closure. In addition, ^{241}Pu was added to the list of radionuclides to be modeled with NUTS since it is a parent isotope for ^{241}Am with a significant inventory at the start of the calculation.

Table 2: Percent Contribution at 2033 to EPA Units for Isotopes Modeled in NUTS

| ID | Total Inventory [Curies] ^a | | | Source EPA Unit ^b | | | |
|--------|---------------------------------------|----------|----------|------------------------------|----------|----------|--------|
| | CH | RH | Total | CH | RH | Total | Cum % |
| Pu-238 | 1.25E+06 | 2.80E+03 | 1.25E+06 | 5.03E+03 | 1.13E+01 | 5.04E+03 | 49.76% |
| Pu-239 | 6.59E+05 | 5.37E+03 | 6.65E+05 | 2.65E+03 | 2.16E+01 | 2.68E+03 | 76.15% |
| Am-241 | 4.42E+05 | 1.58E+04 | 4.58E+05 | 1.78E+03 | 6.35E+01 | 1.84E+03 | 94.35% |
| Pu-240 | 1.07E+05 | 1.67E+03 | 1.08E+05 | 4.29E+02 | 6.74E+00 | 4.36E+02 | 98.65% |
| U-233 | 1.24E+03 | 3.41E+01 | 1.27E+03 | 4.98E+00 | 1.37E-01 | 5.12E+00 | 98.70% |
| Th-229 | 5.25E+00 | 1.39E-01 | 5.39E+00 | 2.12E-02 | 5.59E-04 | 2.17E-02 | 98.70% |
| U-234 | 2.97E+02 | 2.20E+01 | 3.19E+02 | 1.19E+00 | 8.86E-02 | 1.28E+00 | 98.71% |
| Th-230 | 1.69E-01 | 6.67E-03 | 1.76E-01 | 6.80E-03 | 2.68E-04 | 7.07E-03 | 98.71% |

(a) Decayed radionuclide data taken from Fox 2003.

(b) Source EPA Units taken from Table A-2.

3.3 IMPORTANT RADIONUCLIDES FOR CCDF_GF

The radionuclides that are important for modeling the direct solid release pathway are the radionuclides that should be included in CCDF_GF. The direct solid release pathway can be modeled effectively using 8 radionuclides listed in Table 1: ^{238}Pu , ^{239}Pu , ^{241}Am , ^{240}Pu , ^{137}Cs , ^{90}Sr ,

²³³U, and ²³⁴U. These eight radionuclides were chosen because they each have EPA units over unity throughout the 10,000 year regulatory period. As shown in Table 3, these 8 radionuclides account for 99.98% of the EPA units at the time of repository closure. ¹³⁷Cs and ⁹⁰Sr are included even though they have relatively short half-lives because a human intrusion event can occur as early as 100 years after repository closure.

Table 3: Percent Contribution at 2033 to EPA Units for Isotopes Modeled in CCDF_GF for Cuttings Release

| ID | Total Inventory [Curies] ^a | | | Source EPA Unit ^b | | | |
|--------|---------------------------------------|----------|----------|------------------------------|----------|----------|--------|
| | CH | RH | Total | CH | RH | Total | Cum % |
| Pu-238 | 1.25E+06 | 2.80E+03 | 1.25E+06 | 5.03E+03 | 1.13E+01 | 5.04E+03 | 49.76% |
| Pu-239 | 6.59E+05 | 5.37E+03 | 6.65E+05 | 2.65E+03 | 2.16E+01 | 2.68E+03 | 76.15% |
| Am-241 | 4.42E+05 | 1.58E+04 | 4.58E+05 | 1.78E+03 | 6.35E+01 | 1.84E+03 | 94.35% |
| Pu-240 | 1.07E+05 | 1.67E+03 | 1.08E+05 | 4.29E+02 | 6.74E+00 | 4.36E+02 | 98.65% |
| Cs-137 | 4.61E+03 | 1.74E+05 | 1.79E+05 | 1.85E+00 | 7.01E+01 | 7.19E+01 | 99.35% |
| Sr-90 | 2.68E+04 | 1.15E+05 | 1.42E+05 | 1.08E+01 | 4.63E+01 | 5.71E+01 | 99.92% |
| U-233 | 1.24E+03 | 3.41E+01 | 1.27E+03 | 4.98E+00 | 1.37E-01 | 5.12E+00 | 99.97% |
| U-234 | 2.97E+02 | 2.20E+01 | 3.19E+02 | 1.19E+00 | 8.86E-02 | 1.28E+00 | 99.98% |

(a) Decayed radionuclide data taken from Fox 2003.

(b) Source EPA Units taken from Table A-2.

4. RELEVANT PROCEDURES AND REFERENCES

4.1 PROCEDURES

AP-097, *Analysis Plan for Deriving Radionuclide Inventory Information for Performance Assessment Calculations: Compliance Recertification Application*. Sandia National Laboratories Nuclear Waste Management Program Analysis Plan, January 8, 2003.

NP 9-1, *Analyses*. Sandia National Laboratories Nuclear Waste Management Program Procedure, August 29, 2001.

4.2 REFERENCES

General Electric Company (Nuclear Energy Operations). 1989. *Nuclides and Isotopes*, Fourteenth Edition.

LANL. 2003. *Response to the Request for Radionuclide Activities in TRU Waste Streams from TWBID Revision 2.1 Version 3.12, Data Version D.4.0.8. Correspondence*. ERMS# 530918. Carlsbad, NM: Los Alamos National Laboratories.

Fox. 2003. *Calculation of Decayed Radionuclide Inventories for the Compliance Recertification Application, Revision 1*. ERMS# 530992. Sandia National Laboratories. Carlsbad, NM.

APPENDIX A

Table A-1 1: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2001)

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|--------------------------------|------------------------|---------------------------------------|----------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^e | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Ac-225 | α, γ | 10.0 d | 1.55E+00 | 3.68E-02 | --- | --- | --- |
| Ac-227 | α, β, γ | 21.77 a | 5.06E-01 | 4.00E-06 | 100 | 280 | 1.81E-03 |
| Ac-228 | α, β, γ | 6.15 h | 4.79E+00 | 1.43E-01 | --- | --- | --- |
| Ag-109m | <i>ITe</i> | 39.8 s | 1.26E-04 | 0.00E+00 | --- | --- | --- |
| Ag-110 | β, γ, ϵ | 24.6 s | 4.40E-11 | 1.92E-11 | --- | --- | --- |
| Ag-110m | β, γ, ITe | 249.8 d | 3.34E-09 | 1.46E-09 | --- | --- | --- |
| Am-241 | α, γ, SF | 432.7 a | 4.01E+05 | 1.36E+04 | 100 | 280 | 1.48E+03 |
| Am-242 | $\beta, \gamma, \epsilon e$ | 16.02 h | 4.70E-02 | 8.52E-04 | --- | --- | --- |
| Am-242m | α, ITe, γ, SF | 141.0 a | 4.78E-02 | 1.96E-01 | 100 | 280 | 8.69E-04 |
| Am-243 | α, γ, SF | 7.37E+03 a | 2.10E+01 | 7.15E-01 | 100 | 280 | 7.77E-02 |
| Am-245 | β, γ | 2.05 h | 1.31E-10 | 0.00E+00 | --- | --- | --- |
| At-217 | α, β, γ | 32 ms | 1.55E+00 | 3.69E-02 | --- | --- | --- |
| Ba-137m | <i>IT</i> | 2.552 m | 9.05E+03 | 3.36E+05 | --- | --- | --- |
| Bi-210 | α, β, γ | 5.01 d | 2.58E+00 | 2.11E-07 | --- | --- | --- |
| Bi-211 | α, β, γ | 2.14 m | 5.00E-01 | 3.95E-06 | --- | --- | --- |
| Bi-212 | α, β, γ | 1.009 h | 5.84E+00 | 2.70E+00 | --- | --- | --- |
| Bi-213 | α, β, γ | 45.6 m | 1.55E+00 | 3.68E-02 | --- | --- | --- |
| Bi-214 | α, β, γ | 19.9 m | 6.29E+00 | 1.36E-06 | --- | --- | --- |
| Bk-249 | $\alpha, \beta, \gamma, SF$ | 3.2E+02 d | 9.07E-06 | 0.00E+00 | --- | --- | --- |
| Bk-250 | β, γ | 3.217 h | 3.65E-12 | 0.00E+00 | --- | --- | --- |
| C-14 | β | 5730 a | 1.21E+00 | 2.05E+00 | 100 | 280 | 1.17E-02 |
| Cd-109 | γ, ϵ | 462.0 d | 1.28E-04 | 0.00E+00 | --- | --- | --- |
| Cd-113m | β, IT | 14.1 a | 0.00E+00 | 1.64E-01 | --- | --- | --- |
| Ce-141 | β | 32.501 d | 0.00E+00 | 3.77E-19 | --- | --- | --- |
| Ce-144 | β, γ | 284.6 d | 3.56E-04 | 1.82E+00 | --- | --- | --- |
| Cf-249 | α, γ, SF | 351 a | 7.63E-02 | 8.37E-04 | 100 | 280 | 2.75E-04 |
| Cf-250 | α, γ, SF | 13.1 a | 1.83E-01 | 1.50E-02 | --- | --- | --- |
| Cf-251 | α, γ | 9.0E+02 a | 3.64E-04 | 1.59E-04 | 100 | 280 | 1.87E-06 |
| Cf-252 | α, γ, SF | 2.638 a | 2.08E-01 | 1.77E-02 | --- | --- | --- |
| Cm-242 | α, γ, SF | 162.8 d | 3.94E-02 | 7.15E-04 | --- | --- | --- |
| Cm-243 | $\alpha, \gamma, SF, \epsilon$ | 29.1 a | 3.97E-01 | 4.90E-01 | 100 | 280 | 3.16E-03 |
| Cm-244 | α, γ, SF | 18.1 a | 8.28E+03 | 2.70E+02 | --- | --- | --- |
| Cm-245 | α, γ, SF | 8.5E+03 a | 8.41E-03 | 1.06E-02 | 100 | 280 | 6.80E-05 |
| Cm-246 | α, γ, SF | 4.76E+03 a | 1.55E+00 | 6.74E-01 | 100 | 280 | 7.94E-03 |
| Cm-247 | α, γ | 1.56 E+07 a | 2.77E-10 | 9.44E+00 | 100 | 280 | 3.37E-02 |
| Cm-248 | α, SF | 3.48E+05 a | 9.14E-02 | 1.83E-03 | 100 | 280 | 3.33E-04 |

**Table A-1: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2001) – continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|------------------------------------|------------------------|---------------------------------------|----------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Cm-250 | α, β^-, SF | 9700 a | 6.64E-11 | 0.00E+00 | --- | --- | --- |
| Co-60 | β^-, γ | 5.271 a | 9.85E-01 | 1.68E+03 | --- | --- | --- |
| Cs-134 | $\beta^-, \gamma, \epsilon$ | 2.065 a | 2.05E-02 | 3.36E+01 | --- | --- | --- |
| Cs-135 | β^- | 2.3E+06 a | 0.00E+00 | 6.90E-05 | 1000 | 2802 | 2.46E-08 |
| Cs-137 | β^-, γ | 30.17 a | 9.65E+03 | 3.65E+05 | 1000 | 2802 | 1.34E+02 |
| Eu-152 | $\beta^-, \gamma, \epsilon\beta^+$ | 13.48 a | 1.95E+00 | 6.95E+02 | --- | --- | --- |
| Eu-154 | $\beta^-, \gamma, \epsilon\gamma$ | 8.59 a | 1.65E+00 | 4.23E+02 | --- | --- | --- |
| Eu-155 | β^-, γ | 4.71 a | 6.73E-02 | 1.85E+01 | --- | --- | --- |
| Fe-55 | ϵ | 2.73 a | 0.00E+00 | 4.20E-02 | --- | --- | --- |
| Fr-221 | α, γ | 4.8 m | 1.55E+00 | 3.68E-02 | --- | --- | --- |
| Fr-223 | α, β^-, γ | 21.8 m | 6.91E-03 | 5.45E-08 | --- | --- | --- |
| Gd-152 | α | 1.1E+14 a | 4.40E-14 | 1.95E-11 | 100 | 280 | 6.98E-14 |
| H-3 | β^- | 12.3 a | 2.17E+02 | 1.15E+00 | --- | --- | --- |
| I-129 | β^-, γ | 1.57E+07 a | 5.12E-04 | 8.20E-02 | 100 | 280 | 2.95E-04 |
| Kr-85 | β^-, γ | 10.73 a | 4.62E-01 | 1.13E-01 | --- | --- | --- |
| Mn-54 | ϵ, γ | 312.2 d | 0.00E+00 | 1.82E+00 | --- | --- | --- |
| Na-22 | ϵ | 2.6019 a | 3.91E-07 | 2.95E-01 | --- | --- | --- |
| Nb-93m | ITe^- | 16.1 a | 0.00E+00 | 2.75E-04 | --- | --- | --- |
| Nb-95 | β^-, γ | 34.97 d | 0.00E+00 | 7.53E-14 | --- | --- | --- |
| Nb-95m | β^-, γ, IT | 3.61 d | 0.00E+00 | 2.52E-16 | --- | --- | --- |
| Nd144 | α | 2.1E+15 a | 0.00E+00 | 0.00E+00 | 100 | 280 | 0.00E+00 |
| Ni-59 | ϵ | 7.6E+04 a | 7.64E-02 | 2.30E+01 | 1000 | 2802 | 8.24E-03 |
| Ni-63 | β^- | 100 a | 3.72E+00 | 1.12E+03 | 1000 | 2802 | 4.01E-01 |
| Np-237 | α, γ | 2.14E+06 a | 4.80E+00 | 6.66E-01 | 100 | 280 | 1.95E-02 |
| Np-238 | β^-, γ | 2.117 d | 2.36E-04 | 4.28E-06 | --- | --- | --- |
| Np-239 | β^-, γ | 2.355 d | 2.08E+01 | 6.28E-02 | --- | --- | --- |
| Np-240m | β^-, γ, IT | 7.22 m | 1.31E-06 | 1.11E-03 | --- | --- | --- |
| Pa-231 | α, γ | 3.28E+04 a | 1.21E+00 | 1.79E-05 | 100 | 280 | 4.32E-03 |
| Pa-233 | β^-, γ | 27.0 d | 4.75E+00 | 2.31E-03 | --- | --- | --- |
| Pa-234 | β^-, γ | 6.69 h | 9.22E-03 | 2.82E-03 | --- | --- | --- |
| Pa-234m | β^-, γ, IT | 1.17 m | 7.09E+00 | 2.17E+00 | --- | --- | --- |
| Pb-209 | β^- | 3.25 h | 1.55E+00 | 3.68E-02 | --- | --- | --- |
| Pb-210 | α, β^-, γ | 22.3 a | 2.61E+00 | 2.13E-07 | 100 | 280 | 9.30E-03 |
| Pb-211 | β^-, γ | 36.1 m | 5.00E-01 | 3.95E-06 | --- | --- | --- |
| Pb-212 | β^-, γ | 10.64 h | 5.82E+00 | 2.69E+00 | --- | --- | --- |
| Pb-214 | β^-, γ | 27 m | 6.30E+00 | 1.36E-06 | --- | --- | --- |
| Pd-107 | β^- | 6.5E+06 a | 0.00E+00 | 2.88E-06 | 1000 | 2802 | 1.03E-09 |
| Pm-147 | β^-, γ | 2.6234 a | 1.82E+00 | 3.51E+02 | --- | --- | --- |

