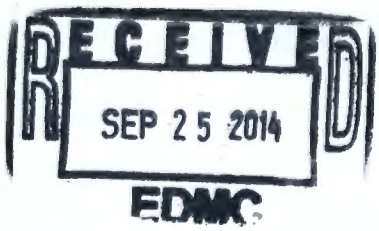
DOE/RL-2014-14
Revision 0

Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 2013



Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

U.S. DEPARTMENT OF ENERGY Richland Operations Office
P.O. Box 550
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Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 2013

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ABSTRACT

This report documents radionuclide air emissions in 2013 from the U.S. Department of Energy (DOE) Hanford Site and the resulting highest effective dose equivalent (EDE) to a member of the public, referred to as the maximally exposed individual (MEI). The report has been prepared in compliance with the Code of Federal Regulations (CFR), Title 40, "Protection of the Environment," Part 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities," and Washington Administrative Code (WAC) Chapter 246-247, "Radiation Protection–Air Emissions," as well as in accordance with the quality principles of 10 CFR 830, "Nuclear Safety Management"; DOE Order 414.1D, *Quality Assurance*; ASME NQA-1, *Quality Assurance Requirements for Nuclear Facility Applications*; and EPA QA/R-5, *EPA Requirements for Quality Assurance Project Plans.*

Under the Clean Air Act, the U.S. Environmental Protection Agency (EPA) codified regulations as 40 CFR 61, Subpart H, by which to govern radionuclide emissions from DOE facilities. Made effective in 1990, these regulations impose a radiological dose standard of 10 mrem/yr EDE to the MEI, which is not to be exceeded. The regulations apply to point-source radioactive material emissions yet are inclusive of fugitive emissions for compliance with the standard. Besides the Hanford Site complying with prescriptive point-source requirements in Subpart H, methods were developed specifically for evaluating fugitive emissions (also frequently referred to or associated with "diffuse emissions"). The methodology for this work was formalized in a Memorandum of Understanding ("Memorandum of Understanding Between the U.S. Environmental Protection Agency and the U.S. Department of Energy Concerning the Clean Air Act Emission Standards for Radionuclides 40 CFR Part 61 Including Subparts H, I, Q & T" [DOE 1995]) between DOE and EPA. Since then, dose estimates from fugitive emissions have been evaluated and reported annually as part of determining the compliance status of the Hanford Site to the dose standard. By reference, WAC 246-247 adopted this dose standard as well as requiring the reporting of radon emissions from Hanford Site sources and the resulting dose.

The EDE to the Hanford Site MEI due to routine and nonroutine emissions in 2013 from Hanford Site point sources was 0.13 mrem (0.0013 mSv). The MEI EDE from fugitive emissions at the Hanford Site in 2013 was 0.055 mrem (0.00055 mSv) and from radon emissions, 0.063 mrem (0.00063 mSv). The total radiological dose for 2013 to the MEI from all Hanford Site radionuclide emissions was 0.25 mrem (0.0025 mSv), or less than 3 percent of the federal and state standard of 10 mrem/yr, with which the Hanford Site was in compliance.

Section 2.0 lists portions of the Hanford Site MEI dose attributable to individual point-sources (i.e., stacks). These doses by stack are appropriate for demonstrating the compliance status of abated stack emissions with applicable terms of the *Hanford Site Air Operating Permit*, which includes the *Hanford Site Radioactive Air Emissions License #FF-01* (FF-01).

For further information on this report, you may contact Dale Jackson, U.S. Department of Energy, Richland Operations Office, by telephone at (509) 376-8086 or e-mail at Dale.Jackson@rl.doe.gov.

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CERTIFICATION OF DOE/RL-2014-14, REV. 0

RADIONUCLIDE AIR EMISSIONS REPORT
FOR THE HANFORD SITE, CALENDAR YEAR 2013

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. See, 18 U.S.C. 1001.

