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## 3.1 Facility Effluent Monitoring

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Liquid and airborne effluents that may contain radioactive or hazardous constituents are continually monitored when released to the environment at the Hanford Site. Facility operators perform the monitoring mainly through analyzing samples collected near points of release into the environment. Effluent monitoring data are evaluated to determine the degree of regulatory compliance for each facility or the entire site, as appropriate. The evaluations are also useful in assessing the effectiveness of effluent treatment and control systems and management practices. Major facilities have their own individual effluent monitoring plans, which are part of *Environmental Monitoring Plan, United States Department of Energy, Richland Operations Office* (DOE 1994a), the comprehensive site environmental monitoring plan required by DOE.

Measuring devices quantify most facility effluent flows, but some flows are calculated using process information. Effluent sampling methods include continuous sampling or periodic confirmatory measurements for most radioactive air emission units and proportional, or grab, sampling for most liquid effluent streams. Liquid and airborne effluents with a potential to contain radioactive materials at prescribed threshold levels are measured for total alpha and beta activity and, as warranted, specific radionuclides. Nonradioactive constituents are also either monitored or sampled, as applicable.

Small quantities of tritium, cobalt-60, strontium-90, technetium-99, ruthenium-106, antimony-125, iodine-129, cesium-134, cesium-137, europium-154, europium-155, radon-220, radon-222, uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239,240, plutonium-241, and americium-241 continue to be released to the environment. However, most radionuclides in effluents at the site are approaching levels indistinguishable from background, or natural, concentrations. A new site mission of environmental restoration, replacing nuclear materials production, is largely responsible for the improved trend in radioactive emissions. This decreasing trend results in significantly smaller offsite radiation doses to the maximally exposed individual attributable to

site activities. Figures 3.1.1 and 3.1.2 depict quantities of several prominent dose-contributing radionuclides released from the site over the past years. In 1996, releases of radioactive and nonradioactive constituents in effluents were less than applicable standards.

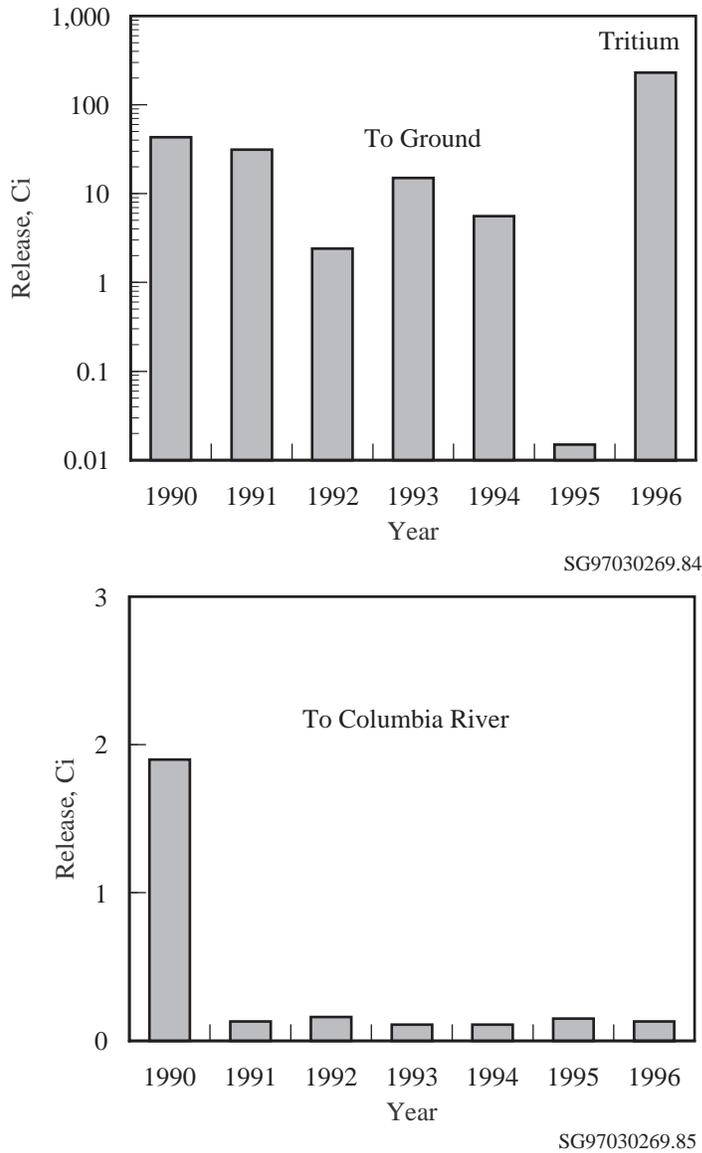
Effluent release data are documented in several reports, in addition to this one, and all are available to the public. For instance, DOE annually submits to EPA and the Washington State Department of Health a report of radioactive airborne emissions from the site (Gleckler et al. 1997), in compliance with National Emission Standards for Hazardous Air Pollutants (40 CFR 61) and Radiation Protection--Air Emissions (WAC 246-247). Data quantifying radioactive liquid and airborne effluents discharged by the site management and integration contractor and its subcontractors and the environmental restoration contractor are reported to DOE annually in the environmental releases report (Gleckler 1997). Monitoring results for liquid streams regulated by the National Pollutant Discharge Elimination System permit are reported to EPA. Monitoring results from liquid effluent streams regulated by WAC-173-216 are reported to the Washington State Department of Ecology. Nonradioactive air emissions are reported annually to the Washington State Department of Ecology.