**Table A-1: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2001) – continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|-------------------------|------------------------|--|----------|---|-------|--------------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Po-210 | α, γ | 138.38 d | 2.60E+00 | 2.13E-07 | --- | --- | --- |
| Po-211 | α, γ | 0.516 s | 1.53E-03 | 1.20E-08 | --- | --- | --- |
| Po-212 | α | 0.298 μs | 3.72E+00 | 1.72E+00 | --- | --- | --- |
| Po-213 | α | 4 μs | 1.52E+00 | 3.60E-02 | --- | --- | --- |
| Po-214 | α, γ | 163.7 μs | 6.30E+00 | 1.36E-06 | --- | --- | --- |
| Po-215 | α, β, γ | 1.780 ms | 5.00E-01 | 3.95E-06 | --- | --- | --- |
| Po-216 | α, γ | 0.145 s | 5.82E+00 | 2.69E+00 | --- | --- | --- |
| Po-218 | α, β, γ | 3.10 m | 6.19E+00 | 1.34E-06 | --- | --- | --- |
| Pr-144 | β, γ | 17.28 m | 3.49E-04 | 1.78E+00 | --- | --- | --- |
| Pu-236 | α, γ, SF | 2.87 a | 4.38E-04 | 0.00E+00 | --- | --- | --- |
| Pu-238 | α, γ, SF | 87.7 a | 1.61E+06 | 3.61E+03 | 100 | 280 | 5.76E+03 |
| Pu-239 | α, γ, SF | 2.41E+04 a | 6.60E+05 | 5.38E+03 | 100 | 280 | 2.37E+03 |
| Pu-240 | α, γ, SF | 6.56E+03 a | 1.07E+05 | 1.68E+03 | 100 | 280 | 3.87E+02 |
| Pu-241 | α, β, γ | 14.4 a | 2.40E+06 | 1.12E+05 | --- | --- | --- |
| Pu-242 | α, γ, SF | 3.75E+05 a | 2.66E+01 | 4.74E-01 | 100 | 280 | 9.68E-02 |
| Pu-243 | β, γ | 4.956 h | 2.74E-10 | 9.33E+00 | --- | --- | --- |
| Pu-244 | α, SF | 8.0E+07 a | 1.29E-06 | 1.10E-03 | 100 | 280 | 3.94E-06 |
| Ra-223 | α, γ | 11.435 d | 5.06E-01 | 3.99E-06 | --- | --- | --- |
| Ra-224 | α, γ | 3.66 d | 5.81E+00 | 2.69E+00 | --- | --- | --- |
| Ra-225 | β, γ | 14.9 d | 1.55E+00 | 3.69E-02 | --- | --- | --- |
| Ra-226 | α, γ | 1.60E+03 a | 6.37E+00 | 1.38E-06 | 100 | 280 | 2.27E-02 |
| Ra-228 | β, γ | 5.76 a | 5.66E+00 | 1.69E-01 | --- | --- | --- |
| Rh-106 | β, γ | 29.9 s | 1.58E-04 | 6.79E-02 | --- | --- | --- |
| Rn-219 | α, γ | 3.96 s | 5.00E-01 | 3.95E-06 | --- | --- | --- |
| Rn-220 | α, γ | 55.6 s | 5.82E+00 | 2.69E+00 | --- | --- | --- |
| Rn-222 | α, γ | 3.8235 d | 6.31E+00 | 1.36E-06 | --- | --- | --- |
| Ru-106 | β | 1.02 a | 1.59E-04 | 6.79E-02 | --- | --- | --- |
| Sb-125 | β, γ | 2.758 a | 5.04E-03 | 4.38E+00 | --- | --- | --- |
| Sb-126 | β, γ | 12.4 d | 0.00E+00 | 4.17E-05 | --- | --- | --- |
| Sb-126m | γ, ITe | 11.0 s | 0.00E+00 | 2.98E-04 | --- | --- | --- |
| Se-79 | β | 6.5E+04 a | 1.32E-04 | 4.46E-02 | 1000 | 2802 | 1.59E-05 |
| Sm-147 | α | 1.06E+11 a | 4.77E-10 | 6.86E-09 | 100 | 280 | 2.62E-11 |
| Sm-148 | α | 7.0E+15 a | 0.00E+00 | 0.00E+00 | 100 | 280 | 0.00E+00 |
| Sm-151 | β, γ | 90 a | 5.68E+01 | 5.80E+02 | 1000 | 2802 | 2.27E-01 |
| Sn-121m | β, γ, ITe | 55 a | 0.00E+00 | 5.15E-04 | 1000 | 2802 | 1.84E-07 |
| Sn-126 | β, γ | 1.0E+05 a | 0.00E+00 | 2.98E-04 | 1000 | 2802 | 1.06E-07 |
| Sr-90 | β | 29.1 a | 5.75E+04 | 2.46E+05 | 1000 | 2802 | 1.08E+02 |
| Tc-99 | β, γ | 2.13E+05 a | 1.67E+02 | 1.59E+02 | 10000 | 28018 | 1.17E-02 |

**Table A-1: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2001) – continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------------|-------------------------|------------------------|---------------------------------------|-----------------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Te-123 | ε | 1.0E+13 a | 6.78E-05 | 0.00E+00 | --- | --- | --- |
| Te-123m | IT | 119.7 d | 4.98E-19 | 0.00E+00 | --- | --- | --- |
| Te-125m | γ, ITe | 58 d | 1.22E-03 | 1.06E+00 | --- | --- | --- |
| Th-227 | α, γ | 18.72 d | 4.93E-01 | 3.89E-06 | --- | --- | --- |
| Th-228 | α, γ | 1.913 a | 5.89E+00 | 2.72E+00 | --- | --- | --- |
| Th-229 | α, γ | 7.3E+03 a | 1.55E+00 | 3.69E-02 | 100 | 280 | 5.68E-03 |
| Th-230 | α, γ | 7.54e+04 a | 1.01E-01 | 3.76E-04 | 10 | 28 | 3.63E-03 |
| Th-231 | β ⁻ , γ | 1.063 d | 3.50E-01 | 5.23E-02 | --- | --- | --- |
| Th-232 | α, γ | 1.4E+10 a | 6.61E+00 | 2.18E-01 | 10 | 28 | 2.44E-01 |
| Th-234 | β ⁻ , γ | 24.10 d | 7.10E+00 | 2.17E+00 | --- | --- | --- |
| Tl-207 | β ⁻ , γ | 4.77 m | 4.98E-01 | 3.93E-06 | --- | --- | --- |
| Tl-208 | β ⁻ , γ | 3.053 m | 2.09E+00 | 9.71E-01 | --- | --- | --- |
| Tl-209 | β ⁻ , γ | 2.2 m | 3.41E-02 | 8.10E-04 | --- | --- | --- |
| U-232 | α, γ, SF | 70 a | 1.64E+00 | 2.53E+00 | 100 | 280 | 1.49E-02 |
| U-233 | α, γ, SF | 1.592E+05 a | 1.24E+03 | 3.41E+01 | 100 | 280 | 4.53E+00 |
| U-234 | α, γ, SF | 2.46E+05 a | 1.68E+02 | 2.17E+01 | 100 | 280 | 6.76E-01 |
| U-235 | α, γ, SF | 7.04E+08 a | 1.32E+00 | 9.42E-01 | 100 | 280 | 8.07E-03 |
| U-236 | α, γ, SF | 2.342E+07 a | 1.30E-01 | 1.42E+00 | 100 | 280 | 5.54E-03 |
| U-237 | β ⁻ , γ | 6.75 d | 2.15E+01 | 1.75E-02 | --- | --- | --- |
| U-238 | α, γ, SF | 4.47E+09 a | 2.44E+01 | 1.30E+02 | 100 | 280 | 5.50E-01 |
| U-240 | β ⁻ , γ | 14.1 h | 1.28E-06 | 1.09E-03 | --- | --- | --- |
| Y-90 | β ⁻ , γ | 2.67 d | 5.74E+04 | 2.43E+05 | --- | --- | --- |
| Y-91 | IT, β ⁻ | 49.71 m | 0.00E+00 | 8.11E-13 | --- | --- | --- |
| Zn-65 | β ⁺ , γ, ε | 243.8 d | 2.32E-10 | 0.00E+00 | --- | --- | --- |
| Zr-93 | β ⁻ , γ | 1.5E+06 a | 1.13E-03 | 3.39E-01 | 1000 | 2802 | 1.21E-04 |
| Zr-95 | β ⁻ , γ | 64.02 d | 0.00E+00 | 3.43E-14 | --- | --- | --- |
| Total: | --- | --- | 5.32E+06 | 1.33E+06 | --- | --- | 1.02E+04 |

(a) Radionuclide inventory information taken from LANL 2003. The inventory information given in LANL 2003 has been decayed through 2001. The total curies are "WIPP-Scale" estimated by assuming a volume of 5,950,000 cubic feet for CH-TRU waste and 250,000 cubic feet for RH-TRU waste.

(b) Release limits are determined in accordance with 40CFR191 (Appendix A, Table 1). Left column corresponds to specific release limits (cumulative releases to the accessible environment for 10,000 years after disposal per "Unit of Waste" identified in Note 1(e) of Table 1, Appendix A, 40CFR191). Right column corresponds to release limit obtained for 2.80 Units of Waste. The 2.80 value for the Unit of Waste corresponds to the Units of Waste present at the end of 2001, the date that is consistent with LANL 2003.

(c) Decay mode and half-life information taken from *Nuclides and Isotopes* (also called the "Chart of the Nuclides"), 14th Ed. (General Electric 1989).

**Table A-2: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2033)**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|--------------------------------------|------------------------|---------------------------------------|-----------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Ac-225 | α, γ | 10.0 d | 5.245E+00 | 1.387E-01 | --- | --- | --- |
| Ac-227 | α, β ⁻ , γ | 21.77 a | 9.567E-01 | 2.503E-04 | 100 | 248 | 3.85E-03 |
| Ac-228 | α, β ⁻ , γ | 6.15 h | 6.462E+00 | 2.126E-01 | --- | --- | --- |
| Ag-109m | ITe ⁻ | 39.8 s | 3.296E-12 | 0.000E+00 | --- | --- | --- |
| Ag-110 | β ⁻ , γ, ε | 24.6 s | 3.658E-25 | 1.596E-25 | --- | --- | --- |
| Ag-110m | β ⁻ , γ, ITe | 249.8 d | 2.778E-23 | 1.212E-23 | --- | --- | --- |
| Am-241 | α, γ, SF | 432.7 a | 4.424E+05 | 1.578E+04 | 100 | 248 | 1.84E+03 |
| Am-242 | β ⁻ , γ, ε e ⁻ | 16.02 h | 4.058E-02 | 1.664E-01 | --- | --- | --- |
| Am-242m | α, ITe ⁻ , γ, SF | 141.0 a | 4.128E-02 | 1.693E-01 | 100 | 248 | 8.48E-04 |
| Am-243 | α, γ, SF | 7.37E+03 a | 2.099E+01 | 7.415E-01 | 100 | 248 | 8.75E-02 |
| Am-245 | β ⁻ , γ | .05 h | 1.329E-21 | 0.000E+00 | --- | --- | --- |
| At-217 | α, β ⁻ , γ | 32 ms | 5.249E+00 | 1.388E-01 | --- | --- | --- |
| Ba-137m | IT | 2.552 m | 4.309E+03 | 1.628E+05 | --- | --- | --- |
| Bi-210 | α, β ⁻ , γ | 5.01 d | 4.886E+00 | 1.407E-05 | --- | --- | --- |
| Bi-211 | α, β ⁻ , γ | 2.14 m | 9.447E-01 | 2.471E-04 | --- | --- | --- |
| Bi-212 | α, β ⁻ , γ | 1.009 h | 7.725E+00 | 2.111E+00 | --- | --- | --- |
| Bi-213 | α, β ⁻ , γ | 45.6 m | 5.238E+00 | 1.385E-01 | --- | --- | --- |
| Bi-214 | α, β ⁻ , γ | 19.9 m | 6.205E+00 | 4.926E-05 | --- | --- | --- |
| Bk-249 | α, β ⁻ , γ, SF | 3.2E+02 d | 9.191E-17 | 0.000E+00 | --- | --- | --- |
| Bk-250 | β ⁻ , γ | 3.217 h | 3.643E-12 | 0.000E+00 | --- | --- | --- |
| C-14 | β ⁻ | 5730 a | 1.206E+00 | 2.046E+00 | 100 | 248 | 1.31E-02 |
| Cd-109 | γ, ε | 462.0 d | 3.338E-12 | 0.000E+00 | --- | --- | --- |
| Cd-113m | β ⁻ , IT | 14.1 a | 0.000E+00 | 3.581E-02 | --- | --- | --- |
| Ce-141 | β ⁻ | 32.501 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ce-144 | β ⁻ , γ | 284.6 d | 1.493E-16 | 7.609E-13 | --- | --- | --- |
| Cf-249 | α, γ, SF | 351 a | 7.166E-02 | 7.858E-04 | 100 | 248 | 2.92E-04 |
| Cf-250 | α, γ, SF | 13.1 a | 3.367E-02 | 2.744E-03 | --- | --- | --- |
| Cf-251 | α, γ | 9.0E+02 a | 3.550E-04 | 1.551E-04 | 100 | 248 | 2.05E-06 |
| Cf-252 | α, γ, SF | 2.638 a | 4.636E-05 | 3.947E-06 | --- | --- | --- |
| Cm-242 | α, γ, SF | 162.8 d | 3.400E-02 | 1.395E-01 | --- | --- | --- |
| Cm-243 | α, γ, SF, ε | 29.1 a | 1.822E-01 | 2.249E-01 | 100 | 248 | 1.64E-03 |
| Cm-244 | α, γ, SF | 18.1 a | 2.434E+03 | 7.943E+01 | --- | --- | --- |
| Cm-245 | α, γ, SF | 8.5E+03 a | 8.587E-03 | 1.060E-02 | 100 | 248 | 7.72E-05 |
| Cm-246 | α, γ, SF | 4.76E+03 a | 1.545E+00 | 6.711E-01 | 100 | 248 | 8.92E-03 |
| Cm-247 | α, γ | 1.56 E+07 a | 7.895E-10 | 9.446E+00 | 100 | 248 | 3.80E-02 |
| Cm-248 | α, SF | 3.48E+05 a | 9.138E-02 | 1.826E-03 | 100 | 248 | 3.75E-04 |
| Cm-250 | α, β ⁻ , SF | 9700 a | 6.634E-11 | 0.000E+00 | --- | --- | --- |

**Table A-2: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2033) – continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|-------------------------|------------------------|---------------------------------------|-----------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Co-60 | β, γ | 5.271 a | 1.464E-02 | 2.499E+01 | --- | --- | --- |
| Cs-134 | β, γ, ε | 2.065 a | 4.365E-07 | 7.154E-04 | --- | --- | --- |
| Cs-135 | β | 2.3E+06 a | 0.000E+00 | 6.899E-05 | 1000 | 2484 | 2.78E-08 |
| Cs-137 | β, γ | 30.17 a | 4.607E+03 | 1.741E+05 | 1000 | 2484 | 7.19E+01 |
| Eu-152 | β, γ, εβ ⁺ | 13.48 a | 3.809E-01 | 1.361E+02 | --- | --- | --- |
| Eu-154 | β, γ, εγ | 8.59 a | 1.254E-01 | 3.212E+01 | --- | --- | --- |
| Eu-155 | β, γ | 4.71 a | 7.680E-04 | 2.107E-01 | --- | --- | --- |
| Fe-55 | ε | 2.73 a | 0.000E+00 | 8.281E-06 | --- | --- | --- |
| Fr-221 | α, γ | 4.8 m | 5.241E+00 | 1.386E-01 | --- | --- | --- |
| Fr-223 | α, β, γ | 21.8 m | 1.305E-02 | 3.415E-06 | --- | --- | --- |
| Gd-152 | α | 1.1E+14 a | 9.745E-14 | 3.861E-11 | 100 | 248 | 1.56E-13 |
| H-3 | β | 12.3 a | 3.607E+01 | 1.903E-01 | --- | --- | --- |
| I-129 | β, γ | 1.57E+07 a | 5.118E-04 | 8.205E-02 | 100 | 248 | 3.32E-04 |
| Kr-85 | β, γ | 10.73 a | 5.840E-02 | 1.426E-02 | --- | --- | --- |
| Mn-54 | ε, γ | 312.2 d | 0.000E+00 | 1.005E-11 | --- | --- | --- |
| Na-22 | ε | 2.6019 a | 7.767E-11 | 5.861E-05 | --- | --- | --- |
| Nb-93m | <i>ITe</i> | 16.1 a | 8.617E-04 | 2.595E-01 | --- | --- | --- |
| Nb-95 | β, γ | 34.97 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Nb-95m | β, γ, <i>IT</i> | 3.61 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Nd144 | α | 2.1E+15 a | 0.000E+00 | 0.000E+00 | 100 | 248 | 0.00E+00 |
| Ni-59 | ε | 7.6E+04 a | 7.642E-02 | 2.300E+01 | 1000 | 2484 | 9.29E-03 |
| Ni-63 | β | 100 a | 2.923E+00 | 8.803E+02 | 1000 | 2484 | 3.56E-01 |
| Np-237 | α, γ | 2.14E+06 a | 9.255E+00 | 8.221E-01 | 100 | 248 | 4.06E-02 |
| Np-238 | β, γ | 2.117 d | 2.039E-04 | 8.361E-04 | --- | --- | --- |
| Np-239 | β, γ | 2.355 d | 2.071E+01 | 7.320E-01 | --- | --- | --- |
| Np-240m | β, γ, <i>IT</i> | 7.22 m | 1.328E-06 | 1.112E-03 | --- | --- | --- |
| Pa-231 | α, γ | 3.28E+04 a | 1.211E+00 | 6.549E-04 | 100 | 248 | 4.88E-03 |
| Pa-233 | β, γ | 27.0 d | 9.169E+00 | 8.147E-01 | --- | --- | --- |
| Pa-234 | β, γ | 6.69 h | 3.142E-02 | 1.669E-01 | --- | --- | --- |
| Pa-234m | β, γ, <i>IT</i> | 1.17 m | 2.416E+01 | 1.283E+02 | --- | --- | --- |
| Pb-209 | β | 3.25 h | 5.244E+00 | 1.387E-01 | --- | --- | --- |
| Pb-210 | α, β, γ | 22.3 a | 4.943E+00 | 1.424E-05 | 100 | 248 | 1.99E-02 |
| Pb-211 | β, γ | 36.1 m | 9.460E-01 | 2.475E-04 | --- | --- | --- |
| Pb-212 | β, γ | 10.64 h | 7.701E+00 | 2.103E+00 | --- | --- | --- |
| Pb-214 | β, γ | 27 m | 6.216E+00 | 4.933E-05 | --- | --- | --- |
| Pd-107 | β | 6.5E+06 a | 0.000E+00 | 2.881E-06 | 1000 | 2484 | 1.16E-09 |
| Pm-147 | β, γ | 2.6234 a | 3.865E-04 | 7.474E-02 | --- | --- | --- |