H. Chaloner for 6/26/14

Doug S. Shoop
Acting Manager
U.S. Department of Energy
Richland Operations Office

Date

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TERMS

BNI	Bechtel National, Inc.
Bq	becquerel [i.e., one nuclear disintegration per second]
CAP-88	Clean Air Act Assessment Package-1988
CAP88-PC	Clean Air Act Assessment Package 1988-Personal Computer
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	Code of Federal Regulations
CHPRC	CH2M HILL Plateau Remediation Company
Ci	curie [equals 3.7×10^{10} Bq]
CSB	Canister Storage Building
CVDF	Cold Vacuum Drying Facility
CWC	Central Waste Complex
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DOE-ORP	U.S. Department of Energy, Office of River Protection
DOE-PNSO	U.S. Department of Energy, Pacific Northwest Site Office
DST	double-shell tank
EDE	effective dose equivalent
EDP	electronic data processing
ENCGS	Energy Northwest Columbia Generating Station
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ETF	200 Area Effluent Treatment Facility
FF-01	*Hanford Site Radioactive Air Emissions License #FF-01*
FFCA	Federal Facility Compliance Agreement
FFM	Far-Field Monitoring
FFTF	Fast Flux Test Facility
FUA	Facility Use Agreement
HEPA	high-efficiency particulate air (filter)
HT	elemental tritium
HTO	tritiated water
ISA	interim storage area
ISS	interim safe storage
LLBG	Low-Level Burial Ground
LIGO	Laser Interferometer Gravitational Wave Observatory
major	a radioactive point source having a radiological dose potential of greater than 0.1 mrem/yr effective dose equivalent after all pollution-control equipment has been removed but operations are otherwise routine (a major point source is also classified by way of a "potential impact category" [PIC] of PIC 1 or PIC 2, as defined in ANSI/HPS N13.1-1999, *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities*)
MASF	Maintenance and Storage Facility
MEI	maximally exposed individual
minor	a radioactive point source having a radiological dose potential of less than or equal to 0.1 mrem/yr effective dose equivalent after all pollution-control equipment has been removed but operations otherwise are routine (a minor

	point source is also classified by way of a "potential impact category" [PIC] of PIC 3 or PIC 4, as defined in ANSI/HPS N13.1-1999)
MOU	Memorandum of Understanding
mrem	millirem [i.e., 1×10^{-3} rem]
MSA	Mission Support Alliance, LLC
mSv	millisievert [sievert = 100 rem]
NA	not applicable
ND	not detected
NEPA	*National Environmental Policy Act*
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFM	Near-Field Monitoring
NOC	Notice of Construction
PFP	Plutonium Finishing Plant
PNNL	Pacific Northwest National Laboratory
PSF	Physical Sciences Facility
PUREX	Plutonium-Uranium Extraction (Plant)
QA	quality assurance
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	Reduction-Oxidation (S Plant)
rem	roentgen equivalent man
RPL	Radiochemistry Processing Laboratory
SNM	special nuclear material
SST	single-shell tank
TEDF	Treated Effluent Disposal Facility
WAC	Washington Administrative Code
WCH	Washington Closure Hanford, LLC
WDOH	Washington State Department of Health
WESF	Waste Encapsulation and Storage Facility
WRAP	Waste Receiving and Processing Facility
WRPS	Washington River Protection Solutions, LLC
WSCF	Waste Sampling and Characterization Facility
WSU	Washington State University
WTP	Waste Treatment and Immobilization Plant

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1.0 INTRODUCTION

This report documents radionuclide air emissions from the U.S. Department of Energy (DOE) Hanford Site in 2013, and the resulting effective dose equivalent (EDE) to the maximally exposed individual (MEI) member of the public. The report complies with reporting requirements in the Code of Federal Regulations (CFR), Title 40, "Protection of the Environment," Part 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities," and in the Washington Administrative Code (WAC) Chapter 246-247, "Radiation Protection — Air Emissions." The report also is in accord with the quality principles of 10 CFR 830, "Nuclear Safety Management"; DOE Order 414.1D, *Quality Assurance*; ASME NQA-1, *Quality Assurance Requirements for Nuclear Facility Applications*; and EPA QA/R-5, EPA *Requirements for Quality Assurance Project Plans*.