### Airborne Emissions

#### Radioactive Airborne Emissions

Radioactive airborne emissions from site activities contain at least one of these forms of radionuclides: particles, noble gases, and volatile elements. Emissions having the potential to exceed 1% of the 10-mrem/yr standard for offsite doses are continuously monitored.

The continuous monitoring of radioactive emissions involves analyzing samples collected at points of discharge to the environment, usually from a stack or vent. Samples are analyzed for total alpha activity, total beta

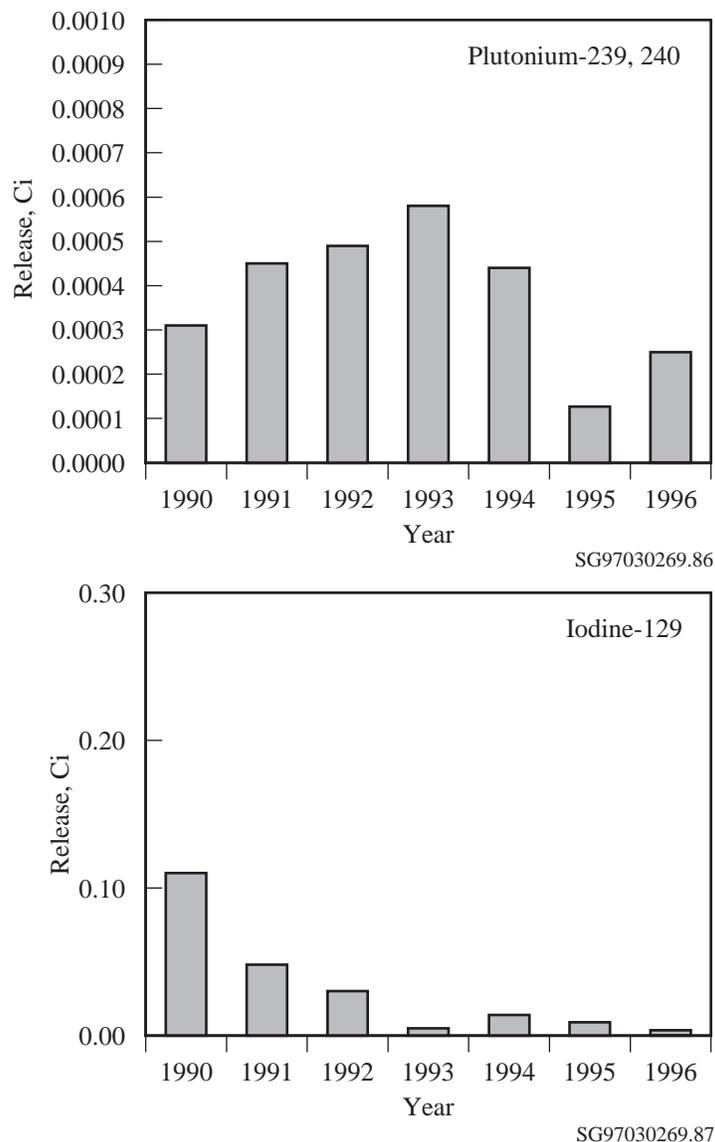


**Figure 3.1.1.** Liquid Releases of Selected Radionuclides from Site Facilities, 1990 Through 1996

activity, and selected radionuclides. The selection of the specific radionuclides that are sampled, analyzed, and reported is based on 1) an evaluation of maximum potential unmitigated emissions expected from known radionuclide inventories in a facility or activity area, 2) the sampling criteria given in contractor environmental compliance manuals, and 3) the potential each radionuclide has to contribute to the offsite public dose. Continuous air monitoring systems with alarms are also used at selected discharge points when a potential exists for radioactive emissions to exceed normal operating ranges by levels requiring immediate personnel alert.

Radioactive emission discharge points are located in the 100, 200, 300, 400, and 600 Areas. The sources for these emissions are summarized below.

- In the 100 Areas, emissions originate from the deactivation of the N Reactor Fuel Storage Basin, the two 100-K Area water-filled storage basins (K Basins) containing irradiated fuel, a recirculation facility that filters radioactive water from the N Reactor basin that was used for storage of irradiated fuel, a room used for cleaning contaminated tools and equipment,



**Figure 3.1.2.** Airborne Releases of Selected Radionuclides from Site Facilities, 1990 Through 1996

and a radiochemistry laboratory. Six radioactive emission points were active in the 100 Areas during 1996.

- The 200 Areas contain inactive facilities for nuclear fuel chemical separations and reprocessing, waste handling and disposal facilities, and steam generation plants using fossil fuels. Primary sources of radionuclide emissions are the Plutonium-Uranium Extraction Plant, Plutonium Finishing Plant, T Plant, 222-S Analytical Laboratory, underground tanks for storage of high-level radioactive waste, and waste evaporators. During 1996, 63 radioactive emission points were active in the 200 Areas.

