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 the comprehensive Hanford Site environmental monitoring plan (DOE/RL-91-50, Rev. 2).

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 gross alpha and beta activity and, as warranted, specific radionuclides. Nonradioactive constituents are also either monitored or sampled, as applicable.

Small quantities of tritium, carbon-14, cobalt-60, strontium-90, technetium-99, antimony-125, iodine-129, cesium-134, cesium-137, radon-220, radon-222, uranium-234, uranium-235, uranium-238, neptunium-237, 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 naturally occurring concentrations. The 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 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 recent years. In 1997, releases of radioactive and nonradioactive constituents in effluents were less than applicable standards.

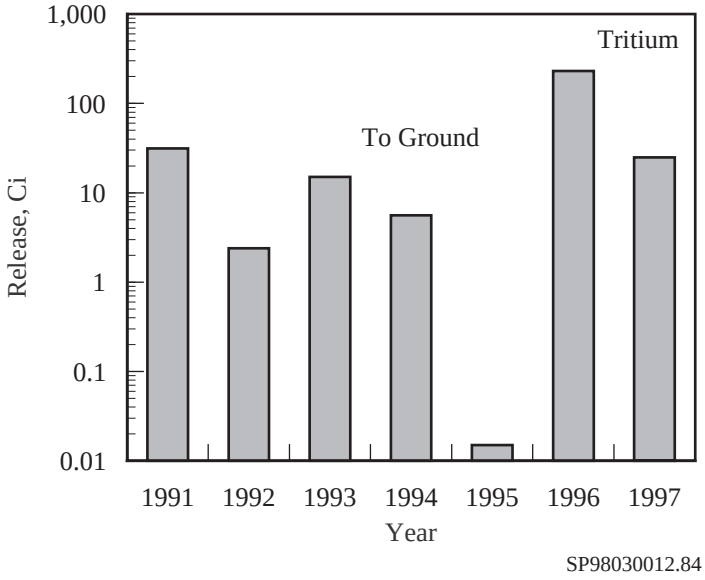
Effluent release data are documented in several reports, in addition to this one, and all are available to the public. For instance, the U.S. Department of Energy (DOE) annually submits to the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Health a report of radioactive airborne emissions from the site (DOE/RL-98-33), in compliance with Title 40, Code of Federal Regulations, Part 61 (40 CFR 61), National Emission Standards for Hazardous Air Pollutants, and Washington Administrative Code (WAC) 246-247, Radiation Protection—Air Emissions. Data quantifying the radioactive liquid and airborne effluents discharged by the site management and integration contractor and its enterprise companies and the environmental restoration contractor are reported to DOE annually in the environmental releases report (HNF-EP-0527-7). 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.

3.1.1 Airborne Emissions

3.1.1.1 Radioactive Airborne Emissions

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

The continuous monitoring of radioactive emissions involves analyzing samples collected at points of discharge



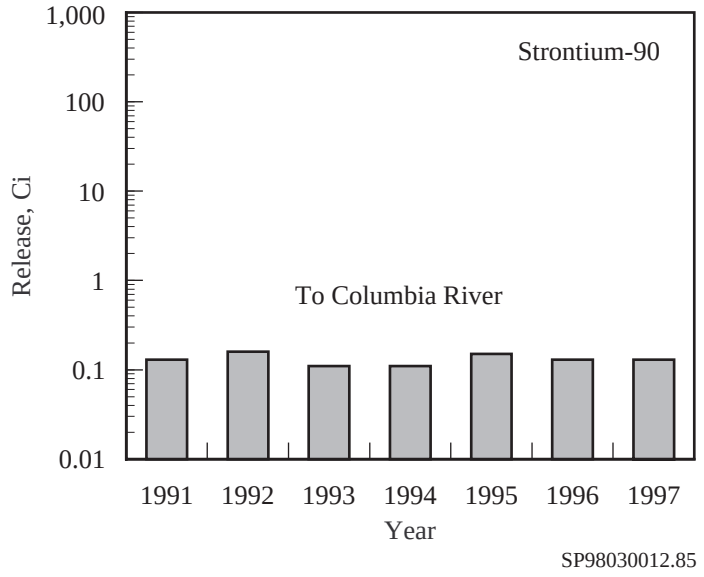


Figure 3.1.1. Liquid Releases of Selected Radionuclides from Hanford Site Facilities, 1991 Through 1997