1.1 HANFORD SITE DESCRIPTION

The Hanford Site (Figure 1-1) is located in a rural region of southeastern Washington State, occupying an area of about 586 mi^2 (1,518 km^2). It lies about 200 mi (320 km) northeast of Portland, Oregon; 170 mi (270 km) southeast of Seattle, Washington; and 124 mi (200 km) southwest of Spokane, Washington. More in-depth discussions on the characteristics and activities at the Hanford Site are available in PNNL-6415, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, and DOE/RL-2013-47, *Hanford Site Environmental Report for Calendar Year 2013* [in press, available by end of September 2013].

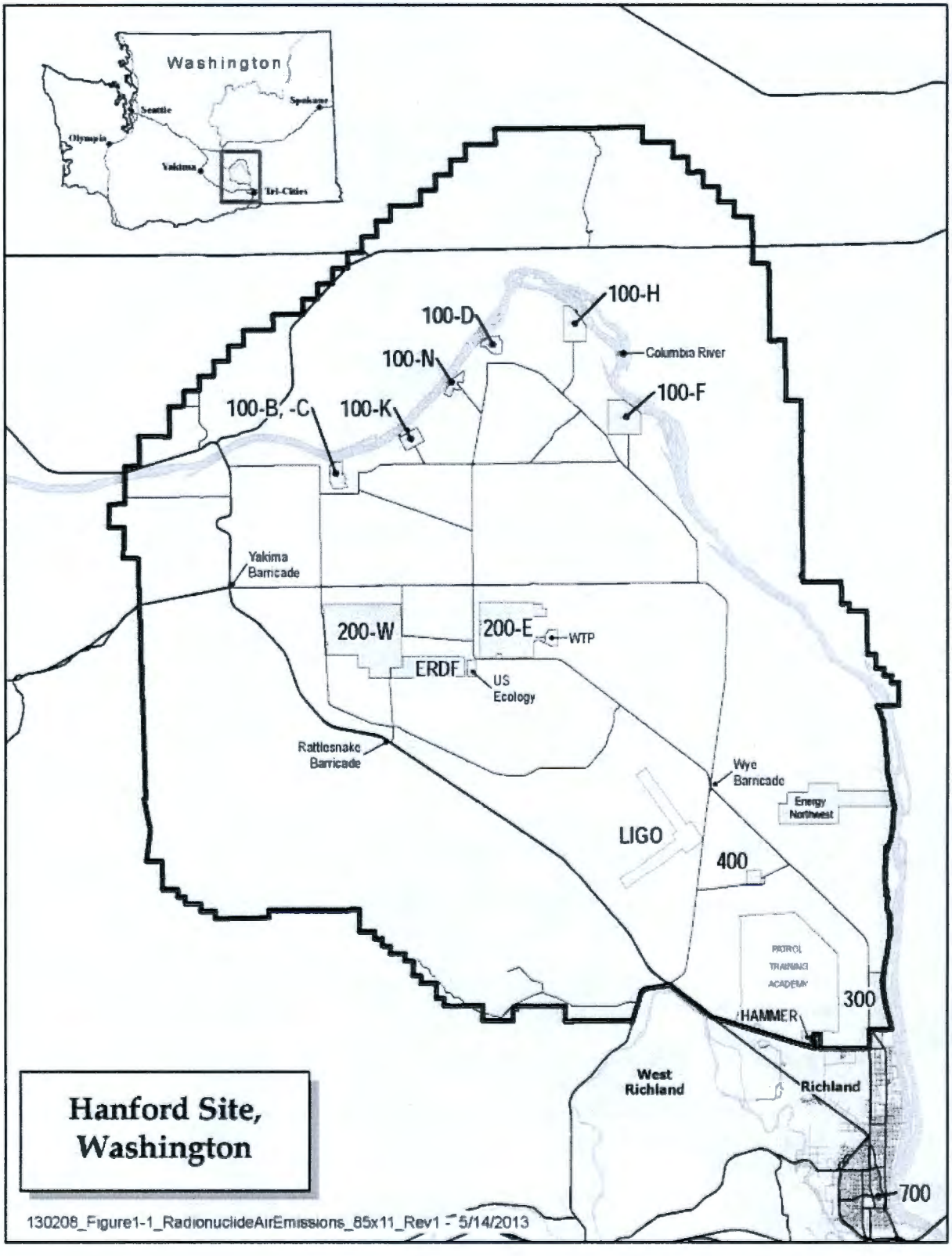
1.1.1 Historical Background

In 1943, the federal government acquired the land that became the Hanford Site, where facilities were constructed and operated as part of the atomic weapons program, which began during World War II. For more than 40 years, most facilities at the Hanford Site were dedicated to operations that produced plutonium for national defense and to managing the radioactive and chemical wastes generated from those production processes. In more recent years, defense programs have ceased while new programs have emerged. New programs include major efforts to clean up contamination in the environment and facilities resulting from past operational practices and the research and development of new and improved waste disposal technologies. Currently, two DOE Offices manage the programs at the Hanford Site. They are the U.S. Department of Energy, Richland Operations Office (DOE-RL) and the U.S. Department of Energy, Office of River Protection (DOE-ORP). The U.S. Department of Energy, Pacific Northwest Site Office (DOE-PNSO), manages the Pacific Northwest National Laboratory (PNNL), which has historic ties to the Hanford Site. PNNL staff currently occupy facilities within and adjacent to the Hanford Site.

1.1.2 Main Areas, Facilities, and Activities

Five main operational areas at the Hanford Site actually or potentially generated radionuclide air emissions in 2013: the 100, 200, 300, 400, and 600 Areas (Figure 1-1). The 100 Areas have the deactivated 105-KW Spent Fuel Storage Basin, the Cold Vacuum Drying Facility (CVDF), and nine deactivated production reactors with support facilities, all located near the Columbia River. The 200 Areas are located on a plateau approximately 21.5 mi (34.7 km) northwest of the City of Richland, Washington, and 7 mi (11.3 km) from the Columbia River. Facilities in the 200 East Area include the Single-Shell Tank (SST) and Double-Shell (DST) Tank Farms, Canister Storage Building (CSB), Waste

