3.1 Facility Effluent Monitoring

L. P. Diediker and D. J. Rokkan

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 at points of release into the environment. Effluent monitoring data are evaluated to determine the degree of regulatory compliance for each facility and/or the entire site. The evaluations are also useful to assess the effectiveness of effluent treatment and control systems and pollution-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).

Measuring devices quantify most facility effluent flows, but some flows are calculated using process information. For most radioactive air emission units, which are primarily ventilated stacks, effluent sampling methods include continuous sampling or periodic measurements. For most liquid effluent streams, proportional sampling or grab sampling is used. Liquid and airborne effluents with a potential to contain radioactive materials at prescribed threshold levels are measured for total alpha and total beta concentrations and, as warranted, specific radionuclides. Non-radioactive constituents and parameters are either measured directly or sampled and analyzed.

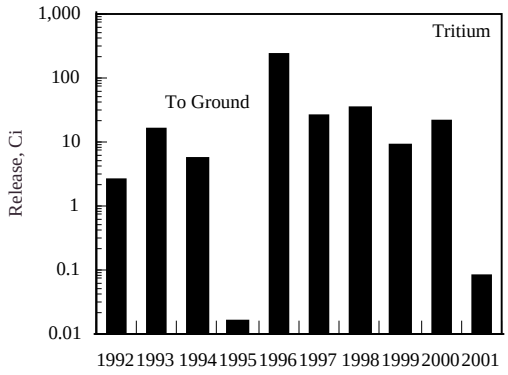
Tritium, cobalt-60, strontium-90, iodine-129, cesium-137, plutonium-238, plutonium-239/240, plutonium-241, and americium-241 were released to the environment through state and federally permitted release points. Most of the radionuclides in effluents at the site are nearing levels indistinguishable from the low concentrations of radionuclides in the environment that occur naturally or originated from atmospheric nuclear-weapons testing. The site mission of environmental cleanup is largely responsible for the downward trend in radioactive emissions, which results in smaller radiation doses to the maximally exposed member of the public. Figures 3.1.1 and 3.1.2 depict quantities of several longer-lived radionuclides released from the site over the past 10 years. In 2001, releases of radioactive and non-radioactive constituents in effluents were less than applicable dose and release standards, respectively.

Effluent release data are documented in several reports besides 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 Washington State Department of Health a report of radioactive airborne emissions from the site (DOE/RL-2002-20), in compliance with Title 40, Code of Federal Regulations, Part 61 (40 CFR 61) and Washington Administrative Code (WAC) 246-247. Data quantifying the radioactive liquid and airborne effluents are reported to DOE annually in an environmental releases report (HNF-EP-0527-11). Summaries of monitoring results are reported annually (HNF-EP-0527-11) for liquid effluents discharged to the Columbia River (regulated by the National Pollutant Discharge Elimination System Permit), liquid effluents discharged to the soil (regulated by WAC 173-216), and for non-radioactive air emissions.

3.1.1 Radioactive Airborne Emissions

Radioactive airborne emissions from Hanford Site activities contain particulate and volatile forms of radionuclides. Emissions with 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 to the environment, usually from a stack or a vent. Samples are analyzed for total alpha and total beta concentration, as well as selected radionuclides. The selection of the specific radionuclides sampled, analyzed,



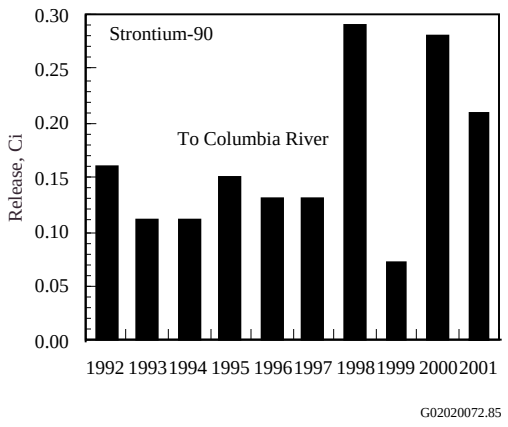
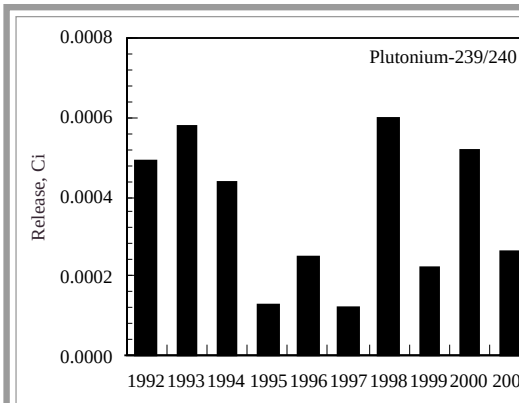