to the environment, usually from a stack or vent. Samples are analyzed for gross alpha and beta activity, as well as selected radionuclides. The selection of the specific radionuclides 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, and 400 Areas. The sources for these emissions are summarized below.

- In the 100 Areas, emissions originate from the deactivation of N Reactor, the two water-filled storage basins (K Basins) containing irradiated fuel, a recirculation facility that filters radioactive water from

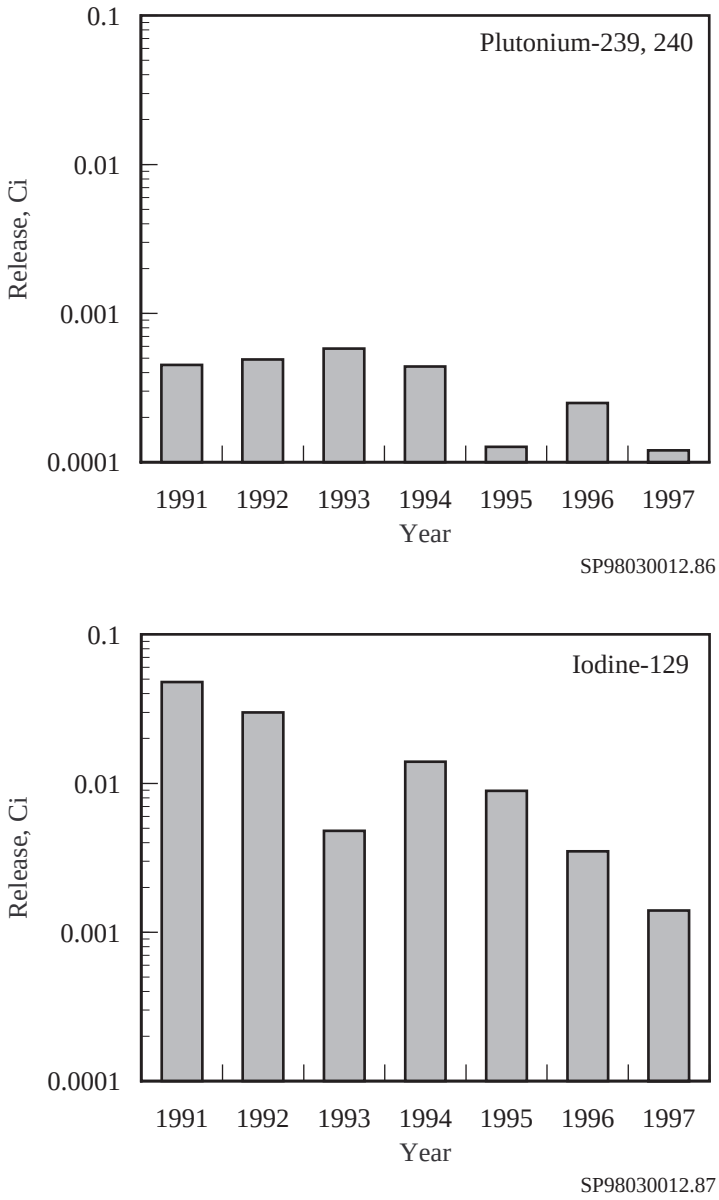


Figure 3.1.2. Airborne Releases of Selected Radionuclides from Hanford Site Facilities, 1991 Through 1997

the N Reactor basin that was used for storage of irradiated fuel, and a radiochemistry laboratory. Five radioactive emission points were active in the 100 Areas during 1997.