**Table A-2: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2033) – continued**

| Nuclide | | | WIPP TRU Waste | | | | Source EPA Unit |
|---------|--------------------------------------|------------------------|--|-----------|---|-------|-----------------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Po-210 | α, γ | 138.38 d | 4.940E+00 | 1.423E-05 | --- | --- | --- |
| Po-211 | α, γ | 0.516 s | 2.884E-03 | 7.543E-07 | --- | --- | --- |
| Po-212 | α | 0.298 μs | 4.921E+00 | 1.344E+00 | --- | --- | --- |
| Po-213 | α | 4 μs | 5.129E+00 | 1.357E-01 | --- | --- | --- |
| Po-214 | α, γ | 163.7 μs | 6.211E+00 | 4.934E-05 | --- | --- | --- |
| Po-215 | α, β ⁻ , γ | 1.780 ms | 9.461E-01 | 2.475E-04 | --- | --- | --- |
| Po-216 | α, γ | 0.145 s | 7.694E+00 | 2.102E+00 | --- | --- | --- |
| Po-218 | α, β ⁻ , γ | 3.10 m | 6.108E+00 | 4.848E-05 | --- | --- | --- |
| Pr-144 | β ⁻ , γ | 17.28 m | 1.463E-16 | 7.453E-13 | --- | --- | --- |
| Pu-236 | α, γ, SF | 2.87 a | 1.830E-07 | 0.000E+00 | --- | --- | --- |
| Pu-238 | α, γ, SF | 87.7 a | 1.250E+06 | 2.804E+03 | 100 | 248 | 5.04E+03 |
| Pu-239 | α, γ, SF | 2.41E+04 a | 6.592E+05 | 5.370E+03 | 100 | 248 | 2.68E+03 |
| Pu-240 | α, γ, SF | 6.56E+03 a | 1.065E+05 | 1.673E+03 | 100 | 248 | 4.36E+02 |
| Pu-241 | α, β ⁻ , γ | 14.4 a | 5.145E+05 | 2.391E+04 | --- | --- | --- |
| Pu-242 | α, γ, SF | 3.75E+05 a | 2.664E+01 | 4.736E-01 | 100 | 248 | 1.09E-01 |
| Pu-243 | β ⁻ , γ | 4.956 h | 7.803E-10 | 9.331E+00 | --- | --- | --- |
| Pu-244 | α, SF | 8.0E+07 a | 1.316E-06 | 1.102E-03 | 100 | 248 | 4.44E-06 |
| Ra-223 | α, γ | 11.435 d | 9.562E-01 | 2.501E-04 | --- | --- | --- |
| Ra-224 | α, γ | 3.66 d | 7.684E+00 | 2.099E+00 | --- | --- | --- |
| Ra-225 | β ⁻ , γ | 14.9 d | 5.249E+00 | 1.388E-01 | --- | --- | --- |
| Ra-226 | α, γ | 1.60E+03 a | 6.284E+00 | 4.989E-05 | 100 | 248 | 2.53E-02 |
| Ra-228 | β ⁻ , γ | 5.76 a | 7.629E+00 | 2.510E-01 | --- | --- | --- |
| Rh-106 | β ⁻ , γ | 29.9 s | 4.382E-14 | 1.867E-11 | --- | --- | --- |
| Rn-219 | α, γ | 3.96 s | 9.450E-01 | 2.471E-04 | --- | --- | --- |
| Rn-220 | α, γ | 55.6 s | 7.695E+00 | 2.102E+00 | --- | --- | --- |
| Rn-222 | α, γ | 3.8235 d | 6.220E+00 | 4.939E-05 | --- | --- | --- |
| Ru-106 | β ⁻ | 1.02 a | 4.424E-14 | 1.886E-11 | --- | --- | --- |
| Sb-125 | β ⁻ , γ | 2.758 a | 1.678E-06 | 1.457E-03 | --- | --- | --- |
| Sb-126 | β ⁻ , γ | 12.4 d | 0.000E+00 | 4.168E-05 | --- | --- | --- |
| Sb-126m | γ, ITe ⁻ | 11.0 s | 0.000E+00 | 2.976E-04 | --- | --- | --- |
| Se-79 | β ⁻ | 6.5E+04 a | 1.321E-04 | 4.454E-02 | 1000 | 2484 | 1.80E-05 |
| Sm-147 | α | 1.06E+11 a | 5.219E-10 | 1.546E-08 | 100 | 248 | 6.44E-11 |
| Sm-148 | α | 7.0E+15 a | 0.000E+00 | 0.000E+00 | 100 | 248 | 0.00E+00 |
| Sm-151 | β ⁻ , γ | 90 a | 4.437E+01 | 4.538E+02 | 1000 | 2484 | 2.01E-01 |
| Sn-121m | β ⁻ , γ, ITe ⁻ | 55 a | 0.000E+00 | 3.306E-04 | 1000 | 2484 | 1.33E-07 |
| Sn-126 | β ⁻ , γ | 1.0E+05 a | 0.000E+00 | 2.979E-04 | 1000 | 2484 | 1.20E-07 |
| Sr-90 | β ⁻ | 29.1 a | 2.684E+04 | 1.151E+05 | 1000 | 2484 | 5.71E+01 |
| Tc-99 | β ⁻ , γ | 2.13E+05 a | 1.673E+02 | 1.593E+02 | 10000 | 24839 | 1.31E-02 |

**Table A-2: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2033) – continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------------|-------------------------|------------------------|---------------------------------------|-----------------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Te-123 | ε | 1.0E+13 a | 6.780E-05 | 0.000E+00 | --- | --- | --- |
| Te-123m | IT | 119.7 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Te-125m | γ, IT ^e | 58 d | 4.061E-07 | 3.526E-04 | --- | --- | --- |
| Th-227 | α, γ | 18.72 d | 9.314E-01 | 2.436E-04 | --- | --- | --- |
| Th-228 | α, γ | 1.913 a | 7.785E+00 | 2.127E+00 | --- | --- | --- |
| Th-229 | α, γ | 7.3E+03 a | 5.255E+00 | 1.390E-01 | 100 | 248 | 2.17E-02 |
| Th-230 | α, γ | 7.54e+04 a | 1.689E-01 | 6.667E-03 | 10 | 25 | 7.07E-03 |
| Th-231 | β, γ | 1.063 d | 1.323E+00 | 9.305E-01 | --- | --- | --- |
| Th-232 | α, γ | 1.4E+10 a | 6.610E+00 | 2.181E-01 | 10 | 25 | 2.75E-01 |
| Th-234 | β, γ | 24.10 d | 2.420E+01 | 1.285E+02 | --- | --- | --- |
| Ti-207 | β, γ | 4.77 m | 9.407E-01 | 2.461E-04 | --- | --- | --- |
| Ti-208 | β, γ | 3.053 m | 2.771E+00 | 7.570E-01 | --- | --- | --- |
| Ti-209 | β, γ | 2.2 m | 1.153E-01 | 3.049E-03 | --- | --- | --- |
| U-232 | α, γ, SF | 70 a | 1.208E+00 | 1.857E+00 | 100 | 248 | 1.23E-02 |
| U-233 | α, γ, SF | 1.592E+05 a | 1.237E+03 | 3.409E+01 | 100 | 248 | 5.12E+00 |
| U-234 | α, γ, SF | 2.46E+05 a | 2.967E+02 | 2.201E+01 | 100 | 248 | 1.28E+00 |
| U-235 | α, γ, SF | 7.04E+08 a | 1.339E+00 | 9.421E-01 | 100 | 248 | 9.18E-03 |
| U-236 | α, γ, SF | 2.342E+07 a | 2.307E-01 | 1.423E+00 | 100 | 248 | 6.66E-03 |
| U-237 | β, γ | 6.75 d | 1.264E+01 | 5.872E-01 | --- | --- | --- |
| U-238 | α, γ, SF | 4.47E+09 a | 2.443E+01 | 1.297E+02 | 100 | 248 | 6.21E-01 |
| U-240 | IT, γ | 14.1 h | 1.302E-06 | 1.091E-03 | --- | --- | --- |
| Y-90 | β, γ | 2.67 d | 2.653E+04 | 1.138E+05 | --- | --- | --- |
| Y-91 | IT, β ⁻ | 49.71 m | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Zn-65 | β ⁺ , γ, ε | 243.8 d | 8.668E-25 | 0.000E+00 | --- | --- | --- |
| Zr-93 | β, γ | 1.5E+06 a | 1.125E-03 | 3.389E-01 | 1000 | 2484 | 1.37E-04 |
| Zr-95 | β, γ | 64.02 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Total: | --- | --- | 3.04E+06 | 6.18E+05 | --- | --- | 1.01E+04 |
| WUF | --- | --- | 3.66E+06 | | 2.48 | --- | --- |

(a) Decayed radionuclide inventory information taken from *Calculation of Decayed Radionuclide Inventories for the Compliance Recertification Application, Revision 1* (Fox 2003). Radionuclide decay was performed using ORIGEN2 Version 2.2.

(b) Release limits are determined in accordance with 40CFR191 (Appendix A, Table 1). Left column corresponds to specific release limits (cumulative releases to the accessible environment for 10,000 years after disposal per "Unit of Waste" identified in Note 1(e) of Table 1, Appendix A, 40CFR191). Right column corresponds to release limit obtained for 2.48 Units of Waste. The 2.48 value for the Unit of Waste corresponds to the Units of Waste present at repository closure, 2033.

(c) Decay mode and half-life information taken from *Nuclides and Isotopes* (also called the "Chart of the Nuclides"), 14th Ed. (General Electric 1989).

**Table A-3: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2133)**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|-----------------------------|------------------------|---------------------------------------|----------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Ac-225 | α, γ | 10.0 d | 1.67E+01 | 4.55E-01 | --- | --- | --- |
| Ac-227 | α, β, γ | 21.77 a | 1.20E+00 | 2.03E-03 | 100 | 248 | 4.84E-03 |
| Ac-228 | α, β, γ | 6.15 h | 6.53E+00 | 2.15E-01 | --- | --- | --- |
| Ag-109m | ITe ⁻ | 39.8 s | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Ag-110 | β, γ, ε | 24.6 s | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Ag-110m | β, γ, ITe | 249.8 d | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Am-241 | α, γ, SF | 432.7 a | 3.92E+05 | 1.41E+04 | 100 | 248 | 1.63E+03 |
| Am-242 | β, γ, ε, e ⁻ | 16.02 h | 2.57E-02 | 1.05E-01 | --- | --- | --- |
| Am-242m | α, ITe ⁻ , γ, SF | 141.0 a | 2.62E-02 | 1.07E-01 | 100 | 248 | 5.37E-04 |
| Am-243 | α, γ, SF | 7.37E+03 a | 2.08E+01 | 8.23E-01 | 100 | 248 | 8.70E-02 |
| Am-245 | β, γ | .05 h | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| At-217 | α, β, γ | 32 ms | 1.67E+01 | 4.55E-01 | --- | --- | --- |
| Ba-137m | IT | 2.552 m | 4.27E+02 | 1.62E+04 | --- | --- | --- |
| Bi-210 | α, β, γ | 5.01 d | 5.97E+00 | 4.75E-04 | --- | --- | --- |
| Bi-211 | α, β, γ | 2.14 m | 1.19E+00 | 2.00E-03 | --- | --- | --- |
| Bi-212 | α, β, γ | 1.009 h | 7.03E+00 | 9.41E-01 | --- | --- | --- |
| Bi-213 | α, β, γ | 45.6 m | 1.67E+01 | 4.54E-01 | --- | --- | --- |
| Bi-214 | α, β, γ | 19.9 m | 5.96E+00 | 7.48E-04 | --- | --- | --- |
| Bk-249 | α, β, γ, SF | 3.2E+02 d | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Bk-250 | β, γ | 3.217 h | 3.63E-12 | 0.00E+00 | --- | --- | --- |
| C-14 | β ⁻ | 5730 a | 1.19E+00 | 2.02E+00 | 100 | 248 | 1.29E-02 |
| Cd-109 | γ, ε | 462.0 d | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Cd-113m | β, IT | 14.1 a | 0.00E+00 | 3.10E-04 | --- | --- | --- |
| Ce-141 | β ⁻ | 32.501 d | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Ce-144 | β, γ | 284.6 d | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Cf-249 | α, γ, SF | 351 a | 5.88E-02 | 6.45E-04 | 100 | 248 | 2.39E-04 |
| Cf-250 | α, γ, SF | 13.1 a | 1.68E-04 | 1.37E-05 | --- | --- | --- |
| Cf-251 | α, γ | 9.0E+02 a | 3.29E-04 | 1.44E-04 | 100 | 248 | 1.90E-06 |
| Cf-252 | α, γ, SF | 2.638 a | 1.80E-16 | 1.53E-17 | --- | --- | --- |
| Cm-242 | α, γ, SF | 162.8 d | 2.16E-02 | 8.84E-02 | --- | --- | --- |
| Cm-243 | α, γ, SF, ε | 29.1 a | 1.60E-02 | 1.98E-02 | 100 | 296 | 1.21E-04 |
| Cm-244 | α, γ, SF | 18.1 a | 5.30E+01 | 1.73E+00 | --- | --- | --- |
| Cm-245 | α, γ, SF | 8.5E+03 a | 9.05E-03 | 1.05E-02 | 100 | 248 | 7.88E-05 |
| Cm-246 | α, γ, SF | 4.76E+03 a | 1.52E+00 | 6.61E-01 | 100 | 248 | 8.79E-03 |
| Cm-247 | α, γ | 1.56 E+07 a | 2.31E-09 | 9.45E+00 | 100 | 248 | 3.80E-02 |
| Cm-248 | α, SF | 3.48E+05 a | 9.14E-02 | 1.83E-03 | 100 | 248 | 3.75E-04 |