- The 300 Area primarily contains laboratories, research facilities, and a fossil fuel powered steam plant. Primary sources of radionuclide emissions are the 324 Waste Technology Engineering Laboratory, 325 Applied Chemistry Laboratory, 327 Post-Irradiation Laboratory, and 340 Vault and Tanks. Radioactive emissions arise from research-and-development and waste handling activities. During 1996, 32 radioactive emission discharge points were active in the 300 Area.
- The 400 Area has the Fast Flux Test Facility, the Maintenance and Storage Facility, and the Fuels and Materials Examination Facility. Operations and

support activities at the Fast Flux Test Facility and Maintenance and Storage Facility released small quantities of radioactive material to the environment, even though the reactor did not operate in 1996. The 400 Area had four radioactive emission discharge points active during 1996.

- The 600 Area encompasses the remaining portions of the Hanford Site not assigned to other areas. One minor radioactive emission point was active during 1996, the 6652-H Ecology Laboratory on the Fitzner/Eberhardt Arid Lands Ecology Reserve; its releases have been incorporated with 400 Area releases.

A summary of the Hanford Site's 1996 radioactive airborne emissions is provided in Table 3.1.1. Several constituents not detected or not measured are included in the table for historical comparisons.

## Nonradioactive Airborne Emissions

Nonradioactive air pollutants emitted from power generating and chemical processing facilities are monitored when activities at a facility are known to potentially generate pollutants of concern.

In past years, gaseous ammonia has been emitted from the Plutonium-Uranium Extraction Plant, 242-A Evaporator, 241-AP Tank Farm, and 241-AW Tank Farm. Ammonia emissions are monitored only when activities at these facilities are capable of generating them. In 1996, the 242-A Evaporator operated during the month of May, producing reportable ammonia emissions. The 200-West Area tank farms produced reportable ammonia emissions in 1996 also. The ammonia releases from the 242-A Evaporator and tank farms in the 200 Areas are summarized in Table 3.1.2.