- 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 Laboratory, underground tanks for storage of high-level radioactive waste, and waste evaporators. During 1997, 54 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 1997, 27 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 1997. The 400 Area had five radioactive emission discharge points active during 1997.

A summary of the Hanford Site's 1997 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.

3.1.1.2 Nonradioactive Airborne Emissions

Nonradioactive air pollutants emitted from power generating and chemical processing facilities are monitored when activities at a facility are known to generate potential 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 all located in the 200-East Area. Ammonia emissions are monitored only when activities at these facilities are capable of generating them. In 1997, the 242-A Evaporator operated for several months, producing reportable ammonia emissions. Also, the 200-West Area tank farms produced reportable ammonia emissions in 1997. The ammonia releases from the 242-A Evaporator and tank farms in the 200 Areas are summarized in Table 3.1.2.

Onsite operating power plants 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 in WAC 173-400. Power plant emissions are calculated from the quantities of fossil fuel consumed, using EPA-approved formulas.

In March 1997, DOE issued an energy savings performance contract to replace the Hanford Site's coal- and oil-fired boilers with smaller, cleaner operating, and more energy efficient diesel- and natural gas-fired boilers. On December 15, 1997, operation of the 200-West Area's package boiler ceased. On December 29, 1997, operation of the Hanford Site's last coal-fired boiler ceased and 14 new diesel-fired boilers came on-line in the 200 Areas.

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 the EPA's permission. Table 3.1.2 summarized the 1997 emissions of nonradioactive constituents (it should be noted that the 100, 400, and 600 Areas have no nonradioactive emission sources of regulatory concern). Table 3.1.2 also included emissions estimates from the 200-West Area's carbon tetrachloride vapor extraction project, even though these emissions do not require reporting because they are below reportable quantities.

3.1.2 Liquid Effluents

3.1.2.1 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 wastewater from laboratories and chemical sewers. These wastewater streams are sampled and analyzed for gross alpha and beta activity, as well as selected radionuclides.

Only facilities in the 200 Areas discharged radioactive liquid effluents to ground disposal facilities in 1997. A summary of radioactive liquid effluents discharged to the 200 Areas' ground disposal facilities in 1997 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.

3.1.2.2 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

Table 3.1.1. Radionuclides Discharged to the Atmosphere at the Hanford Site, 1997

Radionuclide	Half-Life	Release, Ci[a]				
		100 Areas	200-East Area	200-West Area	300 Area	400 Area
Tritium (as HTO)[b]	12.3 yr	NM[a]	NM	NM	1.5×10^{0}	7.9×10^{0}
Tritium (as HT)[b]	12.3 yr	NM	NM	NM	2.1×10^{1}	NM
Cobalt-60	5.3 yr	ND[a]	ND	ND	8.3×10^{-10}	NM
Zinc-65	244.4 d	ND	ND	ND	ND	NM
Strontium-90	29.1 yr	2.1×10^{-5}	2.5×10^{-4}[c]	3.0×10^{-4}[c]	1.5×10^{-5}[c]	NM
Zirconium-95	64.02 d	ND	ND	ND	ND	NM
Ruthenium-106	368 d	ND	ND	NM	ND	NM
Tin-113	115.1 d	ND	ND	NM	ND	NM
Antimony-125	2.77 yr	3.7×10^{-9}	ND	NM	ND	NM
Iodine-129	1.6×10^{7} yr	NM	1.4×10^{-3}	NM	ND	NM
Iodine-131	8.040 d	NM	ND	NM	ND	ND
Cesium-134	2.1 yr	ND	ND	ND	ND	NM
Cesium-137	30 yr	5.5×10^{-5}	9.1×10^{-4}	7.7×10^{-9}	7.9×10^{-7}	4.6×10^{-6}[d]
Europium-152	13.6 yr	ND	ND	ND	ND	NM
Europium-154	8.8 yr	ND	ND	ND	ND	NM
Europium-155	5 yr	ND	ND	ND	ND	NM
Radon-220	56 s	NM	NM	NM	5.0×10^{1}	NM
Radon-222	3.8 d	NM	NM	NM	1.6×10^{0}	NM
Plutonium-238	87.7 yr	5.8×10^{-7}	1.8×10^{-7}	2.2×10^{-6}	9.5×10^{-10}	NM
Plutonium-238,240	2.4×10^{4} yr	3.9×10^{-6}[e]	6.3×10^{-6}[e]	1.1×10^{-4}[e]	1.1×10^{-6}[e]	3.8×10^{-7}[e]
Plutonium-241	14.4 yr	4.0×10^{-5}	6.4×10^{-6}	4.6×10^{-5}	NM	NM
Americium-241	432 yr	2.5×10^{-6}	4.8×10^{-6}	2.0×10^{-5}	6.5×10^{-9}	NM