Figure 1-1. Hanford Site Map.



Encapsulation and Storage Facility (WESF), Plutonium Uranium-Extraction (PUREX) Plant, B Plant Complex, Waste Treatment and Immobilization Plant (WTP), 242-A Evaporator, 200 Area Effluent Treatment Facility (ETF), Treated Effluent Disposal Facility (TEDF), Low-Level Burial Grounds, and the non-DOE U.S. Ecology Low-Level Burial Site. In the 200 West Area are the Plutonium Finishing Plant (PFP), SST and DST Tank Farms, T Plant Complex, U Plant, Reduction-Oxidation (REDOX) Plant, 222-S Laboratory, Central Waste Complex (CWC), Waste Receiving and Processing Facility (WRAP), and the Low-Level Burial Grounds (LLBGs). The 300 Area, just north of the City of Richland, has research and development laboratories. The 400 Area has the deactivated Fast Flux Test Facility (FFTF), 8 mi (12.9 km) north of the City of Richland. The 600 Area has the Environmental Restoration Disposal Facility (ERDF) and the Waste Sampling and Characterization Facility (WSCF); both facilities are immediately east of the 200 West Area.

Notable events in calendar year 2013 relevant to radioactive airborne emissions monitoring and reporting are summarized as follows:

- Environmental restoration activities continued along the river in the 100, 300, and 600 Areas of the Hanford Site. Contaminated soil and debris from inactive waste sites were excavated, transported, and disposed of at ERDF as well as at other appropriate locations. Activities were conducted in the 100 Areas designed to place the retired nuclear reactors in interim safe storage (ISS) pending their final disposition. Those activities include decontamination and decommissioning (D&D) of the reactors and of ancillary facilities, with notable work occurring at the N Reactor. Several facilities in the 300 and 400 Areas were decontaminated, decommissioned, and demolished.

- Waste from SSTs in the 200 Area Tank Farms was transferred to DSTs.

- Bechtel National, Inc. (BNI) continued construction of WTP. Four major facilities are being constructed: the Pretreatment Facility, the High-Level Waste Vitrification Facility, the Low-Activity Waste Vitrification Facility, and the Analytical Laboratory. Through 2013, WTP has received no radioactive material; thus, no radioactive airborne emissions were released as a result of construction in 2013.