Operating power plants on the site emit particulate matter, sulfur oxides, nitrogen oxides, volatile organic compounds, carbon monoxide, and lead. The total annual releases of these constituents are reported in accordance with the air quality standards established by Washington State in WAC-173-400. Power plant emissions are calculated from the quantities of fossil fuel consumed, using EPA-approved formulas.

Should activities lead to chemical emissions in excess of quantities reportable under the Comprehensive Environmental Response, Compensation, and Liability Act, the release totals are reported immediately to EPA. If the

emissions remain stable at predicted levels, they may be reported annually with EPA's permission. Table 3.1.2 summarizes the 1996 emissions of nonradioactive constituents (it should be noted that the 100, 400, and 600 Areas have no nonradioactive emission sources of concern).

## Liquid Effluents

### Radioactive Liquid Effluents

Liquid effluents are discharged from facilities in all areas of the Hanford Site. Effluents that normally or potentially contain radionuclides include cooling water, steam condensates, process condensates, and waste water from laboratories and chemical sewers. These wastewater streams are sampled and analyzed for total alpha activity, total beta activity, and selected radionuclides.

Only facilities in the 200 Areas discharged radioactive liquid effluents to ground disposal sites in 1996. A summary of radioactive liquid effluents discharged to the 200 Areas' ground disposal facilities in 1996 is provided in Table 3.1.3. Table 3.1.4 summarizes data on radionuclides in liquid effluents released from the 100 Areas to the Columbia River. These measurements are used to determine potential radiation doses to the public. Several constituents not detected are included in the tables for historical comparisons.

### Nonradioactive Hazardous Materials in Liquid Effluents

Nonradioactive hazardous materials in liquid effluents are monitored in the 100, 200, 300, and 400 Areas. These effluents are typically discharged to cribs, ponds, ditches, trenches, and the Columbia River. Effluents entering the Columbia River at designated discharge points are sampled and analyzed to determine compliance with the National Pollutant Discharge Elimination System permit for the site. Should chemicals in liquid effluents exceed quantities reportable under the Comprehensive Environmental Response, Compensation, and Liability Act, the release totals are reported immediately to the EPA. If emissions remain stable at predicted levels, they may be reported annually with EPA's permission. In Section 2.0, Table 2.2.3 contains a synopsis of the National Pollutant Discharge Elimination System and State Waste Discharge permit violations in 1996.