**Table A-3: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2133) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|------------------------------------|------------------------|---------------------------------------|----------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Cm-250 | α, β^-, SF | 9700 a | 6.61E-11 | 0.00E+00 | --- | --- | --- |
| Co-60 | β^-, γ | 5.271 a | 2.84E-08 | 4.84E-05 | --- | --- | --- |
| Cs-134 | $\beta^-, \gamma, \epsilon$ | 2.065 a | 1.10E-21 | 1.80E-18 | --- | --- | --- |
| Cs-135 | β^- | 2.3E+06 a | 0.00E+00 | 6.90E-05 | 1000 | 2484 | 2.78E-08 |
| Cs-137 | β^-, γ | 30.17 a | 4.57E+02 | 1.73E+04 | 1000 | 2484 | 7.13E+00 |
| Eu-152 | $\beta^-, \gamma, \epsilon\beta^+$ | 13.48 a | 2.32E-03 | 8.32E-01 | --- | --- | --- |
| Eu-154 | $\beta^-, \gamma, \epsilon\gamma$ | 8.59 a | 3.96E-05 | 1.01E-02 | --- | --- | --- |
| Eu-155 | β^-, γ | 4.71 a | 6.53E-10 | 1.79E-07 | --- | --- | --- |
| Fe-55 | ϵ | 2.73 a | 0.00E+00 | 2.19E-17 | --- | --- | --- |
| Fr-221 | α, γ | 4.8 m | 1.67E+01 | 4.55E-01 | --- | --- | --- |
| Fr-223 | α, β^-, γ | 21.8 m | 1.64E-02 | 2.77E-05 | --- | --- | --- |
| Gd-152 | α | 1.1E+14 a | 1.10E-13 | 4.32E-11 | 100 | 248 | 1.74E-13 |
| H-3 | β^- | 12.3 a | 1.32E-01 | 6.95E-04 | --- | --- | --- |
| I-129 | β^-, γ | 1.57E+07 a | 5.12E-04 | 8.21E-02 | 100 | 248 | 3.32E-04 |
| Kr-85 | β^-, γ | 10.73 a | 9.08E-05 | 2.22E-05 | --- | --- | --- |
| Mn-54 | ϵ, γ | 312.2 d | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Na-22 | ϵ | 2.6019 a | 2.09E-22 | 1.58E-16 | --- | --- | --- |
| Nb-93m | ITe^- | 16.1 a | 1.07E-03 | 3.22E-01 | --- | --- | --- |
| Nb-95 | β^-, γ | 34.97 d | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Nb-95m | β^-, γ, IT | 3.61 d | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Nd144 | α | 2.1E+15 a | 0.00E+00 | 0.00E+00 | 100 | 248 | 0.00E+00 |
| Ni-59 | ϵ | 7.6E+04 a | 7.64E-02 | 2.30E+01 | 1000 | 2484 | 9.28E-03 |
| Ni-63 | β^- | 100 a | 1.38E+00 | 4.14E+02 | 1000 | 2484 | 1.67E-01 |
| Np-237 | α, γ | 2.14E+06 a | 2.29E+01 | 1.31E+00 | 100 | 248 | 9.75E-02 |
| Np-238 | β^-, γ | 2.117 d | 1.29E-04 | 5.30E-04 | --- | --- | --- |
| Np-239 | β^-, γ | 2.355 d | 2.05E+01 | 8.12E-01 | --- | --- | --- |
| Np-240m | β^-, γ, IT | 7.22 m | 1.40E-06 | 1.11E-03 | --- | --- | --- |
| Pa-231 | α, γ | 3.28E+04 a | 1.21E+00 | 2.64E-03 | 100 | 248 | 4.89E-03 |
| Pa-233 | β^-, γ | 27.0 d | 2.27E+01 | 1.30E+00 | --- | --- | --- |
| Pa-234 | β^-, γ | 6.69 h | 3.14E-02 | 1.67E-01 | --- | --- | --- |
| Pa-234m | β^-, γ, IT | 1.17 m | 2.42E+01 | 1.28E+02 | --- | --- | --- |
| Pb-209 | β^- | 3.25 h | 1.67E+01 | 4.55E-01 | --- | --- | --- |
| Pb-210 | α, β^-, γ | 22.3 a | 6.04E+00 | 4.80E-04 | 100 | 248 | 2.43E-02 |
| Pb-211 | β^-, γ | 36.1 m | 1.19E+00 | 2.00E-03 | --- | --- | --- |
| Pb-212 | β^-, γ | 10.64 h | 7.00E+00 | 9.37E-01 | --- | --- | --- |
| Pb-214 | β^-, γ | 27 m | 5.97E+00 | 7.49E-04 | --- | --- | --- |
| Pd-107 | β^- | 6.5E+06 a | 0.00E+00 | 2.88E-06 | 1000 | 2484 | 1.16E-09 |
| Pm-147 | β^-, γ | 2.6234 a | 1.30E-15 | 2.51E-13 | --- | --- | --- |

**Table A-3: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2133) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|--------------------------------------|------------------------|---------------------------------------|----------|--|-------|-----------------|
| ID | Decay Mode ^e | Half-life ^e | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Po-210 | α, γ | 138.38 d | 6.04E+00 | 4.80E-04 | --- | --- | --- |
| Po-211 | α, γ | 0.516 s | 3.62E-03 | 6.11E-06 | --- | --- | --- |
| Po-212 | α | 0.298 μs | 4.47E+00 | 5.99E-01 | --- | --- | --- |
| Po-213 | α | 4 μs | 1.63E+01 | 4.45E-01 | --- | --- | --- |
| Po-214 | α, γ | 163.7 μs | 5.96E+00 | 7.49E-04 | --- | --- | --- |
| Po-215 | α, β ⁻ , γ | 1.780 ms | 1.19E+00 | 2.00E-03 | --- | --- | --- |
| Po-216 | α, γ | 0.145 s | 6.99E+00 | 9.36E-01 | --- | --- | --- |
| Po-218 | α, β ⁻ , γ | 3.10 m | 5.86E+00 | 7.36E-04 | --- | --- | --- |
| Pr-144 | β ⁻ , γ | 17.28 m | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Pu-236 | α, γ, SF | 2.87 a | 5.05E-18 | 0.00E+00 | --- | --- | --- |
| Pu-238 | α, γ, SF | 87.7 a | 5.67E+05 | 1.27E+03 | 100 | 248 | 2.29E+03 |
| Pu-239 | α, γ, SF | 2.41E+04 a | 6.57E+05 | 5.36E+03 | 100 | 248 | 2.67E+03 |
| Pu-240 | α, γ, SF | 6.56E+03 a | 1.05E+05 | 1.66E+03 | 100 | 248 | 4.31E+02 |
| Pu-241 | α, β ⁻ , γ | 14.4 a | 4.17E+03 | 1.94E+02 | --- | --- | --- |
| Pu-242 | α, γ, SF | 3.75E+05 a | 2.66E+01 | 4.74E-01 | 100 | 248 | 1.09E-01 |
| Pu-243 | β ⁻ , γ | 4.956 h | 2.28E-09 | 9.33E+00 | --- | --- | --- |
| Pu-244 | α, SF | 8.0E+07 a | 1.39E-06 | 1.10E-03 | 100 | 248 | 4.44E-06 |
| Ra-223 | α, γ | 11.435 d | 1.20E+00 | 2.03E-03 | --- | --- | --- |
| Ra-224 | α, γ | 3.66 d | 6.99E+00 | 9.35E-01 | --- | --- | --- |
| Ra-225 | β ⁻ , γ | 14.9 d | 1.67E+01 | 4.55E-01 | --- | --- | --- |
| Ra-226 | α, γ | 1.60E+03 a | 6.03E+00 | 7.58E-04 | 100 | 248 | 2.43E-02 |
| Ra-228 | β ⁻ , γ | 5.76 a | 7.70E+00 | 2.54E-01 | --- | --- | --- |
| Rh-106 | β ⁻ , γ | 29.9 s | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Rn-219 | α, γ | 3.96 s | 1.19E+00 | 2.00E-03 | --- | --- | --- |
| Rn-220 | α, γ | 55.6 s | 7.00E+00 | 9.37E-01 | --- | --- | --- |
| Rn-222 | α, γ | 3.8235 d | 5.97E+00 | 7.50E-04 | --- | --- | --- |
| Ru-106 | β ⁻ | 1.02 a | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Sb-125 | β ⁻ , γ | 2.758 a | 2.27E-17 | 1.97E-14 | --- | --- | --- |
| Sb-126 | β ⁻ , γ | 12.4 d | 0.00E+00 | 4.17E-05 | --- | --- | --- |
| Sb-126m | γ, ITe ⁻ | 11.0 s | 0.00E+00 | 2.97E-04 | --- | --- | --- |
| Se-79 | β ⁻ | 6.5E+04 a | 1.32E-04 | 4.45E-02 | 1000 | 2484 | 1.80E-05 |
| Sm-147 | α | 1.06E+11 a | 5.22E-10 | 1.55E-08 | 100 | 248 | 6.44E-11 |
| Sm-148 | α | 7.0E+15 a | 0.00E+00 | 0.00E+00 | 100 | 248 | 0.00E+00 |
| Sm-151 | β ⁻ , γ | 90 a | 2.05E+01 | 2.10E+02 | 1000 | 2484 | 9.28E-02 |
| Sn-121m | β ⁻ , γ, ITe ⁻ | 55 a | 0.00E+00 | 8.26E-05 | 1000 | 2484 | 3.32E-08 |
| Sn-126 | β ⁻ , γ | 1.0E+05 a | 0.00E+00 | 2.98E-04 | 1000 | 2484 | 1.20E-07 |
| Sr-90 | β ⁻ | 29.1 a | 2.48E+03 | 1.06E+04 | 1000 | 2484 | 5.29E+00 |
| Tc-99 | β ⁻ , γ | 2.13E+05 a | 1.67E+02 | 1.59E+02 | 10000 | 24839 | 1.31E-02 |

**Table A-3: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2133) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------------|-------------------------|------------------------|---------------------------------------|-----------------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Te-123 | ε | 1.0E+13 a | 6.78E-05 | 0.00E+00 | --- | --- | --- |
| Te-123m | IT | 119.7 d | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Te-125m | γ, ITe | 58 d | 5.50E-18 | 4.78E-15 | --- | --- | --- |
| Th-227 | α, γ | 18.72 d | 1.17E+00 | 1.97E-03 | --- | --- | --- |
| Th-228 | α, γ | 1.913 a | 7.08E+00 | 9.48E-01 | --- | --- | --- |
| Th-229 | α, γ | 7.3E+03 a | 1.67E+01 | 4.56E-01 | 100 | 248 | 6.92E-02 |
| Th-230 | α, γ | 7.54E+04 a | 5.60E-01 | 2.67E-02 | 10 | 25 | 2.36E-02 |
| Th-231 | β, γ | 1.063 d | 1.39E+00 | 9.31E-01 | --- | --- | --- |
| Th-232 | α, γ | 1.4E+10 a | 6.61E+00 | 2.18E-01 | 10 | 25 | 2.75E-01 |
| Th-234 | β, γ | 24.10 d | 2.42E+01 | 1.29E+02 | --- | --- | --- |
| Ti-207 | β, γ | 4.77 m | 1.18E+00 | 1.99E-03 | --- | --- | --- |
| Ti-208 | β, γ | 3.053 m | 2.52E+00 | 3.37E-01 | --- | --- | --- |
| Ti-209 | β, γ | 2.2 m | 3.67E-01 | 1.00E-02 | --- | --- | --- |
| U-232 | α, γ, SF | 70 a | 4.61E-01 | 7.09E-01 | 100 | 248 | 4.71E-03 |
| U-233 | α, γ, SF | 1.592E+05 a | 1.24E+03 | 3.41E+01 | 100 | 248 | 5.11E+00 |
| U-234 | α, γ, SF | 2.46E+05 a | 5.42E+02 | 2.26E+01 | 100 | 248 | 2.27E+00 |
| U-235 | α, γ, SF | 7.04E+08 a | 1.40E+00 | 9.43E-01 | 100 | 248 | 9.45E-03 |
| U-236 | α, γ, SF | 2.342E+07 a | 5.45E-01 | 1.43E+00 | 100 | 248 | 7.94E-03 |
| U-237 | β, γ | 6.75 d | 1.03E-01 | 4.77E-03 | --- | --- | --- |
| U-238 | α, γ, SF | 4.47E+09 a | 2.44E+01 | 1.30E+02 | 100 | 248 | 6.21E-01 |
| U-240 | IT, γ | 14.1 h | 1.37E-06 | 1.09E-03 | --- | --- | --- |
| Y-90 | β, γ | 2.67 d | 2.45E+03 | 1.05E+04 | --- | --- | --- |
| Y-91 | IT, β | 49.71 m | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Zn-65 | β ⁺ , γ, ε | 243.8 d | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Zr-93 | β, γ | 1.5E+06 a | 1.12E-03 | 3.39E-01 | 1000 | 2484 | 1.37E-04 |
| Zr-95 | β, γ | 64.02 d | 0.00E+00 | 0.00E+00 | --- | --- | --- |
| Total: | --- | --- | 1.73E+06 | 7.85E+04 | --- | --- | 7.04E+03 |

(a) Decayed radionuclide inventory information taken from *Calculation of Decayed Radionuclide Inventories for the Compliance Recertification Application, Revision 1* (Fox 2003). Radionuclide decay was performed using ORIGEN2 Version 2.2.

(b) Release limits are determined in accordance with 40CFR191 (Appendix A, Table 1). Left column corresponds to specific release limits (cumulative releases to the accessible environment for 10,000 years after disposal per "Unit of Waste" identified in Note 1(e) of Table 1, Appendix A, 40CFR191). Right column corresponds to release limit obtained for 2.48 Units of Waste. The 2.48 value for the Unit of Waste corresponds to the Units of Waste present at repository closure, 2033.

(c) Decay mode and half-life information taken from *Nuclides and Isotopes* (also called the "Chart of the Nuclides"), 14th Ed. (General Electric 1989).

**Table A-4: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2383)**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|--------------------------------------|------------------------|---------------------------------------|-----------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Ac-225 | α, γ | 10.0 d | 4.489E+01 | 1.232E+00 | --- | --- | --- |
| Ac-227 | α, β ⁻ , γ | 21.77 a | 1.214E+00 | 7.598E-03 | 100 | 248 | 4.92E-03 |
| Ac-228 | α, β ⁻ , γ | 6.15 h | 6.525E+00 | 2.153E-01 | --- | --- | --- |
| Ag-109m | ITe ⁻ | 39.8 s | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ag-110 | β ⁻ , γ, ε | 24.6 s | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ag-110m | β ⁻ , γ, ITe ⁻ | 249.8 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Am-241 | α, γ, SF | 432.7 a | 2.624E+05 | 9.473E+03 | 100 | 248 | 1.09E+03 |
| Am-242 | β ⁻ , γ, ε e ⁻ | 16.02 h | 8.225E-03 | 3.373E-02 | --- | --- | --- |
| Am-242m | α, ITe ⁻ , γ, SF | 141.0 a | 8.366E-03 | 3.431E-02 | 100 | 248 | 1.72E-04 |
| Am-243 | α, γ, SF | 7.37E+03 a | 2.030E+01 | 1.024E+00 | 100 | 248 | 8.59E-02 |
| Am-245 | β ⁻ , γ | .05 h | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| At-217 | α, β ⁻ , γ | 32 ms | 4.492E+01 | 1.233E+00 | --- | --- | --- |
| Ba-137m | IT | 2.552 m | 1.325E+00 | 5.006E+01 | --- | --- | --- |
| Bi-210 | α, β ⁻ , γ | 5.01 d | 5.477E+00 | 6.029E-03 | --- | --- | --- |
| Bi-211 | α, β ⁻ , γ | 2.14 m | 1.198E+00 | 7.503E-03 | --- | --- | --- |
| Bi-212 | α, β ⁻ , γ | 1.009 h | 6.596E+00 | 2.815E-01 | --- | --- | --- |
| Bi-213 | α, β ⁻ , γ | 45.6 m | 4.483E+01 | 1.230E+00 | --- | --- | --- |
| Bi-214 | α, β ⁻ , γ | 19.9 m | 5.473E+00 | 6.024E-03 | --- | --- | --- |
| Bk-249 | α, β ⁻ , γ, SF | 3.2E+02 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Bk-250 | β ⁻ , γ | 3.217 h | 3.593E-12 | 0.000E+00 | --- | --- | --- |
| C-14 | β ⁻ | 5730 a | 1.156E+00 | 1.961E+00 | 100 | 248 | 1.25E-02 |
| Cd-109 | γ, ε | 462.0 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cd-113m | β ⁻ , IT | 14.1 a | 0.000E+00 | 2.149E-09 | --- | --- | --- |
| Ce-141 | β ⁻ | 32.501 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ce-144 | β ⁻ , γ | 284.6 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cf-249 | α, γ, SF | 351 a | 3.586E-02 | 3.932E-04 | 100 | 248 | 1.46E-04 |
| Cf-250 | α, γ, SF | 13.1 a | 3.005E-10 | 2.420E-11 | --- | --- | --- |
| Cf-251 | α, γ | 9.0E+02 a | 2.709E-04 | 1.184E-04 | 100 | 248 | 1.57E-06 |
| Cf-252 | α, γ, SF | 2.638 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cm-242 | α, γ, SF | 162.8 d | 6.898E-03 | 2.828E-02 | --- | --- | --- |
| Cm-243 | α, γ, SF, ε | 29.1 a | 3.663E-05 | 4.520E-05 | 100 | 296 | 2.76E-07 |
| Cm-244 | α, γ, SF | 18.1 a | 3.702E-03 | 1.208E-04 | --- | --- | --- |
| Cm-245 | α, γ, SF | 8.5E+03 a | 9.801E-03 | 1.032E-02 | 100 | 248 | 8.10E-05 |
| Cm-246 | α, γ, SF | 4.76E+03 a | 1.468E+00 | 6.376E-01 | 100 | 248 | 8.48E-03 |
| Cm-247 | α, γ | 1.56 E+07 a | 5.637E-09 | 9.446E+00 | 100 | 248 | 3.80E-02 |
| Cm-248 | α, SF | 3.48E+05 a | 9.133E-02 | 1.825E-03 | 100 | 248 | 3.75E-04 |
| Cm-250 | α, β ⁻ , SF | 9700 a | 6.542E-11 | 0.000E+00 | --- | --- | --- |