- The 200 Area Interim Storage Area (ISA) continued storing spent fuel from non-defense production reactors in a dry-cask storage system.

- The T Plant waste management activities were in support of layup of the facility and preparing and sending the majority of the waste-container inventory to CWC.

- At PFP facilities, deactivation work continued under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA).

- The 200 Area ETF continued treating radioactive-hazardous aqueous waste.

- The 222-S Laboratory continued characterizing tank waste and supporting Hanford operational and remediation projects.

- WSCF analyzed effluent, environmental, groundwater, and biota samples.

1.1.3 Prime Contractors

The DOE-RL prime contractors, along with their management responsibilities, are briefly described in this section.

- **CH2M HILL Plateau Remediation Company (CHPRC)**. CHPRC manages the Plateau Remediation Contract at the Hanford Site. Summarized here are the principal contractual goals CHPRC is committed to advancing:

  Environmental remediation, decontamination, and decommissioning of facilities on the Central Plateau in the 200 Areas, where five chemical separations plants and other facilities separated and recovered plutonium and other materials used for national defense, including specifically decontamination and demolition of facilities at PFP; groundwater characterization, monitoring, and remediation; site-wide drilling management; characterizing of facilities and waste sites; disposal activities of non-tank farm waste; environmental surveillance and maintenance; managing operations at CVDF, CSB, Liquid Effluent Retention Facility, ETF, 200 Area TEDF, ISA, WRAP, FFTF, CWC, LLBG, WESF, and the T Plant Complex, and as applicable the decontamination and demolition of facilities such as the 105-KW Spent Fuel Storage Basin, PFP, U Plant, and 209-E; monitoring liquid effluents and air emissions; the surveillance and maintenance of inactive facilities on the Central Plateau, such as the PUREX Facility, B Plant Complex, and REDOX Complex; and developing regulatory documents for activities related to groundwater, soil, and facilities.

- **Mission Support Alliance, LLC (MSA)**. MSA is considered the Hanford Site "integrating contractor," responsible for fulfilling the Mission Support Contract goals, which include managing these five primary functions at the Hanford Site: safety, security, and the environment; Site infrastructure and utilities; Site business management; information resources and content management; and portfolio management.

- **Washington Closure Hanford, LLC (WCH)**. WCH manages the River Corridor Closure Project for DOE-RL. The scope of work includes surveillance and maintenance of inactive past-practice waste sites and of inactive facilities; remediation of past-practice waste sites pursuant to CERCLA; closure of *Resource Conservation and Recovery Act of 1976* (RCRA) land-based treatment, storage, and disposal units; and the deactivation, decontamination, decommissioning, and demolition of facilities pursuant to CERCLA.

The DOE-ORP prime contractors at the Hanford Site are identified next, along with their management responsibilities and the facilities they oversee that have or have had radionuclide air emissions.

- **Bechtel National, Inc.** The mission of BNI is to design, build, and commission the Hanford Tank WTP to vitrify the tank waste at the Hanford Site. This project includes a pretreatment facility to separate the tank waste into high-level radioactive and low-activity radioactive streams. The High-Level Vitrification Facility and the Low-Level Vitrification Facility both will immobilize the waste in a glass form encased in canisters.

- **Washington River Protection Solutions, LLC (WRPS)**. WRPS manages the tank farms for DOE-ORP. These responsibilities include storing and retrieving for treatment of approximately 56 million gallons of highly radioactive and hazardous waste stored in 177 underground tanks; characterizing the waste; and eventually delivering the waste to an under-construction

vitrification facility at which the waste will be converted into a glass-like substance for permanent disposal. WRPS also operates the 222-S Radioanalytical Laboratory to support the sampling and characterization of tank waste. As a prime contractor to ORP, Advanced Technologies and Laboratories International, Inc., performs production functions at the 222-S Laboratory, which include receiving, analyzing, and storing samples, as well as performing special tests.

The DOE-PNSO prime contractor at the Hanford Site is identified next, along with its management responsibilities and the facilities it oversees that have or previously had radionuclide air emissions.