**Table 3.1.1.** Release Estimates of Hanford Site Radionuclide Air Emissions, 1996

Radionuclide	Half-Life	Release, Ci <sup>(a)</sup>				
		100 Areas	200-East Area	200-West Area	300 Area	400 Area
<sup>3</sup> H (as HTO) <sup>(b)</sup>	12.3 yr	NM	NM	NM	1.8 x 10 <sup>0</sup>	3.6 x 10 <sup>0</sup>
<sup>3</sup> H (as HT) <sup>(b)</sup>	12.3 yr	NM	NM	NM	1.7 x 10 <sup>0</sup>	NM
<sup>60</sup> Co	5.3 yr	5.1 x 10 <sup>-7</sup>	7.7 x 10 <sup>-10</sup>	ND	ND	NM
<sup>65</sup> Zn	244.4 d	ND	ND	ND	ND	NM
<sup>90</sup> Sr	29.1 yr	2.9 x 10 <sup>-5</sup>	6.2 x 10 <sup>-5(c)</sup>	3.6 x 10 <sup>-4(c)</sup>	2.0 x 10 <sup>-5(c)</sup>	9.0 x 10 <sup>-9(c)</sup>
<sup>95</sup> Zr	64.02 d	ND	ND	ND	ND	NM
<sup>106</sup> Ru	368 d	5.4 x 10 <sup>-7</sup>	9.5 x 10 <sup>-8</sup>	NM	ND	NM
<sup>113</sup> Sn	115.1 d	ND	ND	NM	ND	NM
<sup>125</sup> Sb	2.77 yr	1.9 x 10 <sup>-7</sup>	2.0 x 10 <sup>-6</sup>	NM	ND	NM
<sup>129</sup> I	1.6 x 10 <sup>7</sup> yr	NM	3.9 x 10 <sup>-3</sup>	NM	ND	NM
<sup>131</sup> I	8.040 d	NM	ND	NM	ND	ND
<sup>134</sup> Cs	2.1 yr	1.3 x 10 <sup>-8</sup>	3.0 x 10 <sup>-9</sup>	ND	ND	NM
<sup>137</sup> Cs	30 yr	5.1 x 10 <sup>-5</sup>	5.5 x 10 <sup>-4</sup>	6.5 x 10 <sup>-7</sup>	3.3 x 10 <sup>-6</sup>	5.5 x 10 <sup>-6(d)</sup>
<sup>152</sup> Eu	13.6 yr	ND	ND	ND	ND	NM
<sup>154</sup> Eu	8.8 yr	4.5 x 10 <sup>-7</sup>	ND	ND	ND	NM
<sup>155</sup> Eu	5 yr	1.9 x 10 <sup>-7</sup>	ND	ND	ND	NM
<sup>220</sup> Rn	56 s	NM	NM	NM	5.4 x 10 <sup>1</sup>	NM
<sup>222</sup> Rn	3.8 d	NM	NM	NM	5.0 x 10 <sup>-1</sup>	NM
Uranium, depleted	2.445 x 10 <sup>5</sup> yr	NM	NM	NM	ND <sup>(e)</sup>	NM
<sup>238</sup> Pu	87.7 yr	5.2 x 10 <sup>-7</sup>	2.2 x 10 <sup>-7</sup>	4.2 x 10 <sup>-6</sup>	1.9 x 10 <sup>-8</sup>	NM
<sup>239,240</sup> Pu	2.4 x 10 <sup>4</sup> yr	4.5 x 10 <sup>-6(f)</sup>	6.7 x 10 <sup>-6(f)</sup>	2.4 x 10 <sup>-4(f)</sup>	1.9 x 10 <sup>-6(f)</sup>	8.3 x 10 <sup>-7(f)</sup>
<sup>241</sup> Pu	14.4 yr	4.1 x 10 <sup>-5</sup>	1.7 x 10 <sup>-5</sup>	3.5 x 10 <sup>-4</sup>	NM	NM
<sup>241</sup> Am	432 yr	2.0 x 10 <sup>-6</sup>	9.2 x 10 <sup>-6</sup>	3.7 x 10 <sup>-5</sup>	7.0 x 10 <sup>-8</sup>	NM

(a) 1 Ci = 3.7 x 10<sup>10</sup> Bq; NM = not measured; ND = not detected.

(b) HTO = tritiated water vapor; HT = elemental tritium.

(c) This value includes total beta release data. Total beta and unspecified beta results assumed to be <sup>90</sup>Sr for dose calculations.

(d) The 400 Area's <sup>137</sup>Cs value is derived fully from total beta measurements.

(e) Determined from total alpha measurements. Assumed to be depleted uranium, consisting of 63.478 Ci% <sup>238</sup>U, 0.821 Ci% <sup>235</sup>U, and 35.701 Ci% <sup>234</sup>U (99.797 wt% <sup>238</sup>U, 0.200 wt% <sup>235</sup>U, and 0.003 wt% <sup>234</sup>U).

(f) This value includes total alpha release data. Total alpha and unspecified alpha results assumed to be <sup>239,240</sup>Pu for dose calculations.