**Table A-4: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2383) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|-------------------------|------------------------|---------------------------------------|-----------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Co-60 | β, γ | 5.271 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cs-134 | β, γ, ε | 2.065 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cs-135 | β | 2.3E+06 a | 0.000E+00 | 6.899E-05 | 1000 | 2484 | 2.78E-08 |
| Cs-137 | β, γ | 30.17 a | 1.417E+00 | 5.352E+01 | 1000 | 2484 | 2.21E-02 |
| Eu-152 | β, γ, εβ ⁺ | 13.48 a | 6.825E-09 | 2.439E-06 | --- | --- | --- |
| Eu-154 | β, γ, εγ | 8.59 a | 7.038E-14 | 1.801E-11 | --- | --- | --- |
| Eu-155 | β, γ | 4.71 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Fe-55 | ε | 2.73 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Fr-221 | α, γ | 4.8 m | 4.485E+01 | 1.231E+00 | --- | --- | --- |
| Fr-223 | α, β, γ | 21.8 m | 1.656E-02 | 1.037E-04 | --- | --- | --- |
| Gd-152 | α | 1.1E+14 a | 1.104E-13 | 4.325E-11 | 100 | 248 | 1.75E-13 |
| H-3 | β | 12.3 a | 1.060E-07 | 5.590E-10 | --- | --- | --- |
| I-129 | β, γ | 1.57E+07 a | 5.118E-04 | 8.205E-02 | 100 | 248 | 3.32E-04 |
| Kr-85 | β, γ | 10.73 a | 8.670E-12 | 2.117E-12 | --- | --- | --- |
| Mn-54 | ε, γ | 312.2 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Na-22 | ε | 2.6019 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Nb-93m | <i>ITe</i> | 16.1 a | 1.071E-03 | 3.226E-01 | --- | --- | --- |
| Nb-95 | β, γ | 34.97 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Nb-95m | β, γ, <i>IT</i> | 3.61 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Nd144 | α | 2.1E+15 a | 0.000E+00 | 0.000E+00 | 100 | 248 | 0.00E+00 |
| Ni-59 | ε | 7.6E+04 a | 7.619E-02 | 2.292E+01 | 1000 | 2484 | 9.26E-03 |
| Ni-63 | β | 100 a | 2.092E-01 | 6.297E+01 | 1000 | 2484 | 2.54E-02 |
| Np-237 | α, γ | 2.14E+06 a | 4.962E+01 | 2.284E+00 | 100 | 248 | 2.09E-01 |
| Np-238 | β, γ | 2.117 d | 4.134E-05 | 1.695E-04 | --- | --- | --- |
| Np-239 | β, γ | 2.355 d | 2.004E+01 | 1.010E+00 | --- | --- | --- |
| Np-240m | β, γ, <i>IT</i> | 7.22 m | 1.576E-06 | 1.112E-03 | --- | --- | --- |
| Pa-231 | α, γ | 3.28E+04 a | 1.213E+00 | 7.600E-03 | 100 | 248 | 4.91E-03 |
| Pa-233 | β, γ | 27.0 d | 4.915E+01 | 2.263E+00 | --- | --- | --- |
| Pa-234 | β, γ | 6.69 h | 3.142E-02 | 1.669E-01 | --- | --- | --- |
| Pa-234m | β, γ, <i>IT</i> | 1.17 m | 2.416E+01 | 1.283E+02 | --- | --- | --- |
| Pb-209 | β | 3.25 h | 4.488E+01 | 1.232E+00 | --- | --- | --- |
| Pb-210 | α, β, γ | 22.3 a | 5.541E+00 | 6.100E-03 | 100 | 248 | 2.23E-02 |
| Pb-211 | β, γ | 36.1 m | 1.200E+00 | 7.514E-03 | --- | --- | --- |
| Pb-212 | β, γ | 10.64 h | 6.576E+00 | 2.806E-01 | --- | --- | --- |
| Pb-214 | β, γ | 27 m | 5.484E+00 | 6.035E-03 | --- | --- | --- |
| Pd-107 | β | 6.5E+06 a | 0.000E+00 | 2.881E-06 | 1000 | 2484 | 1.16E-09 |
| Pm-147 | β, γ | 2.6234 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |

**Table A-4: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2383) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|--------------------------------------|------------------------|---------------------------------------|-----------|--|-------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Po-210 | α, γ | 138.38 d | 5.539E+00 | 6.097E-03 | --- | --- | --- |
| Po-211 | α, γ | 0.516 s | 3.658E-03 | 2.290E-05 | --- | --- | --- |
| Po-212 | α | 0.298 μs | 4.202E+00 | 1.793E-01 | --- | --- | --- |
| Po-213 | α | 4 μs | 4.391E+01 | 1.205E+00 | --- | --- | --- |
| Po-214 | α, γ | 163.7 μs | 5.483E+00 | 6.035E-03 | --- | --- | --- |
| Po-215 | α, β ⁻ , γ | 1.780 ms | 1.200E+00 | 7.514E-03 | --- | --- | --- |
| Po-216 | α, γ | 0.145 s | 6.570E+00 | 2.803E-01 | --- | --- | --- |
| Po-218 | α, β ⁻ , γ | 3.10 m | 5.388E+00 | 5.933E-03 | --- | --- | --- |
| Pr-144 | β ⁻ , γ | 17.28 m | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Pu-236 | α, γ, SF | 2.87 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Pu-238 | α, γ, SF | 87.7 a | 7.873E+04 | 1.766E+02 | 100 | 248 | 3.18E+02 |
| Pu-239 | α, γ, SF | 2.41E+04 a | 6.523E+05 | 5.316E+03 | 100 | 248 | 2.65E+03 |
| Pu-240 | α, γ, SF | 6.56E+03 a | 1.026E+05 | 1.612E+03 | 100 | 248 | 4.20E+02 |
| Pu-241 | α, β ⁻ , γ | 14.4 a | 3.456E-02 | 1.145E-02 | --- | --- | --- |
| Pu-242 | α, γ, SF | 3.75E+05 a | 2.663E+01 | 4.736E-01 | 100 | 248 | 1.09E-01 |
| Pu-243 | β ⁻ , γ | 4.956 h | 5.572E-09 | 9.331E+00 | --- | --- | --- |
| Pu-244 | α, SF | 8.0E+07 a | 1.561E-06 | 1.102E-03 | 100 | 248 | 4.44E-06 |
| Ra-223 | α, γ | 11.435 d | 1.213E+00 | 7.594E-03 | --- | --- | --- |
| Ra-224 | α, γ | 3.66 d | 6.562E+00 | 2.800E-01 | --- | --- | --- |
| Ra-225 | β ⁻ , γ | 14.9 d | 4.492E+01 | 1.233E+00 | --- | --- | --- |
| Ra-226 | α, γ | 1.60E+03 a | 5.545E+00 | 6.103E-03 | 100 | 248 | 2.23E-02 |
| Ra-228 | β ⁻ , γ | 5.76 a | 7.703E+00 | 2.541E-01 | --- | --- | --- |
| Rh-106 | β ⁻ , γ | 29.9 s | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Rn-219 | α, γ | 3.96 s | 1.198E+00 | 7.504E-03 | --- | --- | --- |
| Rn-220 | α, γ | 55.6 s | 6.571E+00 | 2.804E-01 | --- | --- | --- |
| Rn-222 | α, γ | 3.8235 d | 5.489E+00 | 6.041E-03 | --- | --- | --- |
| Ru-106 | β ⁻ | 1.02 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Sb-125 | β ⁻ , γ | 2.758 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Sb-126 | β ⁻ , γ | 12.4 d | 0.000E+00 | 4.158E-05 | --- | --- | --- |
| Sb-126m | γ, ITe ⁻ | 11.0 s | 0.000E+00 | 2.969E-04 | --- | --- | --- |
| Se-79 | β ⁻ | 6.5E+04 a | 1.315E-04 | 4.437E-02 | 1000 | 2484 | 1.79E-05 |
| Sm-147 | α | 1.06E+11 a | 5.219E-10 | 1.547E-08 | 100 | 248 | 6.44E-11 |
| Sm-148 | α | 7.0E+15 a | 0.000E+00 | 0.000E+00 | 100 | 248 | 0.00E+00 |
| Sm-151 | β ⁻ , γ | 90 a | 2.995E+00 | 3.062E+01 | 1000 | 2484 | 1.35E-02 |
| Sn-121m | β ⁻ , γ, ITe ⁻ | 55 a | 0.000E+00 | 2.576E-06 | 1000 | 2484 | 1.04E-09 |
| Sn-126 | β ⁻ , γ | 1.0E+05 a | 0.000E+00 | 2.973E-04 | 1000 | 2484 | 1.20E-07 |
| Sr-90 | β ⁻ | 29.1 a | 6.467E+00 | 2.774E+01 | 1000 | 2484 | 1.38E-02 |
| Tc-99 | β ⁻ , γ | 2.13E+05 a | 1.671E+02 | 1.591E+02 | 10000 | 24839 | 1.31E-02 |

**Table A-4: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 2383) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------------|-------------------------|------------------------|---------------------------------------|-----------------|--|------------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Te-123 | ε | 1.0E+13 a | 6.780E-05 | 0.000E+00 | --- | --- | --- |
| Te-123m | IT | 119.7 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Te-125m | γ, ITε | 58 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Th-227 | α, γ | 18.72 d | 1.181E+00 | 7.396E-03 | --- | --- | --- |
| Th-228 | α, γ | 1.913 a | 6.649E+00 | 2.837E-01 | --- | --- | --- |
| Th-229 | α, γ | 7.3E+03 a | 4.496E+01 | 1.235E+00 | 100 | 248 | 1.86E-01 |
| Th-230 | α, γ | 7.54e+04 a | 2.033E+00 | 7.807E-02 | 10 | 25 | 8.50E-02 |
| Th-231 | β, γ | 1.063 d | 1.546E+00 | 9.326E-01 | --- | --- | --- |
| Th-232 | α, γ | 1.4E+10 a | 6.610E+00 | 2.181E-01 | 10 | 25 | 2.75E-01 |
| Th-234 | β, γ | 24.10 d | 2.420E+01 | 1.285E+02 | --- | --- | --- |
| Ti-207 | β, γ | 4.77 m | 1.193E+00 | 7.471E-03 | --- | --- | --- |
| Ti-208 | β, γ | 3.053 m | 2.366E+00 | 1.009E-01 | --- | --- | --- |
| Ti-209 | β, γ | 2.2 m | 9.868E-01 | 2.709E-02 | --- | --- | --- |
| U-232 | α, γ, SF | 70 a | 4.156E-02 | 6.387E-02 | 100 | 248 | 4.24E-04 |
| U-233 | α, γ, SF | 1.592E+05 a | 1.235E+03 | 3.404E+01 | 100 | 248 | 5.11E+00 |
| U-234 | α, γ, SF | 2.46E+05 a | 7.167E+02 | 2.306E+01 | 100 | 248 | 2.98E+00 |
| U-235 | α, γ, SF | 7.04E+08 a | 1.565E+00 | 9.439E-01 | 100 | 248 | 1.01E-02 |
| U-236 | α, γ, SF | 2.342E+07 a | 1.316E+00 | 1.440E+00 | 100 | 248 | 1.11E-02 |
| U-237 | β, γ | 6.75 d | 8.489E-07 | 2.808E-07 | --- | --- | --- |
| U-238 | α, γ, SF | 4.47E+09 a | 2.443E+01 | 1.297E+02 | 100 | 248 | 6.21E-01 |
| U-240 | IT, γ | 14.1 h | 1.545E-06 | 1.091E-03 | --- | --- | --- |
| Y-90 | β, γ | 2.67 d | 6.392E+00 | 2.742E+01 | --- | --- | --- |
| Y-91 | IT, β | 49.71 m | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Zn-65 | β ⁺ , γ, ε | 243.8 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Zr-93 | β, γ | 1.5E+06 a | 1.125E-03 | 3.389E-01 | 1000 | 2484 | 1.37E-04 |
| Zr-95 | β, γ | 64.02 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Total: | --- | --- | 1.10E+06 | 1.75E+04 | --- | --- | 4.49E+03 |

(a) Decayed radionuclide inventory information taken from *Calculation of Decayed Radionuclide Inventories for the Compliance Recertification Application, Revision 1* (Fox 2003). Radionuclide decay was performed using ORIGEN2 Version 2.2.

(b) Release limits are determined in accordance with 40CFR191 (Appendix A, Table 1). Left column corresponds to specific release limits (cumulative releases to the accessible environment for 10,000 years after disposal per "Unit of Waste" identified in Note 1(e) of Table 1, Appendix A, 40CFR191). Right column corresponds to release limit obtained for 2.48 Units of Waste. The 2.48 value for the Unit of Waste corresponds to the Units of Waste present at repository closure, 2033.

(c) Decay mode and half-life information taken from *Nuclides and Isotopes* (also called the "Chart of the Nuclides"), 14th Ed. (General Electric 1989).

