3.1 Facility Effluent Monitoring

B. P. Gleckler

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* (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 for most radioactive air emissions and proportional or "grab" sampling for most liquid effluents. Liquid and airborne effluents with a potential to contain radioactive materials at prescribed threshold levels are measured for total alpha activity, total beta activity, and, as warranted, specific radionuclides. Nonradioactive constituents are also either monitored or sampled, as applicable.

Small quantities of the radionuclides tritium, colbalt-60, strontium-90, ruthenium-106, tin-113, antimony-125, iodine-129, cesium-134, cesium-137, europium-152, europium-154, europium-155, radon-220, radon-222, plutonium-238, plutonium-239,240, plutonium-241, americium-241, and uranium continue to be released to the environment. However, most radionuclides in effluents at the Site are approaching levels indistinguishable from background 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 long-lived, prominent dose-contributing radionuclides released from the Site over the past 7 years. In 1995, 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's Richland Operations Office annually submits to EPA a report of radioactive airborne emissions from the Site, in compliance with National Emission Standards for Hazardous Air Pollutants (DOE 1996e). Data quantifying radioactive liquid and airborne effluents discharged from Westinghouse Hanford Company facilities and activities are reported to DOE annually (WHC 1996a). Monitoring results for liquid streams regulated by the National Pollutant Discharge Elimination System permit are reported monthly to EPA. Nonradioactive air emissions are reported yearly 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. Emission sources 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 activity alpha, total beta 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) sampling criteria given in contractor environmental compliance manuals, and 3) the potential each radionuclide has to

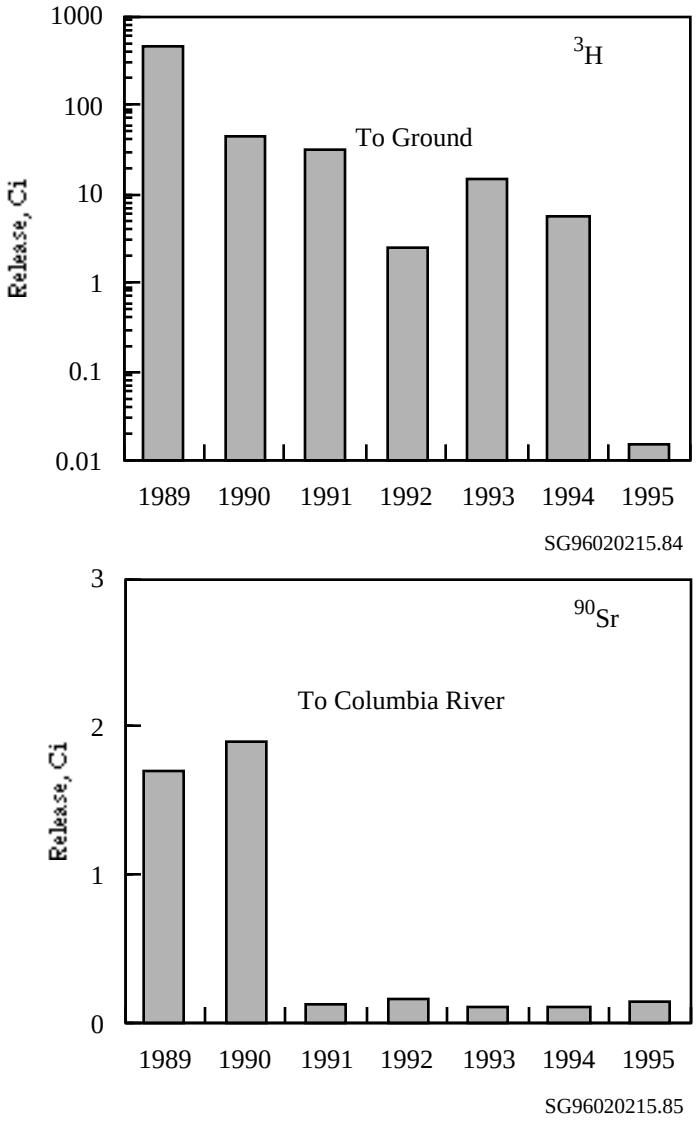

Figure 3.1.1. Liquid Releases of Selected Radionuclides from Site Facilities, 1989 Through 1995

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 shutdown of N Reactor, the two 100-K Area water-filled storage basins containing irradiated fuel, an inactive recirculation facility that filtered radioactive water from the N Reactor basin that was used for storage of irradiated fuel, a room used for cleaning contaminated tools and equipment, and a radiochemistry laboratory. Seven radioactive emission discharge points were active in the 100 Areas during 1995.