(a) 1 Ci = 3.7×10^{10} Bq; NM = not measured; ND = not detected.
(b) HTO = tritiated water vapor; HT = elemental tritium.
(c) This value includes gross beta release data. Gross beta and unspecified beta results assumed to be strontium-90 for dose calculations.
(d) The 400 Area's cesium-137 value is derived fully from gross beta measurements.
(e) This value includes gross alpha release data. Gross alpha and unspecified alpha results assumed to be plutoniun-239,240 for dose calculations.

Table 3.1.2. Nonradioactive Constituents Discharged to the Atmosphere at the Hanford Site, 1997[a]

Constituent	Release, kg		
	200-East Area	200-West Area	300 Area
Particulate matter	1.41×10^{3}	5.62×10^{1}	1.07×10^{4}
Nitrogen oxides	1.61×10^{5}	1.65×10^{4}	3.80×10^{4}
Sulfur oxides	2.35×10^{5}	1.97×10^{2}	1.44×10^{5}
Carbon monoxide	5.33×10^{4}	1.78×10^{2}	3.46×10^{3}
Lead	1.4×10^{2}	3.46×10^{-2}	2.05×10^{1}
Volatile organic compounds[b]	1.15×10^{3}	1.81×10^{2}	1.94×10^{2}
Ammonia[c]	3.60×10^{3}	2.79×10^{3}	NM[d]
Arsenic	1.50×10^{2}	1.16×10^{-2}	1.2×10^{1}
Beryllium	2.02×10^{1}	6.92×10^{-3}	4.44×10^{-1}
Cadmium	1.19×10^{1}	3.05×10^{-2}	2.23×10^{1}
Carbon tetrachloride	NE[d]	2.27×10^{-1}[e]	NE
Chromium	4.34×10^{2}	1.32×10^{-1}	1.35×10^{1}
Cobalt	NE	NE	1.28×10^{1}
Copper	2.73×10^{2}	7.75×10^{-1}	2.94×10^{1}
Formaldehyde	6.12×10^{1}	1.12×10^{0}	4.28×10^{1}
Manganese	6.01×10^{2}	3.88×10^{-2}	7.82×10^{0}
Mercury	4.43×10^{0}	8.31×10^{-3}	3.38×10^{0}
Nickel	3.57×10^{2}	4.98×10^{-2}	2.46×10^{2}
Polycyclic organic matter	NE	4.35×10^{2}	5.80×10^{3}
Selenium	5.42×10^{1}	6.5×10^{-2}	4.01×10^{0}
Vanadium	3.74×10^{1}	1.93×10^{-1}	3.19×10^{2}

(a) The estimate of volatile organic compound emissions do not include emissions from certain laboratory operations.
(b) Produced from burning fossil fuel for steam and electrical generators.
(c) Ammonia releases are from the 200-East Area tank farms, 200-West Area tank farms, and operation of the 242-A Evaporator.
(d) NE = no emissions; NM = not measured.
(e) This is an estimated value because over 99% of the measured values are below the 1-ppmv (parts per million-volume) detection limit.

environment at designated discharge points are sampled and analyzed to determine compliance with the National Pollutant Discharge Elimination System permits and the state waste discharge permits 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 the EPA's permission. A synopsis of the National Pollutant Discharge Elimination System and state waste discharge permit violations in 1997 is given in Section 2.2.7, "Clean Water Act."