**Table 3.1.2.** Nonradioactive Constituents Discharged to the Atmosphere, 1996<sup>(a)</sup>

Constituent	Release, kg <sup>(b)</sup>		
	200-East Area	200-West Area	300 Area
Particulate matter	1.78 x 10 <sup>3</sup>	2.91 x 10 <sup>1</sup>	1.23 x 10 <sup>4</sup>
Nitrogen oxides	2.00 x 10 <sup>5</sup>	1.54 x 10 <sup>4</sup>	4.16 x 10 <sup>4</sup>
Sulfur oxides	2.46 x 10 <sup>5</sup>	1.03 x 10 <sup>2</sup>	1.68 x 10 <sup>5</sup>
Carbon monoxide	6.76 x 10 <sup>4</sup>	7.27 x 10 <sup>1</sup>	3.78 x 10 <sup>3</sup>
Lead	1.73 x 10 <sup>2</sup>	1.81 x 10 <sup>-2</sup>	2.24 x 10 <sup>1</sup>
Volatile organic compounds <sup>(c)</sup>	1.35 x 10 <sup>3</sup>	1.73 x 10 <sup>2</sup>	2.12 x 10 <sup>2</sup>
Ammonia <sup>(d)</sup>	7.07 x 10 <sup>3</sup>	3.32 x 10 <sup>3</sup>	NM <sup>(e)</sup>
Arsenic	1.85 x 10 <sup>2</sup>	8.55 x 10 <sup>-3</sup>	1.32 x 10 <sup>1</sup>
Beryllium	2.50 x 10 <sup>1</sup>	5.09 x 10 <sup>-3</sup>	4.85 x 10 <sup>-1</sup>
Cadmium	1.47 x 10 <sup>1</sup>	2.24 x 10 <sup>-2</sup>	2.44 x 10 <sup>1</sup>
Chromium	5.37 x 10 <sup>2</sup>	9.67 x 10 <sup>-2</sup>	1.48 x 10 <sup>1</sup>
Cobalt	NE <sup>(e)</sup>	NE	1.40 x 10 <sup>1</sup>
Copper	3.37 x 10 <sup>2</sup>	5.70 x 10 <sup>-1</sup>	3.21 x 10 <sup>1</sup>
Formaldehyde	7.55 x 10 <sup>1</sup>	8.24 x 10 <sup>-1</sup>	4.68 x 10 <sup>1</sup>
Manganese	7.42 x 10 <sup>2</sup>	2.85 x 10 <sup>-2</sup>	8.55 x 10 <sup>0</sup>
Mercury	5.47 x 10 <sup>0</sup>	6.11 x 10 <sup>-3</sup>	3.70 x 10 <sup>0</sup>
Nickel	4.41 x 10 <sup>2</sup>	3.66 x 10 <sup>-2</sup>	2.69 x 10 <sup>2</sup>
Polycyclic organic matter	NE	3.20 x 10 <sup>2</sup>	6.35 x 10 <sup>3</sup>
Selenium	6.70 x 10 <sup>1</sup>	4.78 x 10 <sup>-2</sup>	4.39 x 10 <sup>0</sup>
Vanadium	4.62 x 10 <sup>1</sup>	1.42 x 10 <sup>-1</sup>	3.49 x 10 <sup>2</sup>

- (a) The estimate of volatile organic compound emissions do not include emissions from certain laboratory operations.
- (b) Multiply kg by 2.205 to convert to lb.
- (c) Produced from fossil fuel burning for steam generation and electrical generators.
- (d) Ammonia releases are from the 200-East Area tank farms, 200-West Area tank farms, and operation of the 242-A Evaporator.
- (e) NM = Not measured; NE = No emissions.

Liquid effluents containing both radioactive and hazardous constituents are stored at the 200 Areas in underground waste storage tanks or monitored interim-storage facilities. Activities in the 600 and 1100 Areas generate neither radioactive nor nonradioactive hazardous liquid effluents.

## Comprehensive Environmental Response, Compensation, and Liability Act and Washington Administrative Code Chemical Releases

Chemical releases are hazardous chemicals discharged directly to the environment, rather than through a liquid

effluent stream. These releases almost entirely consist of accidental spills. Releases of hazardous substances exceeding specified quantities that are continuous and stable in quantity and rate must be reported as required by Section 103(f)(2) of the Comprehensive Environmental Response, Compensation, and Liability Act.

There were three releases reported under the Act's reportable quantity or WAC 173-303-145 requirements by Hanford contractors in 1996. Effective July 12, 1995, the reportable quantity for ethylene glycol was increased from 0.454 to 2,270 kg (1 to 5,005 lb) by the final rule (60 FR 30926). The number of reportable ethylene glycol releases have been significantly reduced as a result of the change in the reportable quantity. Table 3.1.5 contains a synopsis of 1996 reportable spills pursuant to the Act and WAC 173-303-145.