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

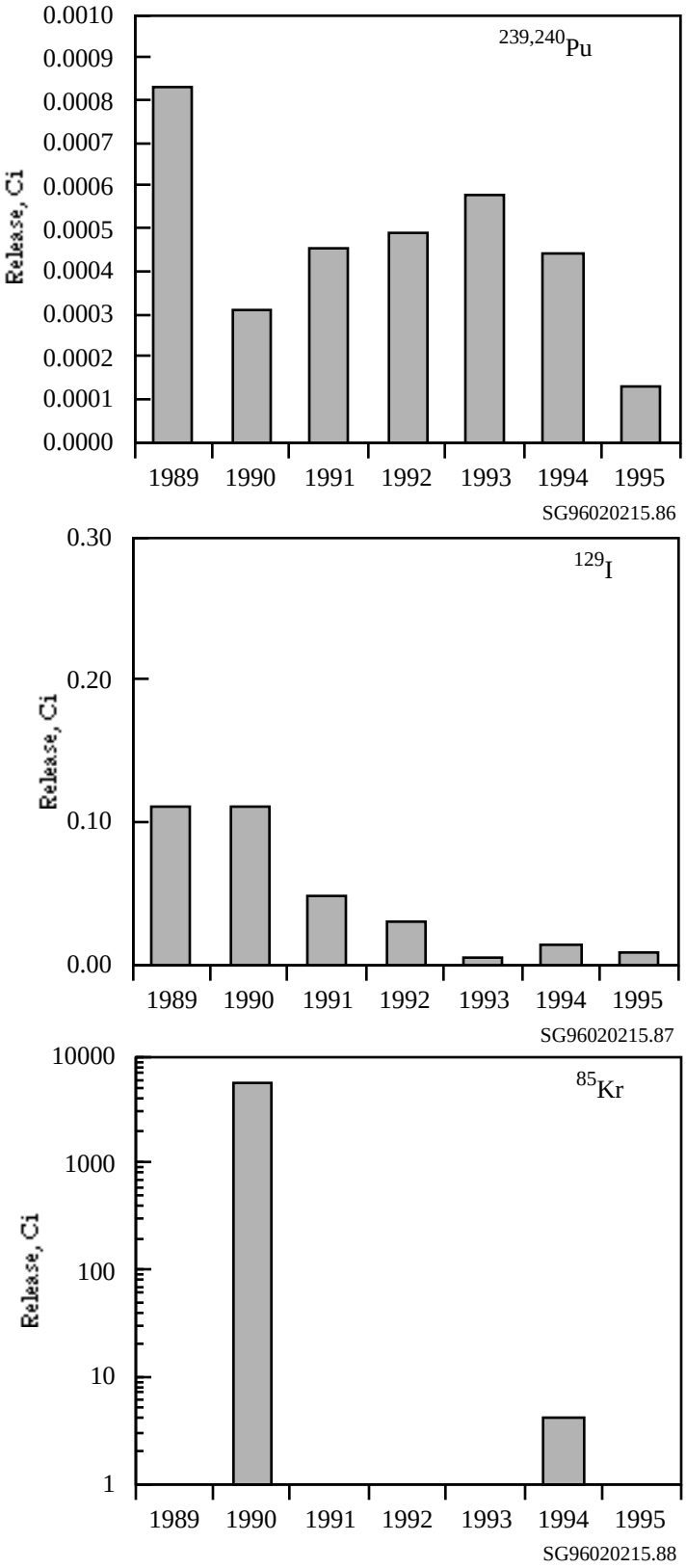

Figure 3.1.2. Airborne Releases of Selected Radionuclides from Site Facilities, 1989 Through 1995

During 1995, 61 radioactive emission discharge 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, the 325 Applied Chemistry Laboratory, the 327 Post-Irradiation Laboratory, and the 340 Vault and Tanks. Radioactive emissions arise from research and development and waste-handling activities. During 1995, 37 radioactive emission discharge points were active in the 300 Area.