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.

Table 3.1.3. Radionuclides in Liquid Effluents Discharged to Ground Disposal Facilities in the 200 Areas, 1997

Radionuclide	Half-Life	Release, Ci[a]
Tritium	12.3 yr	2.5×10^{1}
Carbon-14	5,730 yr	2.2×10^{-5}
Strontium-90	29.1 yr	1.5×10^{-4}
Technetium-99	2.6×10^{6} yr	4.2×10^{-5}
Ruthenium-106	368 d	ND[b]
Tin-113	115 d	ND
Antimony-125	2.8 yr	ND
Iodine-129	1.57×10^{7} yr	1.3×10^{-4}
Cesium-134	2.1 yr	ND
Cesium-137	30 yr	4.6×10^{-4}
Radium-226	1,600 yr	5.5×10^{-5}
Uranium-234	2.45×10^{5} yr	2.3×10^{-4}
Uranium-235	7.04×10^{8} yr	1.9×10^{-5}
Uranium-238	4.47×10^{9} yr	1.7×10^{-4}
Neptunium-237	2.14×10^{6} yr	1.8×10^{-6}
Plutonium-238	87.7 yr	7.4×10^{-5}
Plutonium-239,240	2.4×10^{4} yr	7.0×10^{-5}
Americium-241	432 yr	1.8×10^{-4}

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

Table 3.1.4. Radionuclides in Liquid Effluents Discharged to the Columbia River from the 100 Areas, 1997

Radionuclide	Half-Life	Release, Ci[a]
Tritium	12.3 yr	1.3×10^{-1}
Cobalt-60	5.3 yr	ND[b]
Strontium-90	29.1 yr	1.3×10^{-1}
Ruthenium-106	368 d	ND
Antimony-125	2.8 yr	ND
Cesium-134	2.1 yr	ND
Cesium-137	30 yr	ND
Plutonium-238	87.7 yr	ND
Plutonium-239,240	2.4×10^{4} yr	ND
Americium-241	432 yr	5.9×10^{-7}

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

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

Reportable releases include spills or discharges of hazardous substances or dangerous wastes to the environment, other than releases permitted under state or federal law. 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, Comprehensive, and Liability Act.

Spills or nonpermitted discharges of dangerous wastes or hazardous substances to the environment are required to be reported (WAC 173-303-145). This requirement applies to spills or discharges onto the ground, into the groundwater, into the surfacewater, or into the air such that human health or the environment is threatened, regardless of the quantity of dangerous waste or hazardous substance.

There were seven releases reported under the Act's reportable quantity or WAC 173-303-145 requirements by Hanford Site contractors in 1997. Table 3.1.5 contains a synopsis of 1997 reportable releases pursuant to these regulations.

Table 3.1.5. Comprehensive Environmental Response, Compensation, and Liability Act and Washington Administrative Code Reportable Spills, 1997

Material	Quantity	Location
Carbon tetrachloride	Undetermined	Transuranic Waste Storage and Assay Facilty, 200-West Area
Diesel fuel	Undetermined	Conoco Station, 300 Area
No. 2 diesel fuel	Undetermined	241-A-701 Building, 200-East Area
Nitrogen dioxide	5.15 kg (11.35 lb)	Plutonium Finishing Plant, 200-West Area
Radioactive air	1.4×10^{-4} Ci, ^{90}Sr 1.4×10^{-5} Ci, ^{137}Cs	B Plant, 200-East Area
	$<3.1 \times 10^{0}$ Ci, ^{219}Rn $<4.6 \times 10^{1}$ Ci, ^{220}Rn $<5.0 \times 10^{-1}$ Ci, ^{222}Rn	324 Building, 300 Area
Radioactive water	Undetermined	105-KW, 100-K Area