- **Battelle Memorial Institute**. Battelle Memorial Institute operates PNNL for DOE-PNSO. PNNL staff perform research and development in the physical, chemical, life, and environmental sciences; investigate advanced methods of nuclear waste management; and conduct applicable liquid effluent and emission monitoring at the DOE facilities it manages.

Some privately or publicly owned facilities capable of generating airborne radioactive emissions are located at or near the Hanford Site. These facilities include (1) a low-level waste burial site operated by U.S. Ecology on the 200 Area plateau, (2) the Energy Northwest Columbia Generating Station (ENCGS) commercial nuclear power reactor and office buildings, near the Columbia River, north of the 300 Area and east of the 400 Area, (3) the Test America laboratory south of the 300 Area, (4) the AREVA Federal Services LLC fuel fabrication facility, adjacent to the Hanford Site southern boundary, (5) Perma-Fix Northwest, Inc., adjacent to the east side of the AREVA Federal Services LLC, (6) Unitech Services, Inc., located 1 mi (1.6 km) south of the southern boundary of the Hanford Site, and (7) the DOE-PNSO PNNL Campus in north Richland, which includes the PNNL Site and Battelle's research laboratories in north Richland. Emissions from these facilities are not included in this report because they are not regulated as part of the Hanford Site; however, they may be separately regulated as required by applicable regulations.

1.2 POINT-SOURCE DESCRIPTIONS

This section includes descriptions of point sources. A point source is reported in this document if in 2013 it met the following four criteria: (1) required continuous monitoring or periodic confirmatory measurements in accordance with 40 CFR 61, Subpart H, and with WAC 246-247, (2) was described in the FF-01, (3) emitted or had the potential to emit radionuclides, and (4) is a stack, vent, or otherwise ducted flow that was monitored via emission sampling.

Air emissions from other sources of radioactive materials are reported in Sections 4.0 and 5.0. Fugitive emissions from those sources were estimated using methods described in Section 4.0.

1.2.1 General Description and Reporting Criteria

Radionuclide air emissions from point sources generally are discharged from stacks and vents (from this point forward, stack implies vent or otherwise ducted flow as well, unless vent is used as the proper name or description of a point source). Stack sizes, shapes, and discharge paths vary because of facility requirements at the time of construction. Discharge heights range from nearly ground level to 200 ft (61 m), and flow rates range from less than 100 ft^3/min (0.047 m^3/s) to 290,000 ft^3/min (137 m^3/s). Stacks vary in design from horizontal to vertical, rectangular to cylindrical, actively to passively ventilated, and permanent to portable.

A point source is designated "major" when in the hypothetical absence of all pollution control equipment its potential maximum emissions can cause a dose greater than 0.1 mrem/yr EDE to a member of the public and who lives near and/or has unrestricted access to a place of employment on the Hanford Site. A point source is "minor" when under the same hypothetical conditions its potential maximum emissions in the absence of all pollution control equipment cannot cause a dose greater than 0.1 mrem/yr EDE.

These principal emission abatement devices were used singly or in combination to remove radioactive constituents from most stack emissions during 2013: (1) high-efficiency particulate air (HEPA) filters, (2) sand filters, (3) deep-bed fiberglass filters, (4) fiberglass prefilters, and (5) charcoal adsorbers. Generally, from one to three stages of HEPA filtration were used as the final particulate-removal method before an air emission stream was exhausted to the atmosphere. Other emission abatement technology employed at stacks includes: demisters, deentrainers, moisture separators, water chillers, condensers, evaporative towers, isolation and backdraft dampers, and so on (see Tables 2-3 and 2-4 for a listing of emission abatement technology employed at each stack).

1.2.2 100 Area Facilities

The 100 Areas contain nine inactive production reactors and their associated support facilities. Many of the reactors have been placed in ISS and many associated support facilities demolished. The only active point sources of radionuclide air emissions are at facilities in the 100-K Area. Those point sources are briefly described below and their locations illustrated in Figure 1-2.

1.2.2.1 100-K Areas

Located in this area is CVDF, along with various ancillary structures. Currently under CERCLA management are two retired reactors awaiting decommissioning; one remaining storage basin, originally of two, which previously stored irradiated nuclear fuel under water; and various supporting structures.