**Table A-5: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 3,033)**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|--------------------------------------|------------------------|---------------------------------------|-----------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Ac-225 | α, γ | 10.0 d | 1.150E+02 | 3.165E+00 | --- | --- | --- |
| Ac-227 | α, β ⁻ , γ | 21.77 a | 1.221E+00 | 2.039E-02 | 100 | 248 | 5.00E-03 |
| Ac-228 | α, β ⁻ , γ | 6.15 h | 6.525E+00 | 2.153E-01 | --- | --- | --- |
| Ag-109m | ITe ⁻ | 39.8 s | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ag-110 | β ⁻ , γ, ε | 24.6 s | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ag-110m | β ⁻ , γ, ITe | 249.8 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Am-241 | α, γ, SF | 432.7 a | 9.254E+04 | 3.340E+03 | 100 | 248 | 3.86E+02 |
| Am-242 | β ⁻ , γ, ε e ⁻ | 16.02 h | 4.246E-04 | 1.741E-03 | --- | --- | --- |
| Am-242m | α, ITe ⁻ , γ, SF | 141.0 a | 4.318E-04 | 1.770E-03 | 100 | 248 | 8.87E-06 |
| Am-243 | α, γ, SF | 7.37E+03 a | 1.910E+01 | 1.524E+00 | 100 | 248 | 8.30E-02 |
| Am-245 | β ⁻ , γ | .05 h | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| At-217 | α, β ⁻ , γ | 32 ms | 1.151E+02 | 3.168E+00 | --- | --- | --- |
| Ba-137m | IT | 2.552 m | 3.979E-07 | 1.503E-05 | --- | --- | --- |
| Bi-210 | α, β ⁻ , γ | 5.01 d | 5.379E+00 | 4.107E-02 | --- | --- | --- |
| Bi-211 | α, β ⁻ , γ | 2.14 m | 1.206E+00 | 2.014E-02 | --- | --- | --- |
| Bi-212 | α, β ⁻ , γ | 1.009 h | 6.555E+00 | 2.164E-01 | --- | --- | --- |
| Bi-213 | α, β ⁻ , γ | 45.6 m | 1.148E+02 | 3.161E+00 | --- | --- | --- |
| Bi-214 | α, β ⁻ , γ | 19.9 m | 5.376E+00 | 4.105E-02 | --- | --- | --- |
| Bk-249 | α, β ⁻ , γ, SF | 3.2E+02 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Bk-250 | β ⁻ , γ | 3.217 h | 3.501E-12 | 0.000E+00 | --- | --- | --- |
| C-14 | β ⁻ | 5730 a | 1.068E+00 | 1.813E+00 | 100 | 248 | 1.16E-02 |
| Cd-109 | γ, ε | 462.0 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cd-113m | β ⁻ , IT | 14.1 a | 0.000E+00 | 8.322E-23 | --- | --- | --- |
| Ce-141 | β ⁻ | 32.501 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ce-144 | β ⁻ , γ | 284.6 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cf-249 | α, γ, SF | 351 a | 9.915E-03 | 1.087E-04 | 100 | 248 | 4.04E-05 |
| Cf-250 | α, γ, SF | 13.1 a | 3.546E-12 | 0.000E+00 | --- | --- | --- |
| Cf-251 | α, γ | 9.0E+02 a | 1.640E-04 | 7.170E-05 | 100 | 248 | 9.49E-07 |
| Cf-252 | α, γ, SF | 2.638 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cm-242 | α, γ, SF | 162.8 d | 3.561E-04 | 1.460E-03 | --- | --- | --- |
| Cm-243 | α, γ, SF, ε | 29.1 a | 4.992E-12 | 6.160E-12 | 100 | 296 | 3.77E-14 |
| Cm-244 | α, γ, SF | 18.1 a | 5.805E-14 | 1.894E-15 | --- | --- | --- |
| Cm-245 | α, γ, SF | 8.5E+03 a | 1.034E-02 | 9.794E-03 | 100 | 248 | 8.10E-05 |
| Cm-246 | α, γ, SF | 4.76E+03 a | 1.334E+00 | 5.797E-01 | 100 | 248 | 7.71E-03 |
| Cm-247 | α, γ | 1.56 E+07 a | 1.180E-08 | 9.446E+00 | 100 | 248 | 3.80E-02 |
| Cm-248 | α, SF | 3.48E+05 a | 9.120E-02 | 1.822E-03 | 100 | 248 | 3.75E-04 |
| Cm-250 | α, β ⁻ , SF | 9700 a | 6.374E-11 | 0.000E+00 | --- | --- | --- |

**Table A-5: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 3,033) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|-------------------------|------------------------|---------------------------------------|-----------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Co-60 | β, γ | 5.271 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cs-134 | β, γ, ε | 2.065 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cs-135 | β | 2.3E+06 a | 0.000E+00 | 6.897E-05 | 1000 | 2484 | 2.78E-08 |
| Cs-137 | β, γ | 30.17 a | 4.254E-07 | 1.607E-05 | 1000 | 2484 | 6.64E-09 |
| Eu-152 | β, γ, εβ ⁺ | 13.48 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Eu-154 | β, γ, εγ | 8.59 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Eu-155 | β, γ | 4.71 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Fe-55 | ε | 2.73 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Fr-221 | α, γ | 4.8 m | 1.149E+02 | 3.163E+00 | --- | --- | --- |
| Fr-223 | α, β, γ | 21.8 m | 1.666E-02 | 2.783E-04 | --- | --- | --- |
| Gd-152 | α | 1.1E+14 a | 1.104E-13 | 4.325E-11 | 100 | 248 | 1.75E-13 |
| H-3 | β | 12.3 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| I-129 | β, γ | 1.57E+07 a | 5.118E-04 | 8.204E-02 | 100 | 248 | 3.32E-04 |
| Kr-85 | β, γ | 10.73 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Mn-54 | ε, γ | 312.2 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Na-22 | ε | 2.6019 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Nb-93m | <i>ITe</i> | 16.1 a | 1.071E-03 | 3.223E-01 | --- | --- | --- |
| Nb-95 | β, γ | 34.97 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Nb-95m | β, γ, <i>IT</i> | 3.61 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Nd144 | α | 2.1E+15 a | 0.000E+00 | 0.000E+00 | 100 | 248 | 0.00E+00 |
| Ni-59 | ε | 7.6E+04 a | 7.577E-02 | 2.279E+01 | 1000 | 2484 | 9.21E-03 |
| Ni-63 | β | 100 a | 1.563E-03 | 4.704E-01 | 1000 | 2484 | 1.90E-04 |
| Np-237 | α, γ | 2.14E+06 a | 8.392E+01 | 3.522E+00 | 100 | 248 | 3.52E-01 |
| Np-238 | β, γ | 2.117 d | 2.133E-06 | 8.749E-06 | --- | --- | --- |
| Np-239 | β, γ | 2.355 d | 1.885E+01 | 1.504E+00 | --- | --- | --- |
| Np-240m | β, γ, <i>IT</i> | 7.22 m | 2.036E-06 | 1.112E-03 | --- | --- | --- |
| Pa-231 | α, γ | 3.28E+04 a | 1.220E+00 | 2.040E-02 | 100 | 248 | 5.00E-03 |
| Pa-233 | β, γ | 27.0 d | 8.316E+01 | 3.490E+00 | --- | --- | --- |
| Pa-234 | β, γ | 6.69 h | 3.142E-02 | 1.669E-01 | --- | --- | --- |
| Pa-234m | β, γ, <i>IT</i> | 1.17 m | 2.416E+01 | 1.283E+02 | --- | --- | --- |
| Pb-209 | β | 3.25 h | 1.150E+02 | 3.164E+00 | --- | --- | --- |
| Pb-210 | α, β, γ | 22.3 a | 5.443E+00 | 4.155E-02 | 100 | 248 | 2.21E-02 |
| Pb-211 | β, γ | 36.1 m | 1.208E+00 | 2.017E-02 | --- | --- | --- |
| Pb-212 | β, γ | 10.64 h | 6.533E+00 | 2.157E-01 | --- | --- | --- |
| Pb-214 | β, γ | 27 m | 5.386E+00 | 4.113E-02 | --- | --- | --- |
| Pd-107 | β | 6.5E+06 a | 0.000E+00 | 2.881E-06 | 1000 | 2484 | 1.16E-09 |
| Pm-147 | β, γ | 2.6234 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Po-210 | α, γ | 138.38 d | 5.439E+00 | 4.153E-02 | --- | --- | --- |

**Table A-5: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 3,033) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|--------------------------------------|------------------------|---------------------------------------|-----------|--|-------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Po-211 | α, γ | 0.516 s | 3.681E-03 | 6.146E-05 | --- | --- | --- |
| Po-212 | α | 0.298 μs | 4.175E+00 | 1.378E-01 | --- | --- | --- |
| Po-213 | α | 4 μs | 1.125E+02 | 3.096E+00 | --- | --- | --- |
| Po-214 | α, γ | 163.7 μs | 5.383E+00 | 4.112E-02 | --- | --- | --- |
| Po-215 | α, β ⁻ , γ | 1.780 ms | 1.208E+00 | 2.017E-02 | --- | --- | --- |
| Po-216 | α, γ | 0.145 s | 6.528E+00 | 2.154E-01 | --- | --- | --- |
| Po-218 | α, β ⁻ , γ | 3.10 m | 5.293E+00 | 4.042E-02 | --- | --- | --- |
| Pr-144 | β ⁻ , γ | 17.28 m | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Pu-236 | α, γ, SF | 2.87 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Pu-238 | α, γ, SF | 87.7 a | 4.636E+02 | 1.041E+00 | 100 | 248 | 1.87E+00 |
| Pu-239 | α, γ, SF | 2.41E+04 a | 6.403E+05 | 5.218E+03 | 100 | 248 | 2.60E+03 |
| Pu-240 | α, γ, SF | 6.56E+03 a | 9.580E+04 | 1.505E+03 | 100 | 248 | 3.92E+02 |
| Pu-241 | α, β ⁻ , γ | 14.4 a | 1.031E-02 | 9.774E-03 | --- | --- | --- |
| Pu-242 | α, γ, SF | 3.75E+05 a | 2.660E+01 | 4.740E-01 | 100 | 248 | 1.09E-01 |
| Pu-243 | β ⁻ , γ | 4.956 h | 1.166E-08 | 9.331E+00 | --- | --- | --- |
| Pu-244 | α, SF | 8.0E+07 a | 2.017E-06 | 1.102E-03 | 100 | 248 | 4.45E-06 |
| Ra-223 | α, γ | 11.435 d | 1.220E+00 | 2.038E-02 | --- | --- | --- |
| Ra-224 | α, γ | 3.66 d | 6.519E+00 | 2.151E-01 | --- | --- | --- |
| Ra-225 | β ⁻ , γ | 14.9 d | 1.150E+02 | 3.167E+00 | --- | --- | --- |
| Ra-226 | α, γ | 1.60E+03 a | 5.446E+00 | 4.158E-02 | 100 | 248 | 2.21E-02 |
| Ra-228 | β ⁻ , γ | 5.76 a | 7.703E+00 | 2.541E-01 | --- | --- | --- |
| Rh-106 | β ⁻ , γ | 29.9 s | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Rn-219 | α, γ | 3.96 s | 1.206E+00 | 2.014E-02 | --- | --- | --- |
| Rn-220 | α, γ | 55.6 s | 6.529E+00 | 2.155E-01 | --- | --- | --- |
| Rn-222 | α, γ | 3.8235 d | 5.392E+00 | 4.115E-02 | --- | --- | --- |
| Ru-106 | β ⁻ | 1.02 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Sb-125 | β ⁻ , γ | 2.758 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Sb-126 | β ⁻ , γ | 12.4 d | 0.000E+00 | 4.140E-05 | --- | --- | --- |
| Sb-126m | γ, ITe ⁻ | 11.0 s | 0.000E+00 | 2.956E-04 | --- | --- | --- |
| Se-79 | β ⁻ | 6.5E+04 a | 1.306E-04 | 4.406E-02 | 1000 | 2484 | 1.78E-05 |
| Sm-147 | α | 1.06E+11 a | 5.219E-10 | 1.547E-08 | 100 | 248 | 6.44E-11 |
| Sm-148 | α | 7.0E+15 a | 0.000E+00 | 0.000E+00 | 100 | 248 | 0.00E+00 |
| Sm-151 | β ⁻ , γ | 90 a | 2.005E-02 | 2.050E-01 | 1000 | 2484 | 9.06E-05 |
| Sn-121m | β ⁻ , γ, ITe ⁻ | 55 a | 0.000E+00 | 3.129E-10 | 1000 | 2484 | 1.26E-13 |
| Sn-126 | β ⁻ , γ | 1.0E+05 a | 0.000E+00 | 2.959E-04 | 1000 | 2484 | 1.19E-07 |
| Sr-90 | β ⁻ | 29.1 a | 1.235E-06 | 5.295E-06 | 1000 | 2484 | 2.63E-09 |
| Tc-99 | β ⁻ , γ | 2.13E+05 a | 1.667E+02 | 1.588E+02 | 10000 | 24839 | 1.31E-02 |
| Te-123 | ε | 1.0E+13 a | 6.780E-05 | 0.000E+00 | --- | --- | --- |

**Table A-5: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 3,033) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------------|-------------------------|------------------------|---------------------------------------|-----------------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Te-123m | IT | 119.7 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Te-125m | γ, IT ^e | 58 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Th-227 | α, γ | 18.72 d | 1.189E+00 | 1.985E-02 | --- | --- | --- |
| Th-228 | α, γ | 1.913 a | 6.605E+00 | 2.180E-01 | --- | --- | --- |
| Th-229 | α, γ | 7.3E+03 a | 1.152E+02 | 3.172E+00 | 100 | 248 | 4.77E-01 |
| Th-230 | α, γ | 7.54e+04 a | 6.981E+00 | 2.144E-01 | 10 | 25 | 2.90E-01 |
| Th-231 | β ⁻ , γ | 1.063 d | 1.956E+00 | 9.358E-01 | --- | --- | --- |
| Th-232 | α, γ | 1.4E+10 a | 6.610E+00 | 2.181E-01 | 10 | 25 | 2.75E-01 |
| Th-234 | β ⁻ , γ | 24.10 d | 2.420E+01 | 1.285E+02 | --- | --- | --- |
| Tl-207 | β ⁻ , γ | 4.77 m | 1.201E+00 | 2.005E-02 | --- | --- | --- |
| Tl-208 | β ⁻ , γ | 3.053 m | 2.351E+00 | 7.761E-02 | --- | --- | --- |
| Tl-209 | β ⁻ , γ | 2.2 m | 2.528E+00 | 6.960E-02 | --- | --- | --- |
| U-232 | α, γ, SF | 70 a | 7.957E-05 | 1.223E-04 | 100 | 248 | 8.13E-07 |
| U-233 | α, γ, SF | 1.592E+05 a | 1.231E+03 | 3.396E+01 | 100 | 248 | 5.09E+00 |
| U-234 | α, γ, SF | 2.46E+05 a | 7.439E+02 | 2.331E+01 | 100 | 248 | 3.09E+00 |
| U-235 | α, γ, SF | 7.04E+08 a | 1.980E+00 | 9.474E-01 | 100 | 248 | 1.18E-02 |
| U-236 | α, γ, SF | 2.342E+07 a | 3.227E+00 | 1.470E+00 | 100 | 248 | 1.89E-02 |
| U-237 | β ⁻ , γ | 6.75 d | 2.529E-07 | 2.397E-07 | --- | --- | --- |
| U-238 | α, γ, SF | 4.47E+09 a | 2.443E+01 | 1.297E+02 | 100 | 248 | 6.21E-01 |
| U-240 | IT, γ | 14.1 h | 1.996E-06 | 1.091E-03 | --- | --- | --- |
| Y-90 | β ⁻ , γ | 2.67 d | 1.221E-06 | 5.235E-06 | --- | --- | --- |
| Y-91 | IT, β ⁻ | 49.71 m | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Zn-65 | β ⁺ , γ, ε | 243.8 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Zr-93 | β ⁻ , γ | 1.5E+06 a | 1.124E-03 | 3.386E-01 | 1000 | 2484 | 1.37E-04 |
| Zr-95 | β ⁻ , γ | 64.02 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Total: | --- | --- | 8.33E+05 | 1.08E+04 | --- | --- | 3.39E+03 |

(a) Decayed radionuclide inventory information taken from *Calculation of Decayed Radionuclide Inventories for the Compliance Recertification Application, Revision 1* (Fox 2003). Radionuclide decay was performed using ORIGEN2 Version 2.2.

(b) Release limits are determined in accordance with 40CFR191 (Appendix A, Table 1). Left column corresponds to specific release limits (cumulative releases to the accessible environment for 10,000 years after disposal per "Unit of Waste" identified in Note 1(e) of Table 1, Appendix A, 40CFR191). Right column corresponds to release limit obtained for 2.48 Units of Waste. The 2.48 value for the Unit of Waste corresponds to the Units of Waste present at repository closure, 2033.

(c) Decay mode and half-life information taken from *Nuclides and Isotopes* (also called the "Chart of the Nuclides"), 14th Ed. (General Electric 1989).

