Environmental Protection Agency

§ 191.27 Effective date.

The standards in this subpart shall be effective on January 19, 1994.

APPENDIX A TO PART 191—TABLE FOR SUBPART B

TABLE 1—RELEASE LIMITS FOR CONTAINMENT

REQUIREMENTS

[Cumulative releases to the accessible environment for 10,000 years after disposal]

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Release limit per 1,000 MTHM or other unit of waste (see notes) (curies)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Americium-241 or -243</td>
<td>100</td>
</tr>
<tr>
<td>Carbon-14</td>
<td>100</td>
</tr>
<tr>
<td>Cesium-135 or -137</td>
<td>1,000</td>
</tr>
<tr>
<td>Iodine-129</td>
<td>100</td>
</tr>
<tr>
<td>Neptunium-237</td>
<td>100</td>
</tr>
<tr>
<td>Plutonium-239, -239, -240, or -242</td>
<td>100</td>
</tr>
<tr>
<td>Radium-226</td>
<td>100</td>
</tr>
<tr>
<td>Strontium-90</td>
<td>1,000</td>
</tr>
<tr>
<td>Technetium-99</td>
<td>10,000</td>
</tr>
<tr>
<td>Thorium-230 or -232</td>
<td>10</td>
</tr>
<tr>
<td>Tin-122</td>
<td>1,000</td>
</tr>
<tr>
<td>Uranium-233, -234, -235, -236, or -238</td>
<td>100</td>
</tr>
<tr>
<td>Any other alpha-emitting radionuclide with a half-life greater than 20 years</td>
<td>100</td>
</tr>
<tr>
<td>Any other radionuclide with a half-life greater than 20 years that does not emit alpha particles</td>
<td>1,000</td>
</tr>
</tbody>
</table>

APPLICATION OF TABLE 1

Note 1: Units of Waste. The Release Limits in Table 1 apply to the amount of wastes in any one of the following:

(a) An amount of spent nuclear fuel containing 1,000 metric tons of heavy metal (MTHM) exposed to a burnup between 25,000 megawatt-days per metric ton of heavy metal (MWd/MTHM) and 40,000 MWd/MTHM;

(b) The high-level radioactive wastes generated from reprocessing each 1,000 MTHM exposed to a burnup between 25,000 MWd/MTHM and 40,000 MWd/MTHM;

(c) Each 100,000,000 curies of gamma or beta-emitting radionuclides with half-lives greater than 20 years but less than 100 years (for use as discussed in Note 5 or with materials that are identified by the Commission as high-level radioactive waste in accordance with part B of the definition of high-level waste in the NWPA);

(d) Each 1,000,000 curies of other radionuclides (i.e., gamma or beta-emitters with half-lives greater than 100 years or any alpha-emitters with half-lives greater than 20 years) (for use as discussed in Note 5 or with materials that are identified by the Commission as high-level radioactive waste in accordance with part B of the definition of high-level waste in the NWPA).

§ 191.25 Compliance with other Federal regulations.

Compliance with the provisions in this subpart does not negate the necessity to comply with any other applicable Federal regulations or requirements.

§ 191.26 Alternative provisions.

The Administrator may, by rule, substitute for any of the provisions of this subpart alternative provisions chosen after:

(a) The alternative provisions have been proposed for public comment in the Federal Register together with information describing the costs, risks, and benefits of disposal in accordance with the alternative provisions and the reasons why compliance with the existing provisions of this subpart appears inappropriate;

(b) A public comment period of at least 90 days has been completed, during which an opportunity for public hearings in affected areas of the country has been provided; and

(c) The public comments received have been fully considered in developing the final version of such alternative provisions.
(e) An amount of transuranic (TRU) wastes containing one million curies of alpha-emitting transuranic radionuclides with half-lives greater than 20 years.

Note 2: Release Limits for Specific Disposal Systems. To develop Release Limits for a particular disposal system, the quantities in Table 1 shall be adjusted for the amount of waste included in the disposal system compared to the various units of waste defined in Note 1. For example:

(a) If a particular disposal system contained the high-level wastes from 50,000 MTHM, the Release Limits for that system would be the quantities in Table 1 multiplied by 50 (50,000 MTHM divided by 1,000 MTHM).