Figure 3.1.1. Liquid Releases of Selected Radionuclides from the Hanford Site, 1992 through 2001



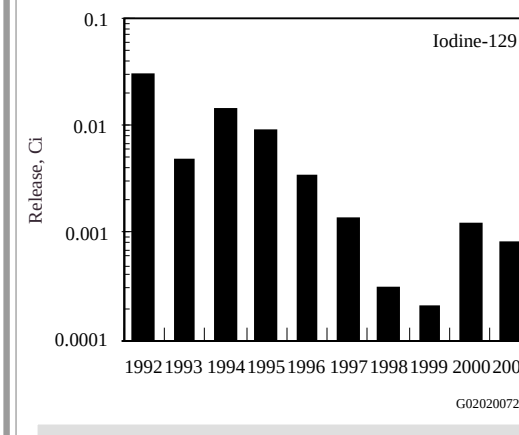


Figure 3.1.2. Airborne Releases of Selected Radionuclides from the Hanford Site, 1992 through 2001

and reported is based on (1) an evaluation of maximum potential of 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 public dose. Continuous air monitoring systems with alarms also are used at selected emission points when a potential exists for radioactive emissions to exceed normal operating ranges at levels requiring immediate personnel alert.

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

- In the 100 Areas, emissions originated via normal evaporation from two water-filled storage basins (100-K East and 100-K West Fuel Storage Basins, which contain irradiated nuclear fuel), the Cold Vacuum Drying Facility, the 105-KW Integrated Water Treatment filter backwash system, and a low-level radiological laboratory. In 2001, five radioactive emission points were active in the 100 Areas.
- In the 200 Areas, the primary sources of radionuclide emissions were the Plutonium Finishing Plant, T Plant, 222-S laboratory, underground tanks that were storing high-level radioactive waste, waste evaporators, and the inactive Plutonium-Uranium Extraction Plant. In 2001, 49 radioactive emission points were active in the 200 Areas.
- The 300 Area primarily has laboratories and research facilities. Primary sources of airborne radionuclide emissions were the 324 Waste Technology Engineering Laboratory, 325 Applied Chemistry Laboratory, 327 Post-Irradiation Laboratory, and 340 Vault and Tanks. In 2001, 22 radioactive emission discharge points were active in the 300 Area.
- The 400 Area has the shutdown 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. In 2001, five radioactive emission points were active in the 400 Area.

- The 600 Area has the Waste Sampling and Characterization Facility, at which low-level radiological and chemical analyses of various types of samples (e.g., particulate air filters, liquid, soil, and vegetation) are performed. This facility had two radioactive emission points in 2001, which are considered as being in the 200-West Area for release and dose-modeling purposes.

A summary of the Hanford Site radioactive airborne emissions in 2001 is provided in Table 3.1.1.

3.1.2 Non-Radioactive Airborne Emissions

Non-radioactive 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, AP tank farm, and AW tank farm, all located in the 200-East Area. Ammonia emissions are tracked only when activities at these facilities are capable of generating them. In 2001, the 200 Areas tank farms produced reportable ammonia emissions, summarized in Table 3.1.2.

Onsite diesel-powered electrical generating plants emitted 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 (AP-42).