**Table A-6: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 7033)**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|-------------------------|------------------------|---------------------------------------|-----------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Ac-225 | α, γ | 10.0 d | 4.595E+02 | 1.267E+01 | --- | --- | --- |
| Ac-227 | α, β, γ | 21.77 a | 1.383E+00 | 9.633E-02 | 100 | 248 | 5.95E-03 |
| Ac-228 | α, β, γ | 6.15 h | 6.525E+00 | 2.153E-01 | --- | --- | --- |
| Ag-109m | ITe | 39.8 s | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ag-110 | β, γ, ε | 24.6 s | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ag-110m | β, γ, ITe | 249.8 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Am-241 | α, γ, SF | 432.7 a | 1.515E+02 | 5.476E+00 | 100 | 248 | 6.32E-01 |
| Am-242 | β, γ, ε e' | 16.02 h | 5.088E-12 | 2.086E-11 | --- | --- | --- |
| Am-242m | α, ITe, γ, SF | 141.0 a | 5.175E-12 | 2.121E-11 | 100 | 248 | 1.06E-13 |
| Am-243 | α, γ, SF | 7.37E+03 a | 1.312E+01 | 4.010E+00 | 100 | 248 | 6.90E-02 |
| Am-245 | β, γ | .05 h | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| At-217 | α, β, γ | 32 ms | 4.600E+02 | 1.269E+01 | --- | --- | --- |
| Ba-137m | IT | 2.552 m | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Bi-210 | α, β, γ | 5.01 d | 2.015E+01 | 6.155E-01 | --- | --- | --- |
| Bi-211 | α, β, γ | 2.14 m | 1.365E+00 | 9.510E-02 | --- | --- | --- |
| Bi-212 | α, β, γ | 1.009 h | 6.555E+00 | 2.162E-01 | --- | --- | --- |
| Bi-213 | α, β, γ | 45.6 m | 4.590E+02 | 1.266E+01 | --- | --- | --- |
| Bi-214 | α, β, γ | 19.9 m | 2.014E+01 | 6.152E-01 | --- | --- | --- |
| Bk-249 | α, β, γ, SF | 3.2E+02 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Bk-250 | β, γ | 3.217 h | 2.985E-12 | 0.000E+00 | --- | --- | --- |
| C-14 | β | 5730 a | 6.585E-01 | 1.118E+00 | 100 | 248 | 7.15E-03 |
| Cd-109 | γ, ε | 462.0 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cd-113m | β, IT | 14.1 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ce-141 | β | 32.501 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ce-144 | β, γ | 284.6 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cf-249 | α, γ, SF | 351 a | 3.636E-06 | 3.986E-08 | 100 | 248 | 1.48E-08 |
| Cf-250 | α, γ, SF | 13.1 a | 3.024E-12 | 0.000E+00 | --- | --- | --- |
| Cf-251 | α, γ | 9.0E+02 a | 7.485E-06 | 3.270E-06 | 100 | 248 | 4.33E-08 |
| Cf-252 | α, γ, SF | 2.638 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cm-242 | α, γ, SF | 162.8 d | 4.278E-12 | 1.754E-11 | --- | --- | --- |
| Cm-243 | α, γ, SF, ε | 29.1 a | 0.000E+00 | 0.000E+00 | 100 | 296 | 0.00E+00 |
| Cm-244 | α, γ, SF | 18.1 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cm-245 | α, γ, SF | 8.5E+03 a | 7.767E-03 | 7.071E-03 | 100 | 248 | 5.97E-05 |
| Cm-246 | α, γ, SF | 4.76E+03 a | 7.427E-01 | 3.225E-01 | 100 | 248 | 4.29E-03 |
| Cm-247 | α, γ | 1.56 E+07 a | 2.083E-08 | 9.446E+00 | 100 | 248 | 3.80E-02 |
| Cm-248 | α, SF | 3.48E+05 a | 9.043E-02 | 1.808E-03 | 100 | 248 | 3.71E-04 |
| Cm-250 | α, β, SF | 9700 a | 5.435E-11 | 0.000E+00 | --- | --- | --- |

**Table A-6: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 7033) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|-------------------------|------------------------|---------------------------------------|-----------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Co-60 | β, γ | 5.271 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cs-134 | β, γ, ε | 2.065 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cs-135 | β | 2.3E+06 a | 0.000E+00 | 6.889E-05 | 1000 | 2484 | 2.77E-08 |
| Cs-137 | β, γ | 30.17 a | 0.000E+00 | 0.000E+00 | 1000 | 2484 | 0.00E+00 |
| Eu-152 | β, γ, εβ ⁺ | 13.48 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Eu-154 | β, γ, εγ | 8.59 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Eu-155 | β, γ | 4.71 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Fe-55 | ε | 2.73 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Fr-221 | α, γ | 4.8 m | 4.591E+02 | 1.266E+01 | --- | --- | --- |
| Fr-223 | α, β, γ | 21.8 m | 1.886E-02 | 1.314E-03 | --- | --- | --- |
| Gd-152 | α | 1.1E+14 a | 1.104E-13 | 4.325E-11 | 100 | 248 | 1.75E-13 |
| H-3 | β | 12.3 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| I-129 | β, γ | 1.57E+07 a | 5.116E-04 | 8.204E-02 | 100 | 248 | 3.32E-04 |
| Kr-85 | β, γ | 10.73 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Mn-54 | ε, γ | 312.2 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Na-22 | ε | 2.6019 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Nb-93m | ITe ^c | 16.1 a | 1.069E-03 | 3.218E-01 | --- | --- | --- |
| Nb-95 | β, γ | 34.97 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Nb-95m | β, γ, IT | 3.61 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Nd144 | α | 2.1E+15 a | 0.000E+00 | 0.000E+00 | 100 | 248 | 0.00E+00 |
| Ni-59 | ε | 7.6E+04 a | 7.318E-02 | 2.202E+01 | 1000 | 2484 | 8.89E-03 |
| Ni-63 | β | 100 a | 1.275E-16 | 3.839E-14 | 1000 | 2484 | 1.55E-17 |
| Np-237 | α, γ | 2.14E+06 a | 1.019E+02 | 4.165E+00 | 100 | 248 | 4.27E-01 |
| Np-238 | β, γ | 2.117 d | 2.556E-14 | 1.048E-13 | --- | --- | --- |
| Np-239 | β, γ | 2.355 d | 1.295E+01 | 3.958E+00 | --- | --- | --- |
| Np-240m | β, γ, IT | 7.22 m | 4.852E-06 | 1.112E-03 | --- | --- | --- |
| Pa-231 | α, γ | 3.28E+04 a | 1.382E+00 | 9.632E-02 | 100 | 248 | 5.95E-03 |
| Pa-233 | β, γ | 27.0 d | 1.010E+02 | 4.127E+00 | --- | --- | --- |
| Pa-234 | β, γ | 6.69 h | 3.142E-02 | 1.669E-01 | --- | --- | --- |
| Pa-234m | β, γ, IT | 1.17 m | 2.416E+01 | 1.283E+02 | --- | --- | --- |
| Pb-209 | β | 3.25 h | 4.594E+02 | 1.267E+01 | --- | --- | --- |
| Pb-210 | α, β, γ | 22.3 a | 2.039E+01 | 6.228E-01 | 100 | 248 | 8.46E-02 |
| Pb-211 | β, γ | 36.1 m | 1.367E+00 | 9.524E-02 | --- | --- | --- |
| Pb-212 | β, γ | 10.64 h | 6.533E+00 | 2.156E-01 | --- | --- | --- |
| Pb-214 | β, γ | 27 m | 2.018E+01 | 6.163E-01 | --- | --- | --- |
| Pd-107 | β | 6.5E+06 a | 0.000E+00 | 2.880E-06 | 1000 | 2484 | 1.16E-09 |
| Pm-147 | β, γ | 2.6234 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |

**Table A-6: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 7033) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|--------------------------------------|------------------------|---------------------------------------|-----------|--|-------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Po-210 | α, γ | 138.38 d | 2.038E+01 | 6.224E-01 | --- | --- | --- |
| Po-211 | α, γ | 0.516 s | 4.166E-03 | 2.904E-04 | --- | --- | --- |
| Po-212 | α | 0.298 μs | 4.175E+00 | 1.377E-01 | --- | --- | --- |
| Po-213 | α | 4 μs | 4.494E+02 | 1.240E+01 | --- | --- | --- |
| Po-214 | α, γ | 163.7 μs | 2.017E+01 | 6.160E-01 | --- | --- | --- |
| Po-215 | α, β ⁻ , γ | 1.780 ms | 1.367E+00 | 9.526E-02 | --- | --- | --- |
| Po-216 | α, γ | 0.145 s | 6.528E+00 | 2.153E-01 | --- | --- | --- |
| Po-218 | α, β ⁻ , γ | 3.10 m | 1.983E+01 | 6.058E-01 | --- | --- | --- |
| Pr-144 | β ⁻ , γ | 17.28 m | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Pu-236 | α, γ, SF | 2.87 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Pu-238 | α, γ, SF | 87.7 a | 1.893E-11 | 4.166E-11 | 100 | 248 | 2.44E-13 |
| Pu-239 | α, γ, SF | 2.41E+04 a | 5.706E+05 | 4.650E+03 | 100 | 248 | 2.32E+03 |
| Pu-240 | α, γ, SF | 6.56E+03 a | 6.268E+04 | 9.849E+02 | 100 | 248 | 2.56E+02 |
| Pu-241 | α, β ⁻ , γ | 14.4 a | 7.750E-03 | 7.056E-03 | --- | --- | --- |
| Pu-242 | α, γ, SF | 3.75E+05 a | 2.642E+01 | 4.736E-01 | 100 | 248 | 1.08E-01 |
| Pu-243 | β ⁻ , γ | 4.956 h | 2.059E-08 | 9.331E+00 | --- | --- | --- |
| Pu-244 | α, SF | 8.0E+07 a | 4.808E-06 | 1.102E-03 | 100 | 248 | 4.46E-06 |
| Ra-223 | α, γ | 11.435 d | 1.382E+00 | 9.630E-02 | --- | --- | --- |
| Ra-224 | α, γ | 3.66 d | 6.519E+00 | 2.151E-01 | --- | --- | --- |
| Ra-225 | β ⁻ , γ | 14.9 d | 4.598E+02 | 1.268E+01 | --- | --- | --- |
| Ra-226 | α, γ | 1.60E+03 a | 2.040E+01 | 6.232E-01 | 100 | 248 | 8.46E-02 |
| Ra-228 | β ⁻ , γ | 5.76 a | 7.703E+00 | 2.541E-01 | --- | --- | --- |
| Rh-106 | β ⁻ , γ | 29.9 s | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Rn-219 | α, γ | 3.96 s | 1.365E+00 | 9.512E-02 | --- | --- | --- |
| Rn-220 | α, γ | 55.6 s | 6.529E+00 | 2.154E-01 | --- | --- | --- |
| Rn-222 | α, γ | 3.8235 d | 2.019E+01 | 6.169E-01 | --- | --- | --- |
| Ru-106 | β ⁻ | 1.02 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Sb-125 | β ⁻ , γ | 2.758 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Sb-126 | β ⁻ , γ | 12.4 d | 0.000E+00 | 4.026E-05 | --- | --- | --- |
| Sb-126m | γ, ITe ⁻ | 11.0 s | 0.000E+00 | 2.875E-04 | --- | --- | --- |
| Se-79 | β ⁻ | 6.5E+04 a | 1.252E-04 | 4.222E-02 | 1000 | 2484 | 1.70E-05 |
| Sm-147 | α | 1.06E+11 a | 5.219E-10 | 1.547E-08 | 100 | 248 | 6.44E-11 |
| Sm-148 | α | 7.0E+15 a | 0.000E+00 | 0.000E+00 | 100 | 248 | 0.00E+00 |
| Sm-151 | β ⁻ , γ | 90 a | 8.358E-16 | 8.547E-15 | 1000 | 2484 | 3.78E-18 |
| Sn-121m | β ⁻ , γ, ITe ⁻ | 55 a | 0.000E+00 | 0.000E+00 | 1000 | 2484 | 0.00E+00 |
| Sn-126 | β ⁻ , γ | 1.0E+05 a | 0.000E+00 | 2.880E-04 | 1000 | 2484 | 1.16E-07 |
| Sr-90 | β ⁻ | 29.1 a | 0.000E+00 | 0.000E+00 | 1000 | 2484 | 0.00E+00 |
| Tc-99 | β ⁻ , γ | 2.13E+05 a | 1.646E+02 | 1.567E+02 | 10000 | 24839 | 1.29E-02 |

**Table A-6: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 7033) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------------|-------------------------|------------------------|---------------------------------------|-----------------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Te-123 | ε | 1.0E+13 a | 6.780E-05 | 0.000E+00 | --- | --- | --- |
| Te-123m | IT | 119.7 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Te-125m | γ, ITe ⁻ | 58 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Th-227 | α, γ | 18.72 d | 1.346E+00 | 9.376E-02 | --- | --- | --- |
| Th-228 | α, γ | 1.913 a | 6.605E+00 | 2.179E-01 | --- | --- | --- |
| Th-229 | α, γ | 7.3E+03 a | 4.605E+02 | 1.270E+01 | 100 | 248 | 1.91E+00 |
| Th-230 | α, γ | 7.54e+04 a | 3.288E+01 | 1.052E+00 | 10 | 25 | 1.37E+00 |
| Th-231 | β ⁻ , γ | 1.063 d | 4.312E+00 | 9.549E-01 | --- | --- | --- |
| Th-232 | α, γ | 1.4E+10 a | 6.610E+00 | 2.181E-01 | 10 | 25 | 2.75E-01 |
| Th-234 | β ⁻ , γ | 24.10 d | 2.420E+01 | 1.285E+02 | --- | --- | --- |
| Tl-207 | β ⁻ , γ | 4.77 m | 1.359E+00 | 9.472E-02 | --- | --- | --- |
| Tl-208 | β ⁻ , γ | 3.053 m | 2.351E+00 | 7.756E-02 | --- | --- | --- |
| Tl-209 | β ⁻ , γ | 2.2 m | 1.010E+01 | 2.787E-01 | --- | --- | --- |
| U-232 | α, γ, SF | 70 a | 1.499E-21 | 2.305E-21 | 100 | 248 | 1.53E-23 |
| U-233 | α, γ, SF | 1.592E+05 a | 1.211E+03 | 3.345E+01 | 100 | 248 | 5.01E+00 |
| U-234 | α, γ, SF | 2.46E+05 a | 7.356E+02 | 2.452E+01 | 100 | 248 | 3.06E+00 |
| U-235 | α, γ, SF | 7.04E+08 a | 4.365E+00 | 9.669E-01 | 100 | 248 | 2.15E-02 |
| U-236 | α, γ, SF | 2.342E+07 a | 1.248E+01 | 1.615E+00 | 100 | 248 | 5.68E-02 |
| U-237 | β ⁻ , γ | 6.75 d | 1.901E-07 | 1.731E-07 | --- | --- | --- |
| U-238 | α, γ, SF | 4.47E+09 a | 2.443E+01 | 1.297E+02 | 100 | 248 | 6.21E-01 |
| U-240 | IT, γ | 14.1 h | 4.757E-06 | 1.091E-03 | --- | --- | --- |
| Y-90 | β ⁻ , γ | 2.67 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Y-91 | IT, β ⁻ | 49.71 m | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Zn-65 | β ⁺ , γ, ε | 243.8 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Zr-93 | β ⁻ , γ | 1.5E+06 a | 1.122E-03 | 3.381E-01 | 1000 | 2484 | 1.37E-04 |
| Zr-95 | β ⁻ , γ | 64.02 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Total: | --- | --- | 6.40E+05 | 6.42E+03 | --- | --- | 2.59E+03 |

(a) Decayed radionuclide inventory information taken from *Calculation of Decayed Radionuclide Inventories for the Compliance Recertification Application, Revision 1* (Fox 2003). Radionuclide decay was performed using ORIGEN2 Version 2.2.

(b) Release limits are determined in accordance with 40CFR191 (Appendix A, Table 1). Left column corresponds to specific release limits (cumulative releases to the accessible environment for 10,000 years after disposal per "Unit of Waste" identified in Note 1(e) of Table 1, Appendix A, 40CFR191). Right column corresponds to release limit obtained for 2.48 Units of Waste. The 2.48 value for the Unit of Waste corresponds to the Units of Waste present at repository closure, 2033.

(c) Decay mode and half-life information taken from *Nuclides and Isotopes* (also called the "Chart of the Nuclides"), 14th Ed. (General Electric 1989).