(b) If a particular disposal system contained three million curies of alpha-emitting transuranic wastes, the Release Limits for that system would be the quantities in Table 1 multiplied by three (three million curies divided by one million curies).

(c) If a particular disposal system contained both the high-level wastes from 50,000 MTHM and 5 million curies of alpha-emitting transuranic wastes, the Release Limits for that system would be the quantities in Table 1 multiplied by 55:

\[
\frac{50,000 \text{ MTHM}}{1,000 \text{ MTHM}} + \frac{5,000,000 \text{ curies TRU}}{1,000,000 \text{ curies TRU}} = 55
\]

Note 3: Adjustments for Reactor Fuels with Different Burnup. For disposal systems containing reactor fuels (or the high-level wastes from reactor fuels) exposed to an average burnup of less than 25,000 MWd/MTHM or greater than 60,000 MWd/MTHM, the units of waste defined in (a) and (b) of Note 1 shall be adjusted. The unit shall be multiplied by the ratio of 30,000 MWd/MTHM divided by the fuel’s actual average burnup, except that a value of 5,000 MWd/MTHM may be used when the average fuel burnup is below 5,000 MWd/MTHM and a value of 100,000 MWd/MTHM shall be used when the average fuel burnup is above 100,000 MWd/MTHM. This adjusted unit of waste shall then be used in determining the Release Limits for the disposal system.

For example, if a particular disposal system contained only high-level wastes with an average burnup of 3,000 MWd/MTHM, the unit of waste for that disposal system would be:

\[
1,000 \text{ MTHM} \times \frac{30,000}{5,000} = 6,000 \text{ MTHM}
\]

If that disposal system contained the high-level wastes from 60,000 MTHM (with an average burnup of 3,000 MWd/MTHM), then the Release Limits for that system would be the quantities in Table 1 multiplied by ten:

\[
\frac{60,000 \text{ MTHM}}{6,000 \text{ MTHM}} = 10
\]

which is the same as:

\[
\frac{60,000 \text{ MTHM}}{1,000 \text{ MTHM}} \times \frac{(5,000 \text{ MWd/MTHM})}{(30,000 \text{ MWd/MTHM})} = 10
\]

Note 4: Treatment of Fractionated High-Level Wastes. In some cases, a high-level waste stream from reprocessing spent nuclear fuel may have been (or will be) separated into two or more high-level waste components destined for different disposal systems. In such cases, the implementing agency may allocate the Release Limit multiplier (based upon the original MTHM and the average fuel burnup of the high-level waste stream) among the various disposal systems as it chooses, provided that the total Release Limit multiplier used for that waste stream at all of its disposal systems may not exceed the Release Limit multiplier that would be used if the entire waste stream were disposed of in one disposal system.

Note 5: Treatment of Wastes with Poorly Known Burnups or Original MTHM. In some cases, the records associated with particular high-level waste streams may not be adequate to accurately determine the original metric tons of heavy metal in the reactor fuel that created the waste, or to determine the average burnup that the fuel was exposed to. If the uncertainties are such that the original amount of heavy metal or the average fuel burnup for particular high-level waste streams cannot be quantified, the units of waste derived from (a) and (b) of Note 1 shall no longer be used. Instead, the units of waste defined in (c) and (d) of Note 1 shall be used for such high-level waste streams. If the uncertainties in such information allow a range of values to be associated with the original amount of heavy metal or the average fuel burnup, then the calculations described in previous Notes will be conducted using the values that result in the smallest Release Limits, except that the Release Limits need not be smaller than those that would be calculated using the units of waste defined in (c) and (d) of Note 1.