- The 400 Area contains 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 the Maintenance and Storage Facility released small quantities of radioactive material to the environment, even though the reactor did not operate in 1995. The 400 Area had four active radioactive emission discharge points during 1995.

- The 600 Area encompasses the remaining portions of the Hanford Site not assigned to other areas. One minor radioactive emission point was active during 1995 (the 6652-H Ecology Laboratory on the Fitzner/Eberhardt Arid Lands Ecology Reserve).

A summary of the Hanford Site's 1995 radioactive airborne emissions from point sources is provided in Table 3.1.1. The Hanford Site also produces radioactive airborne emissions from diffuse and fugitive sources. Estimates of the radioactive airborne emissions from these sources can be found in the report *Radionuclide Air Emissions Report for the Hanford Site Calendar Year 1995* (DOE 1996e).

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, 200-East Area Tank Farms, and 200-West Area Tank Farms. Ammonia emissions are monitored only when activities at these facilities are capable of generating them. In 1995, the 242-A Evaporator operated during April, June, and July producing reportable ammonia emissions. The 200-East Area and 200-West Area Tank Farms also produced reportable ammonia emissions in 1995. The ammonia releases from the 242-A Evaporator, and 200 Areas Tank Farms are provided in Table 3.1.2.

Operating powerhouses 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 the Washington State Department of Ecology. Powerhouse 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 1995 emissions of nonradioactive constituents (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 waste-water 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 facilities in 1995. A summary of radioactive liquid effluents discharged to the 200 Areas' ground disposal facilities in 1995 is provided in Table 3.1.3. Table 3.1.4 summarizes data on radionuclides released from the 100 Areas to the Columbia River. Releases entering the river via ground water are not measured directly but are assessed through the environmental surveillance of river water (see Section 4.2, "Surface Water and Sediment Surveillance"). These measurements are used with the direct effluent measurements to determine potential public doses.

Table 3.1.1. Radionuclides Discharged to the Atmosphere from the Hanford Site, 1995

Radionuclide	Half-Life	Release, Ci[a]				
		100 Areas	200-East Area	200-West Area	300 Area	400 Area[b]
^{3}H (as HTO)[c]	12.3 yr	NM[d]	NM	NM	2.80	2.5×10^{-2}
^{3}H (as HT)[e]	12.3 yr	NM	NM	NM	3.84	NM
^{60}Co	5.3 yr	9.2×10^{-6}	ND[d]	ND	ND	NM
^{65}Zn	244.4 d	ND	ND	ND	ND	NM
^{90}Sr	29.1 yr	6.1×10^{-5}	6.8×10^{-5}[f]	1.0×10^{-4}[f]	1.8×10^{-5}[f]	6.1×10^{-8}[f]
^{95}ZrNb	64.02 d	ND	ND	ND	ND	NM
^{106}Ru	368 d	1.1×10^{-5}	6.7×10^{-6}	1.0×10^{-8}	ND	NM
^{113}Sn	115.1 d	ND	8.0×10^{-7}	1.4×10^{-7}	ND	NM
^{125}Sb	2.77 yr	2.8×10^{-6}	9.1×10^{-6}	1.2×10^{-7}	ND	NM
^{129}I	1.6×10^{7} yr	NM	8.9×10^{-3}	NM	ND	NM
^{131}I	8.040 d	NM	ND	NM	ND	ND
^{134}Cs	2.1 yr	1.3×10^{-6}	2.4×10^{-8}	1.1×10^{-7}	2.7×10^{-8}	NM
^{137}Cs	30 yr	2.5×10^{-4}	3.8×10^{-4}	1.9×10^{-5}	1.5×10^{-6}	5.9×10^{-6}[g]
^{152}Eu	13.6 yr	ND	3.7×10^{-7}	1.6×10^{-7}	ND	NM
^{154}Eu	8.8 yr	8.3×10^{-6}	4.6×10^{-7}	2.6×10^{-7}	ND	NM
^{155}Eu	5 yr	1.5×10^{-6}	2.2×10^{-7}	1.2×10^{-7}	4.3×10^{-8}	NM
^{220}Rn	56 s	NM	NM	NM	79	NM
^{222}Rn	3.8 d	NM	NM	NM	0.4	NM
Uranium, depleted	$\geq 2.445 \times 10^{5}$	NM	NM	NM	2.2×10^{-8}[h]	NM
^{238}Pu	87.7 yr	2.3×10^{-6}	6.9×10^{-7}	2.6×10^{-6}	2.5×10^{-9}	NM
^{239,240}Pu	2.4×10^{4} yr	1.5×10^{-5}[i]	7.9×10^{-6}[i]	1.0×10^{-4}[i]	2.1×10^{-6}[i]	1.7×10^{-6}[i]
^{241}Pu	14.4 yr	2.1×10^{-4}	1.2×10^{-4}	2.0×10^{-4}	NM	NM
^{241}Am	432 yr	5.7×10^{-6}	1.6×10^{-5}	1.7×10^{-5}	1.1×10^{-8}	NM