**Table 3.1.3.** Radionuclides in Liquid Effluents Discharged to Ground Disposal Facilities in the 200 Areas, 1996

Radionuclide	Half-Life	Release, Ci <sup>(a)</sup>
<sup>3</sup> H	12.3 yr	2.2 x 10 <sup>2</sup>
<sup>14</sup> C	5,730 yr	8.5 x 10 <sup>-5</sup>
<sup>90</sup> Sr	29.1 yr	1.5 x 10 <sup>-4</sup>
<sup>99</sup> Tc	2.6 x 10 <sup>6</sup> yr	1.5 x 10 <sup>-4</sup>
<sup>106</sup> Ru	368 d	ND <sup>(b)</sup>
<sup>113</sup> Sn	115.1 d	ND
<sup>125</sup> Sb	2.77 yr	ND
<sup>134</sup> Cs	2.1 yr	ND
<sup>137</sup> Cs	30 yr	6.7 x 10 <sup>-6</sup>
<sup>152</sup> Eu	13.6 yr	ND
<sup>154</sup> Eu	8.8 yr	ND
<sup>155</sup> Eu	5 yr	ND
<sup>234</sup> U	2.445 x 10 <sup>5</sup> yr	2.0 x 10 <sup>-4</sup>
<sup>235</sup> U	7.04 x 10 <sup>8</sup> yr	ND
<sup>238</sup> U	4.47 x 10 <sup>9</sup> yr	1.5 x 10 <sup>-4</sup>
<sup>238</sup> Pu	87.7 yr	2.4 x 10 <sup>-5</sup>
<sup>239,240</sup> Pu	2.4 x 10 <sup>4</sup> yr	2.6 x 10 <sup>-5</sup>
<sup>241</sup> Am	432 yr	9.3 x 10 <sup>-5</sup>

(a) 1 Ci = 3.7 x 10<sup>10</sup> Bq.  
 (b) ND = Not detected.

**Table 3.1.4.** Radionuclides in Liquid Effluents Discharged to the Columbia River from the 100 Areas, 1996

Radionuclide	Half-Life	Release, Ci <sup>(a)</sup>
<sup>3</sup> H	12.3 yr	1.3 x 10 <sup>-1</sup>
<sup>60</sup> Co	5.3 yr	2.3 x 10 <sup>-3</sup>
<sup>90</sup> Sr	29.1 yr	1.2 x 10 <sup>-1</sup>
<sup>106</sup> Ru	368 d	ND <sup>(b)</sup>
<sup>125</sup> Sb	2.77 yr	3.5 x 10 <sup>-3</sup>
<sup>134</sup> Cs	2.1 yr	ND
<sup>137</sup> Cs	30 yr	3.8 x 10 <sup>-3</sup>
<sup>154</sup> Eu	8.8 yr	ND
<sup>155</sup> Eu	5 yr	1.2 x 10 <sup>-3</sup>
<sup>238</sup> Pu	87.7 yr	4.0 x 10 <sup>-5</sup>
<sup>239,240</sup> Pu	2.4 x 10 <sup>4</sup> yr	ND
<sup>241</sup> Am	432 yr	1.1 x 10 <sup>-4</sup>

(a) 1 Ci = 3.7 x 10<sup>10</sup> Bq.  
 (b) ND = Not detected.

**Table 3.1.5.** Comprehensive Environmental Response, Compensation, and Liability Act and Washington Administrative Code Reportable Spills, 1996

Material	Occurrence	Quantity	Location
Radioactive water	1	8.6 x 10 <sup>-6</sup> Ci, <sup>90</sup> Sr 2.7 x 10 <sup>-4</sup> Ci, <sup>137</sup> Cs	105-KW Basin
Ammonium bifluoride and ferric chloride hexahydrate	1	0.5 kg, NH <sub>4</sub> F <sub>2</sub> 1.2 kg, ferric chloride hexahydrate	Sent to Richland Landfill
Polychlorinated biphenyl	1	Undetermined	105-KE Basin
Raw sewage/water	1	Undetermined	MO-398 Building