Note 6: Uses of Release Limits to Determine Compliance with §191.13 Once release limits for a particular disposal system have been determined in accordance with Notes 1 through 5, these release limits shall be used to determine compliance with the requirements of §191.13 as follows. In cases where a mixture of radionuclides is projected to be released to the accessible environment, the limiting values shall be determined as follows: For each radionuclide in the mixture, determine the ratio between the cumulative release quantity projected over 10,000 years...
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and the limit for that radionuclide as determined from Table 1 and Notes 1 through 5.
The sum of such ratios for all the radionuclides in the mixture may not exceed one
with regard to §191.13(a)(1) and may not exceed ten with regard to §191.13(a)(2).

For example, if radionuclides A, B, and C are projected to be released in amounts Q_a,
Q_b, and Q_c, and if the applicable Release Limits are RL_a, RL_b, and RL_c, then the cumulative
releases over 10,000 years shall be limited so that the following relationship exists:

\[
\frac{Q_a}{RL_a} + \frac{Q_b}{RL_b} + \frac{Q_c}{RL_c} \leq 1
\]


APPENDIX B TO PART 191—CALCULATION OF ANNUAL COMMITTED EFFECTIVE DOSE

I. Equivalent Dose

The calculation of the committed effective dose (CED) begins with the determination of
the equivalent dose, \(H_T\), to a tissue or organ, \(T\), listed in Table B.2 below by using the equation:

\[
H_T = \sum_{R} D_{TR} \cdot w_R
\]

where \(D_{TR}\) is the absorbed dose in rads (one SI unit, equals 100 rads) averaged
over the tissue or organ, \(T\), due to radiation type, \(R\), and \(w_R\) is the radiation weighting
factor which is given in Table B.1 below. The unit of equivalent dose is the rem (sievert, in
SI units).

**Table B.1—Radiation Weighting Factors, \(w_R\)**

<table>
<thead>
<tr>
<th>Radiation type and energy range</th>
<th>(w_R) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photons, all energies</td>
<td>1</td>
</tr>
<tr>
<td>Electrons and muons, all energies</td>
<td>1</td>
</tr>
<tr>
<td>Neutrons, energy &lt; 10 keV</td>
<td>1</td>
</tr>
<tr>
<td>&gt;10 keV to 2 MeV</td>
<td>10</td>
</tr>
<tr>
<td>&gt;2 MeV to 20 MeV</td>
<td>20</td>
</tr>
<tr>
<td>&gt;20 MeV</td>
<td>5</td>
</tr>
<tr>
<td>Protons, other than recoil protons, &gt;2 MeV</td>
<td>5</td>
</tr>
<tr>
<td>Alpha particles, fission fragments, heavy nuclei</td>
<td>20</td>
</tr>
</tbody>
</table>

1 The values are considered to be appropriate for protection for individuals of both sexes and all ages.

2 For purposes of calculation, the remainder is comprised of the five tissues or organs not specifically listed in Table B.2
   that receive the highest dose equivalents; a weighting factor of 0.06 is applied to each of them, including the various sec-
   tions of the gastrointestinal tract which are treated as separate organs. This covers all tissues and organs except the
   hands and forearms, the test and ankles, the skin and the lens of the eye. The excpected tissues and organs should be
   excluded from the computation of \(H_T\).

III. Annual Committed Tissue or Organ Equivalent Dose

For internal irradiation from incorporated radionuclides, the total absorbed dose will be
spread out in time, being gradually delivered as the radionuclide decays. The time
distribution of the absorbed dose rate will vary with the radionuclide, its form, the mode of
intake and the tissue within which it is incorporated. To take account of this distribution
the quantity committed equivalent dose, \(H_T(t)\) where is the integration time in
years following an intake over any particular year, is used and is the integral over time of
the equivalent dose rate in a particular tissue or organ that will be received by an individual
following an intake of radioactive material into the body. The time period, \(t\), is taken as 50 years as an average
time of exposure following intake:

\[
H_T(t) = \int_{0}^{t} H_T' dt
\]

for a single intake of activity at time \(t_0\) where \(H_T'(t)\) is the relevant equivalent-dose
rate in a tissue or organ at time \(t\). For the purposes of this part, the previously men-
tioned single intake may be considered to be an annual intake.