Table 3.1.1. Radionuclides Discharged to the Atmosphere at the Hanford Site, 2001

		Release, Ci[a]				
Radionuclide	**Half-Life**	**100 Areas**	**200-East Area**	**200-West Area**	**300 Area**	**400 Area**
Tritium (as HT)[b]	12.3 yr	NM[c]	NM	NM	8.9E+01	NM
Tritium (as HTO)[b]	12.3 yr	NM	NM	NM	2.4E+02	3.1E-01
Cobalt-60	5.3 yr	3.0E-08	ND[d]	ND	ND	NM
Strontium-90	29.1 yr	9.0E-06	1.2E-04[e]	1.4E-04[e]	2.8E-05[e]	NM
Technetium-99	213,000 yr	NM	NM	NM	ND	NM
Antimony-125	2.77 yr	ND	ND	ND	ND	NM
Iodine-129	16,000,000 yr	NM	8.4E-04	NM	NM	NM
Cesium-137	30 yr	2.1E-05	1.2E-04	5.5E-05	3.7E-06	7.5E-06[f]
Uranium-234	240,000 yr	NM	NM	NM	1.5E-10	NM
Uranium-238	4,500,000,000 yr	NM	NM	NM	3.3E-11	NM
Plutonium-238	87.7 yr	1.5E-07	4.4E-08	4.5E-06	7.7E-09	NM
Plutonium-239/240	24,000 yr	1.2E-06	2.1E-06[g]	2.6E-04[g]	1.9E-07[g]	6.9E-07[g]
Plutonium-241	14.4 yr	1.2E-05	3.1E-06	1.4E-04	NM	NM
Americium-241	432 yr	9.5E-07	2.6E-06	4.2E-05	2.5E-08	NM
Americium-243	7,380 yr	NM	NM	NM	ND	NM

(a) 1 Ci = 3.7E+10 becquerels.
(b) HT = Elemental tritium; HTO = tritiated water vapor.
(c) NM = Not measured.
(d) ND = Not detected (i.e., either the radionuclide was not detected in any sample during the year or the average of all the measurements for that given radionuclide or type of radioactivity made during the year was below background levels).
(e) This value includes gross beta release data. Gross beta and unspecified beta results were assumed to be strontium-90 in dose calculations.
(f) This value includes gross beta release data. Gross beta results were assumed to be cesium-137 in dose calculations.
(g) This value includes gross alpha release data. Gross alpha and unspecified alpha results were assumed to be plutonium-239/240 for dose calculations.

Table 3.1.2. Non-Radioactive Constituents Discharged to the Atmosphere at the Hanford Site, 2001

Constituent	Release, kg			
	200 Areas		300 Area	
Particulate matter	790	(1,742)	610	(1,345)
Nitrogen oxides	25,000	(55,115)	4,500	(9,921)
Sulfur oxides	2,700	(5,952)	35	(77)
Carbon monoxide	17,000	(37,478)	11,000	(24,251)
Lead	0.47	(1.0)	0.00	
Volatile organic compounds[a,b]	5,800	(12,787)	700	(1,543)
Ammonia[c]	12,000	(26,455)	NE[d]	
Other toxic air pollutants[c]	2,600	(5,732)	NE	

(a) The estimate of volatile organic compounds does not include emissions from certain laboratory operations.
(b) Produced from burning fossil fuel for steam and electrical generators, calculated estimates from the 200-East and 200-West Areas tank farms, and operation of the 242-A evaporator and the Effluent Treatment Facility.
(c) Releases are calculated estimates from the 200-East and 200-West Areas tank farms and operation of the 242-A evaporator and the Effluent Treatment Facility.
(d) NE = No emissions.

Should activities result in chemical emissions in excess of quantities reportable under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), the release totals are immediately reported 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 emissions of non-radioactive constituents in 2001 (Note: the 100, 400, and 600 Areas have no non-radioactive emission sources of regulatory concern). Table 3.1.2 also includes emission estimates from the carbon tetrachloride vapor extraction work in the 200-West Area. These emissions are accounted for in the table category of "other toxic air pollutants" and do not require reporting because they are below the respective reportable quantity.

3.1.3 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 condensate, process condensate, and wastewater from laboratories and chemical sewers. These wastewater streams are sampled and analyzed for total alpha and total beta, as well as selected radionuclides.

In 2001, only facilities in the 200 Areas discharged radioactive liquid effluents to the ground, which went to a single location, the 616-A crib, also known as the State-Approved Land Disposal Site. A summary of radioactive liquid effluents 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, the sources of which include secondary cooling water used at the 100-K Fuel Storage Basins and shoreline seepage of groundwater that has passed near the retired 1301-N and 1325-N cribs in the 100-N Area. These measured values are used to determine potential radiation doses to the public via the liquid pathway.