(a) 1 Ci = 3.7×10^{10} Bq.
(b) Releases from the 400 Area contain emissions from one stack in the 600 Area.
(c) HTO = tritiated water vapor.
(d) NM = not measured; ND = none detected.
(e) HT = elemental tritium.
(f) This value includes total beta release data. Total beta and unspecified beta results are assumed to be ^{90}Sr for dose calculations.
(g) The 400 Area's ^{137}Cs value is derived fully from total beta measurements.
(h) Determined from total alpha measurements. Assumed to be depleted uranium consisting of 63.478 Ci% ^{238}U, 0.821 Ci% ^{235}U, and 35.701 Ci% ^{234}U (99.797 wt% ^{238}U, 0.200 wt% ^{235}U, and 0.003 wt% ^{234}U).
(i) This value includes total alpha release data. Total alpha and unspecified alpha results assumed to be ^{239,240}Pu for dose calculations.

Table 3.1.2. Nonradioactive Constituents Discharged to the Atmosphere, 1995[a]

Constituent	Release, kg		
	200-East Area	200-West Area	300 Area
Particulate matter	1.70×10^{3}	3.19×10^{2}	1.60×10^{4}
Nitrogen oxides	1.77×10^{5}	2.82×10^{4}	4.69×10^{4}
Sulfur oxides	2.25×10^{5}	3.53×10^{4}	2.34×10^{5}
Carbon monoxide	6.43×10^{4}	1.01×10^{4}	4.25×10^{3}
Lead	1.62×10^{2}	2.53×10^{1}	2.52×10^{1}
Volatile organic compounds[b]	6.43×10^{2}	1.00×10^{2}	2.38×10^{2}
Ammonia[c]	6.18×10^{3}	1.53×10^{3}	NM
Arsenic	1.73×10^{2}	2.70×10^{1}	1.48×10^{1}
Beryllium	2.33×10^{1}	3.64×10^{0}	5.46×10^{-1}
Cadmium	1.37×10^{1}	2.18×10^{0}	2.74×10^{1}
Carbon tetrachloride[d]	NM	9.07×10^{1}	NM
Chromium	5.01×10^{2}	7.83×10^{1}	1.67×10^{1}
Cobalt	NE	NE	1.57×10^{1}
Copper	3.15×10^{2}	5.02×10^{2}	3.62×10^{1}
Formaldehyde	7.05×10^{1}	1.25×10^{1}	5.27×10^{1}
Manganese	6.93×10^{2}	1.08×10^{2}	9.63×10^{0}
Mercury	5.11×10^{0}	8.08×10^{-1}	4.16×10^{0}
Nickel	4.12×10^{2}	6.43×10^{1}	3.03×10^{2}
Polycyclic organic matter	NE	6.00×10^{2}	7.14×10^{3}
Selenium	6.26×10^{1}	9.84×10^{0}	4.94×10^{0}
Vanadium	4.31×10^{1}	7.79×10^{0}	3.93×10^{2}

(a) The estimate of volatile organic compound emissions do not include emissions from certain laboratory operations; NM = not measured; NE = no emissions.
(b) Produced from burning fossil fuels for steam generation.
(c) Ammonia releases are from the 200-East Area Tank Farms, 200-West Area Tank Farms, and the operation of the 242-A Evaporator.
(d) Does not include CCl_4 Vapor Extraction Project releases from passively ventilated wells.