**Table A-7: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 12,033)**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|--------------------------------------|------------------------|---------------------------------------|-----------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Ac-225 | α, γ | 10.0 d | 7.337E+02 | 2.025E+01 | --- | --- | --- |
| Ac-227 | α, β ⁻ , γ | 21.77 a | 1.818E+00 | 1.847E-01 | 100 | 248 | 8.06E-03 |
| Ac-228 | α, β ⁻ , γ | 6.15 h | 6.525E+00 | 2.153E-01 | --- | --- | --- |
| Ag-109m | ITe ⁻ | 39.8 s | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ag-110 | β ⁻ , γ, ε | 24.6 s | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ag-110m | β ⁻ , γ, ITe | 249.8 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Am-241 | α, γ, SF | 432.7 a | 5.507E-02 | 6.503E-03 | 100 | 248 | 2.48E-04 |
| Am-242 | β ⁻ , γ, ε e ⁻ | 16.02 h | 6.378E-22 | 2.615E-21 | --- | --- | --- |
| Am-242m | α, ITe ⁻ , γ, SF | 141.0 a | 6.487E-22 | 2.660E-21 | 100 | 248 | 1.33E-23 |
| Am-243 | α, γ, SF | 7.37E+03 a | 8.203E+00 | 6.054E+00 | 100 | 248 | 5.74E-02 |
| Am-245 | β ⁻ , γ | .05 h | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| At-217 | α, β ⁻ , γ | 32 ms | 7.345E+02 | 2.027E+01 | --- | --- | --- |
| Ba-137m | IT | 2.552 m | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Bi-210 | α, β ⁻ , γ | 5.01 d | 4.914E+01 | 1.612E+00 | --- | --- | --- |
| Bi-211 | α, β ⁻ , γ | 2.14 m | 1.795E+00 | 1.824E-01 | --- | --- | --- |
| Bi-212 | α, β ⁻ , γ | 1.009 h | 6.555E+00 | 2.162E-01 | --- | --- | --- |
| Bi-213 | α, β ⁻ , γ | 45.6 m | 7.328E+02 | 2.023E+01 | --- | --- | --- |
| Bi-214 | α, β ⁻ , γ | 19.9 m | 4.913E+01 | 1.611E+00 | --- | --- | --- |
| Bk-249 | α, β ⁻ , γ, SF | 3.2E+02 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Bk-250 | β ⁻ , γ | 3.217 h | 2.446E-12 | 0.000E+00 | --- | --- | --- |
| C-14 | β ⁻ | 5730 a | 3.596E-01 | 6.102E-01 | 100 | 248 | 3.90E-03 |
| Cd-109 | γ, ε | 462.0 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cd-113m | β ⁻ , IT | 14.1 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ce-141 | β ⁻ | 32.501 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Ce-144 | β ⁻ , γ | 284.6 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cf-249 | α, γ, SF | 351 a | 1.845E-10 | 2.022E-12 | 100 | 248 | 7.51E-13 |
| Cf-250 | α, γ, SF | 13.1 a | 2.478E-12 | 0.000E+00 | --- | --- | --- |
| Cf-251 | α, γ | 9.0E+02 a | 1.578E-07 | 6.896E-08 | 100 | 248 | 9.13E-10 |
| Cf-252 | α, γ, SF | 2.638 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cm-242 | α, γ, SF | 162.8 d | 5.363E-22 | 2.199E-21 | --- | --- | --- |
| Cm-243 | α, γ, SF, ε | 29.1 a | 0.000E+00 | 0.000E+00 | 100 | 296 | 0.00E+00 |
| Cm-244 | α, γ, SF | 18.1 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cm-245 | α, γ, SF | 8.5E+03 a | 5.166E-03 | 4.703E-03 | 100 | 248 | 3.97E-05 |
| Cm-246 | α, γ, SF | 4.76E+03 a | 3.570E-01 | 1.551E-01 | 100 | 248 | 2.06E-03 |
| Cm-247 | α, γ | 1.56 E+07 a | 2.126E-08 | 9.436E+00 | 100 | 248 | 3.80E-02 |
| Cm-248 | α, SF | 3.48E+05 a | 8.953E-02 | 1.789E-03 | 100 | 248 | 3.68E-04 |
| Cm-250 | α, β ⁻ , SF | 9700 a | 4.454E-11 | 0.000E+00 | --- | --- | --- |

**Table A-7: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 12,033) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|-------------------------|------------------------|---------------------------------------|-----------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Co-60 | β, γ | 5.271 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cs-134 | β, γ, ε | 2.065 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Cs-135 | β | 2.3E+06 a | 0.000E+00 | 6.878E-05 | 1000 | 2484 | 2.77E-08 |
| Cs-137 | β, γ | 30.17 a | 0.000E+00 | 0.000E+00 | 1000 | 2484 | 0.00E+00 |
| Eu-152 | β, γ, εβ ⁺ | 13.48 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Eu-154 | β, γ, εγ | 8.59 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Eu-155 | β, γ | 4.71 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Fe-55 | ε | 2.73 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Fr-221 | α, γ | 4.8 m | 7.331E+02 | 2.023E+01 | --- | --- | --- |
| Fr-223 | α, β, γ | 21.8 m | 2.481E-02 | 2.520E-03 | --- | --- | --- |
| Gd-152 | α | 1.1E+14 a | 1.104E-13 | 4.325E-11 | 100 | 248 | 1.75E-13 |
| H-3 | β | 12.3 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| I-129 | β, γ | 1.57E+07 a | 5.116E-04 | 8.202E-02 | 100 | 248 | 3.32E-04 |
| Kr-85 | β, γ | 10.73 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Mn-54 | ε, γ | 312.2 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Na-22 | ε | 2.6019 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Nb-93m | ITε | 16.1 a | 1.066E-03 | 3.212E-01 | --- | --- | --- |
| Nb-95 | β, γ | 34.97 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Nb-95m | β, γ, IT | 3.61 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Nd144 | α | 2.1E+15 a | 0.000E+00 | 0.000E+00 | 100 | 248 | 0.00E+00 |
| Ni-59 | ε | 7.6E+04 a | 7.008E-02 | 2.109E+01 | 1000 | 2484 | 8.52E-03 |
| Ni-63 | β | 100 a | 0.000E+00 | 0.000E+00 | 1000 | 2484 | 0.00E+00 |
| Np-237 | α, γ | 2.14E+06 a | 1.018E+02 | 4.159E+00 | 100 | 248 | 4.27E-01 |
| Np-238 | β, γ | 2.117 d | 3.204E-24 | 1.314E-23 | --- | --- | --- |
| Np-239 | β, γ | 2.355 d | 8.097E+00 | 5.974E+00 | --- | --- | --- |
| Np-240m | β, γ, IT | 7.22 m | 8.341E-06 | 1.112E-03 | --- | --- | --- |
| Pa-231 | α, γ | 3.28E+04 a | 1.817E+00 | 1.847E-01 | 100 | 248 | 8.06E-03 |
| Pa-233 | β, γ | 27.0 d | 1.008E+02 | 4.120E+00 | --- | --- | --- |
| Pa-234 | β, γ | 6.69 h | 3.142E-02 | 1.669E-01 | --- | --- | --- |
| Pa-234m | β, γ, IT | 1.17 m | 2.416E+01 | 1.283E+02 | --- | --- | --- |
| Pb-209 | β | 3.25 h | 7.337E+02 | 2.025E+01 | --- | --- | --- |
| Pb-210 | α, β, γ | 22.3 a | 4.972E+01 | 1.631E+00 | 100 | 248 | 2.07E-01 |
| Pb-211 | β, γ | 36.1 m | 1.798E+00 | 1.826E-01 | --- | --- | --- |
| Pb-212 | β, γ | 10.64 h | 6.533E+00 | 2.156E-01 | --- | --- | --- |
| Pb-214 | β, γ | 27 m | 4.920E+01 | 1.614E+00 | --- | --- | --- |
| Pd-107 | β | 6.5E+06 a | 0.000E+00 | 2.878E-06 | 1000 | 2484 | 1.16E-09 |
| Pm-147 | β, γ | 2.6234 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Po-210 | α, γ | 138.38 d | 4.971E+01 | 1.630E+00 | --- | --- | --- |

**Table A-7: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 12,033) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------|--------------------------------------|------------------------|---------------------------------------|-----------|--|-------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Po-211 | α, γ | 0.516 s | 5.480E-03 | 5.566E-04 | --- | --- | --- |
| Po-212 | α | 0.298 μs | 4.175E+00 | 1.377E-01 | --- | --- | --- |
| Po-213 | α | 4 μs | 7.177E+02 | 1.981E+01 | --- | --- | --- |
| Po-214 | α, γ | 163.7 μs | 4.918E+01 | 1.614E+00 | --- | --- | --- |
| Po-215 | α, β ⁻ , γ | 1.780 ms | 1.798E+00 | 1.826E-01 | --- | --- | --- |
| Po-216 | α, γ | 0.145 s | 6.528E+00 | 2.153E-01 | --- | --- | --- |
| Po-218 | α, β ⁻ , γ | 3.10 m | 4.834E+01 | 1.587E+00 | --- | --- | --- |
| Pr-144 | β ⁻ , γ | 17.28 m | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Pu-236 | α, γ, SF | 2.87 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Pu-238 | α, γ, SF | 87.7 a | 1.273E-21 | 5.219E-21 | 100 | 248 | 2.61E-23 |
| Pu-239 | α, γ, SF | 2.41E+04 a | 4.941E+05 | 4.027E+03 | 100 | 248 | 2.01E+03 |
| Pu-240 | α, γ, SF | 6.56E+03 a | 3.689E+04 | 5.796E+02 | 100 | 248 | 1.51E+02 |
| Pu-241 | α, β ⁻ , γ | 14.4 a | 5.154E-03 | 4.694E-03 | --- | --- | --- |
| Pu-242 | α, γ, SF | 3.75E+05 a | 2.619E+01 | 4.716E-01 | 100 | 248 | 1.07E-01 |
| Pu-243 | β ⁻ , γ | 4.956 h | 2.100E-08 | 9.329E+00 | --- | --- | --- |
| Pu-244 | α, SF | 8.0E+07 a | 8.263E-06 | 1.102E-03 | 100 | 248 | 4.47E-06 |
| Ra-223 | α, γ | 11.435 d | 1.817E+00 | 1.846E-01 | --- | --- | --- |
| Ra-224 | α, γ | 3.66 d | 6.519E+00 | 2.151E-01 | --- | --- | --- |
| Ra-225 | β ⁻ , γ | 14.9 d | 7.342E+02 | 2.026E+01 | --- | --- | --- |
| Ra-226 | α, γ | 1.60E+03 a | 4.975E+01 | 1.632E+00 | 100 | 248 | 2.07E-01 |
| Ra-228 | β ⁻ , γ | 5.76 a | 7.703E+00 | 2.541E-01 | --- | --- | --- |
| Rh-106 | β ⁻ , γ | 29.9 s | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Rn-219 | α, γ | 3.96 s | 1.795E+00 | 1.824E-01 | --- | --- | --- |
| Rn-220 | α, γ | 55.6 s | 6.529E+00 | 2.154E-01 | --- | --- | --- |
| Rn-222 | α, γ | 3.8235 d | 4.925E+01 | 1.615E+00 | --- | --- | --- |
| Ru-106 | β ⁻ | 1.02 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Sb-125 | β ⁻ , γ | 2.758 a | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Sb-126 | β ⁻ , γ | 12.4 d | 0.000E+00 | 3.889E-05 | --- | --- | --- |
| Sb-126m | γ, ITe ⁻ | 11.0 s | 0.000E+00 | 2.777E-04 | --- | --- | --- |
| Se-79 | β ⁻ | 6.5E+04 a | 1.187E-04 | 4.003E-02 | 1000 | 2484 | 1.62E-05 |
| Sm-147 | α | 1.06E+11 a | 5.219E-10 | 1.547E-08 | 100 | 248 | 6.44E-11 |
| Sm-148 | α | 7.0E+15 a | 0.000E+00 | 0.000E+00 | 100 | 248 | 0.00E+00 |
| Sm-151 | β ⁻ , γ | 90 a | 0.000E+00 | 0.000E+00 | 1000 | 2484 | 0.00E+00 |
| Sn-121m | β ⁻ , γ, ITe ⁻ | 55 a | 0.000E+00 | 0.000E+00 | 1000 | 2484 | 0.00E+00 |
| Sn-126 | β ⁻ , γ | 1.0E+05 a | 0.000E+00 | 2.781E-04 | 1000 | 2484 | 1.12E-07 |
| Sr-90 | β ⁻ | 29.1 a | 0.000E+00 | 0.000E+00 | 1000 | 2484 | 0.00E+00 |
| Tc-99 | β ⁻ , γ | 2.13E+05 a | 1.619E+02 | 1.542E+02 | 10000 | 24839 | 1.27E-02 |
| Te-123 | ε | 1.0E+13 a | 6.780E-05 | 0.000E+00 | --- | --- | --- |

**Table A-7: 40CFR191 Release Limits and Source Term EPA Units for WIPP-Scale TRU Waste
(Calendar Year = 12,033) - continued**

| Nuclide | | | WIPP TRU Waste | | | | |
|---------------|-----------------------------|------------------------|---------------------------------------|-----------------|--|------|-----------------|
| ID | Decay Mode ^c | Half-life ^c | Total Inventory [Curies] ^a | | Release Limits Inventory [Ci] ^b | | Source EPA Unit |
| | | | CH | RH | (Ci/UW) | (Ci) | |
| Te-123m | <i>IT</i> | 119.7 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Te-125m | γ, ITe' | 58 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Th-227 | α, γ | 18.72 d | 1.770E+00 | 1.798E-01 | --- | --- | --- |
| Th-228 | α, γ | 1.913 a | 6.605E+00 | 2.179E-01 | --- | --- | --- |
| Th-229 | α, γ | 7.3E+03 a | 7.353E+02 | 2.029E+01 | 100 | 248 | 3.04E+00 |
| Th-230 | α, γ | 7.54e+04 a | 6.357E+01 | 2.118E+00 | 10 | 25 | 2.64E+00 |
| Th-231 | β, γ | 1.063 d | 6.900E+00 | 9.762E-01 | --- | --- | --- |
| Th-232 | α, γ | 1.4E+10 a | 6.610E+00 | 2.181E-01 | 10 | 25 | 2.75E-01 |
| Th-234 | β, γ | 24.10 d | 2.420E+01 | 1.285E+02 | --- | --- | --- |
| Tl-207 | β, γ | 4.77 m | 1.788E+00 | 1.816E-01 | --- | --- | --- |
| Tl-208 | β, γ | 3.053 m | 2.351E+00 | 7.756E-02 | --- | --- | --- |
| Tl-209 | β, γ | 2.2 m | 1.613E+01 | 4.451E-01 | --- | --- | --- |
| U-232 | α, γ, SF | 70 a | 0.000E+00 | 0.000E+00 | 100 | 248 | 0.00E+00 |
| U-233 | α, γ, SF | 1.592E+05 a | 1.188E+03 | 3.281E+01 | 100 | 248 | 4.91E+00 |
| U-234 | α, γ, SF | 2.46E+05 a | 7.255E+02 | 2.599E+01 | 100 | 248 | 3.03E+00 |
| U-235 | α, γ, SF | 7.04E+08 a | 6.986E+00 | 9.881E-01 | 100 | 248 | 3.21E-02 |
| U-236 | α, γ, SF | 2.342E+07 a | 1.969E+01 | 1.729E+00 | 100 | 248 | 8.62E-02 |
| U-237 | β, γ | 6.75 d | 1.265E-07 | 1.152E-07 | --- | --- | --- |
| U-238 | α, γ, SF | 4.47E+09 a | 2.443E+01 | 1.297E+02 | 100 | 248 | 6.21E-01 |
| U-240 | <i>IT, \gamma</i> | 14.1 h | 8.176E-06 | 1.091E-03 | --- | --- | --- |
| Y-90 | β, γ | 2.67 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Y-91 | <i>IT, \beta'</i> | 49.71 m | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Zn-65 | $\beta^+, \gamma, \epsilon$ | 243.8 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Zr-93 | β, γ | 1.5E+06 a | 1.120E-03 | 3.373E-01 | 1000 | 2484 | 1.36E-04 |
| Zr-95 | β, γ | 64.02 d | 0.000E+00 | 0.000E+00 | --- | --- | --- |
| Total: | --- | --- | 5.40E+05 | 5.46E+03 | --- | --- | 2.17E+03 |

(a) Decayed radionuclide inventory information taken from *Calculation of Decayed Radionuclide Inventories for the Compliance Recertification Application, Revision 1* (Fox 2003). Radionuclide decay was performed using ORIGEN2 Version 2.2.

(b) Release limits are determined in accordance with 40CFR191 (Appendix A, Table 1). Left column corresponds to specific release limits (cumulative releases to the accessible environment for 10,000 years after disposal per "Unit of Waste" identified in Note 1(e) of Table 1, Appendix A, 40CFR191). Right column corresponds to release limit obtained for 2.48 Units of Waste. The 2.48 value for the Unit of Waste corresponds to the Units of Waste present at repository closure, 2033.

(c) Decay mode and half-life information taken from *Nuclides and Isotopes* (also called the "Chart of the Nuclides"), 14th Ed. (General Electric 1989).