Table 3.1.3. Radionuclides in Liquid Effluents from the 200 Areas Discharged to the State-Approved Land Disposal Site, 2001

Radionuclide	Half-Life	Release, Ci[a]
Tritium	12.3 yr	0.079

(a) 1 Ci = 3.7×10^{10} becquerels.

Table 3.1.4. Radionuclides in Liquid Effluents from the 100 Areas Discharged to the Columbia River, 2001

Radionuclide	Half-Life	Release, Ci[a]
Tritium	12.3 yr	0.11
Strontium-90	29.1 yr	0.21
Plutonium-239/240	24,000 yr	0.000039
Americium-241	432 yr	0.00001

(a) 1 Ci = 3.7×10^{10} becquerels.

3.1.4 Non-Radioactive Hazardous Materials in Liquid Effluents

Non-radioactive hazardous materials in liquid effluents are monitored in the 100, 200, 300, and 400 Areas. These effluents are discharged to the State-Approved Land Disposal Site and to the Columbia River. Effluents entering the 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 (40 CFR 122 and WAC 173-216). Should chemicals in liquid effluents exceed quantities reportable under CERCLA, the release totals are immediately reported to the EPA. With EPA's permission, if emissions remain stable at predicted levels, they may be reported annually. A synopsis of the permitted National Pollutant Discharge Elimination System and state waste discharge activities in 2001 is given in Section 2.2.8.

Liquid waste containing both radioactive and hazardous constituents is stored at the 200 Areas in underground waste storage tanks or interim storage facilities.

3.1.5 CERCLA and Washington Administrative Code Releases to the Environment

Releases that are reportable to the state and/or EPA include spills or discharges of hazardous substances or dangerous wastes to the environment, other than releases permitted under state or federal law. Accidents and equipment failures cause the majority of these releases. Releases of hazardous substances that are continuous and stable in quantity and rate, but that exceed specified limits, must be reported as required by Section 103(f)(2) of CERCLA.

Spills or non-permitted 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 surface water (i.e., Columbia River), or into the air such that human health or the environment is threatened, regardless of the quantity of dangerous waste or hazardous substance.

In accordance with both CERCLA and Washington Administrative Code reporting requirements (WAC 173-303-145), three releases were reported in 2001. Table 3.1.5 contains a synopsis of those releases.

Table 3.1.5. Reportable Releases to the Environment at the Hanford Site, 2001[a]

Material	Quantity	Description
Radioactive air	Small amount (potential only; no actual release to environment)	While a velocity probe was being withdrawn from the 291-Z-1 stack, the stack sampling system was inadvertently bumped, which dislodged material within the sampling line that caused the constant air monitor to annunciate. It was later determined that no uncontrolled elevated emission from the stack occurred, but nonetheless an initial notification was made to the Washington State Department of Health.
Carbon disulfide	1.2 kg (2.6 lb)	Liquid carbon disulfide was released to the inside of a cardboard storage box being delivered to the 1163 Building (the Central Storage Building in the former 1100 Area). The liquid leaked through the container to the concrete floor underneath. Several employees inhaled the vapors from the leaked chemical. They were sent to the Hanford Environmental Health Foundation for precautionary evaluation. The Washington State Department of Ecology was notified of the incident because of the "threat to human health." This is a highly volatile material that may be fatal if inhaled, swallowed, or absorbed through the skin.
Low-level radioactive liquid	7.68 L (2 gal); 160 pCi/L (5.9 Bq/L) alpha and 290 pCi/L (10.7 Bq/L) beta	Leachate from the Effluent Retention Disposal Facility leaked to the immediate soil column after a relief valve failed in a pipeline. This type of relief valve is located in manholes with soil bottoms. The leachate was released into three separate manholes.
Polychlorinated biphenyls (Aroclors 1248 and 1254)	~37.9 L (10 gal) of oil matrix; at least 1.18 kg (2.6 lb) of oil	On May 10, 2001, during excavation work at the 600-23 burial ground (Operable Unit 100-1U-6), a tank was unearthed that began leaking polychlorinated biphenyl-contaminated oil to the underlying soil in an amount that exceeded the CERCLA reportable quantity amount of 454 g (1 lb). The affected soil was cleaned up and disposed of properly.

(a) As required by WAC 173-303-145.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*.