Table 3.1.3. Radionuclides in Liquid Effluents Discharged to Ground Disposal Facilities from the 200 Areas, 1995

Radionuclide	Half-Life	Release, Ci[a]
^{3}H	12.3 yr	1.5×10^{-2}
^{60}Co	5.3 yr	9.5×10^{-3}
^{90}Sr	29.1 yr	1.2×10^{-1}
^{99}Tc	2.1×10^{5} yr	2.3×10^{-4}
^{106}Ru	368 d	1.9×10^{-1}
^{113}Sn	115 d	1.0×10^{-1}
^{125}Sb	2.8 yr	3.8×10^{-3}
^{134}Cs	2.1 yr	1.2×10^{-3}
^{137}Cs	30 yr	4.5×10^{-2}
^{152}Eu	13.3 yr	1.1×10^{-3}
^{154}Eu	8.8 yr	3.3×10^{-2}
^{155}Eu	4.96 yr	2.3×10^{-2}
Total uranium	$>2.4 \times 10^{5}$ yr	5.5×10^{-4}
^{238}Pu	87.7 yr	7.5×10^{-4}
$^{239,240}Pu$	2.4×10^{4} yr	7.2×10^{-3}
^{241}Am	432 yr	1.2×10^{-3}

(a) 1 Ci = 3.7×10^{10} Bq.

Table 3.1.4. Radionuclides in Liquid Effluents Discharged to the Columbia River from the 100 Areas, 1995

Radionuclide	Half-Life	Release, Ci[a]
^{3}H	12.3 yr	1.5×10^{-1}
^{60}Co	5.3 yr	1.1×10^{-4}
^{90}Sr	29.1 yr	2.1×10^{-1}
^{106}Ru	368 d	ND[b]
^{125}Sb	2.8 yr	2.7×10^{-4}
^{134}Cs	2.1 yr	ND
^{137}Cs	30 yr	2.1×10^{-3}
^{154}Eu	8.8 yr	4.1×10^{-3}
^{238}Pu	87.7 yr	ND
$^{239,240}Pu$	2.4×10^{4} yr	4.3×10^{-7}
^{241}Am	432 yr	1.2×10^{-5}

(a) 1 Ci = 3.7×10^{10} Bq.
(b) ND = not detected.

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 permits for the Site. Should chemicals in liquid effluents that exceed quantities reportable under the Comprehensive Environmental Response, Compensation, and Liability Act, the release totals are reported immediately to EPA. If emissions remain stable at predicted levels, they may be reported annually with EPA's permission. Table 3.1.5 contains a synopsis of the National Pollutant Discharge Elimination System permit violations in 1995.

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 as amended.

There were 18 releases reported under the Comprehensive Environmental Response, Compensation, and Liability Act-reportable quantity and Washington Administrative Code requirements by Hanford contractors in 1995. Effective July 1995, the reportable ethylene glycol quantity was increased from 0.454 kg (1 lb) to 2270 kg (5,005 lb), by the final rule for *Federal Register* 60FR30926. The number of reportable ethylene glycol releases have been significantly reduced as a result of the change in the reportable quantity. Table 3.1.6 contains a synopsis of 1995 Comprehensive Environmental Response, Compensation, and Liability Act reportable spills.

Table 3.1.5. National Pollutant Discharge Elimination System Permit Violations, 1995

Date	Facility	Material	Concentration
5/23/95	310 TEDF[a]	Copper solution	0.3 µg/L
6/06/95	310 TEDF	Copper solution	5.0 µg/L
7/07/95	310 TEDF	Copper solution	0.7 µg/L
7/11/95	310 TEDF	Total suspended solids	2.0 mg/L
8/22/95	310 TEDF	Bis'phthalate	9 µg/L

(a) TEDF = Treated Effluent Disposal Facility.

Table 3.1.6. Comprehensive Environmental Response, Compensation, and Liability Act and Washington Administrative Code Reportable Spills, 1995

Material	Occurrences	Quantity[a]
Ethylene glycol	11	67.6 kg
#6 fuel oil	1	4 kg
Sodium hydroxide	1	3.8 L
Freon R-12	1	79 g
Mercury (metallic)	1	190 g
Sulfur dioxide	1	Undetermined[b]
Diesel/unleaded fuel	1	Undetermined[c]
Waste oil	1	Undetermined[d]

(a) To convert kg to lb, multiply by 2.205; grams to lb, multiply by 0.002205; L to gal, multiply by 0.2642.
(b) Released to atmosphere, violated Washington Administrative Code air emission standard of 1,000 ppm/h.
(c) This spill was found while removing underground storage tanks.
(d) This spill was found while removing an underground storage tank.