105-KW Unfiltered air from the spent-fuel storage basin in the 105-KW Building was exhausted via a vent on the building roof. Emissions were sampled for particulate radionuclides.

296-K-142 This major stack exhausted filtered air from CVDF. Particulate emissions were sampled. This stack was downgraded to minor status in October 2013. That action included replacing conventional emission sampling and analysis with a yearly reporting of calculated emissions.

105-KW Air Sparging Vent Air from the work area of the 105-KW Integrated Water Treatment System passively moves through this major vent, equipped with a single HEPA filter. During back-washing of system filters, particulate radionuclides may become airborne and captured on the HEPA filter, which is destructively analyzed and the results shown in Table 5-2, not Table 2-1 where data for conventional major stacks are reported.

1.2.3 200 East Area Facilities

The 200 East Area contains facilities formerly operated for chemical separations and reprocessing. Some facilities are currently supporting waste handling and disposal while others are being managed under surveillance and maintenance status. Locations of radionuclide air emission discharge points in the 200 East Area are illustrated in Figure 1-3. The majority of radionuclides discharged from the

200 Areas are in particulate form, apart from the volatile long-lived radionuclide ^{129}I sampled at the PUREX Plant.

1.2.3.1 Plutonium-Uranium Extraction Facility

The PUREX Facility was used to separate plutonium from spent nuclear fuel. The facility was deactivated in June 1997 and is currently managed under surveillance and maintenance status.

291-A-1 This major stack exhausted filtered air from the canyon. Emissions were sampled for particulate radionuclides and for ^{129}I, a volatile radionuclide.

1.2.3.2 B Plant Complex

The B Plant Complex separated plutonium from spent nuclear fuel, but its operations were later reconfigured to remove ^{90}Sr and ^{137}Cs from highly radioactive liquid waste. The main canyon building, 221-B, contains radioactive contamination from various production campaigns, primarily contained in concrete walls. The B Plant Complex, excluding WESF, was deactivated in 1998 and is currently managed under surveillance and maintenance status.

296-B-1 This major stack, the replacement B Plant main stack, exhausted filtered air from the main canyon and process cells in the 221-B Building, from the process cell in the 212-B Building, and from the 224-B Building via the vessel vent. Particulate emissions were sampled.

1.2.3.3 Waste Encapsulation and Storage Facility

At WESF, ^{90}Sr and ^{137}Cs from waste separations material were converted to solid strontium fluoride and cesium chloride, respectively. Those cesium and strontium compounds were separately double-encapsulated and placed in water-filled storage basins at WESF. The current mission for WESF is to continue storing these radioactive capsules and maintaining the process portion of the facility.

296-B-10 This major stack exhausted filtered air from the 225-B Building. Particulate emissions were sampled.

1.2.3.4 200 East Area Tank Farms

Radioactive waste stored in Tank Farms consists of sludge and saltcake in SSTs and liquids and slurry in DSTs.

296-A-18 This minor stack exhausted filtered air from the 241-AY-101 Tank annulus. Particulate emissions were sampled.

296-A-19 This major stack exhausted filtered air from the 241-AY-102 Tank annulus. (**Note:** In March 2013, the potential-emission designation of the stack changed from minor to major.) Particulate emissions were sampled.

296-A-20 This minor stack exhausted filtered air from the 241-AZ-101 and -102 Tank annuli. Particulate emissions were sampled.

296-A-26 This minor stack did not operate in 2013. When in use, it exhausts filtered air from the waste unloading room and sump tank at the 204-AR Waste Unloading Station and particulate emissions are sampled.

296-A-28 This minor stack exhausted filtered air from the tank annuli in the 241-AW Tank Farm. Particulate emissions were sampled.

296-A-30 This minor stack exhausted filtered air from the tank annuli in the 241-AN Tank Farm. Particulate emissions were sampled.

296-A-40 This minor stack exhausted filtered air from the 241-AP tanks. Particulate emissions were sampled.

296-A-41 This minor stack exhausted filtered air from the tank annuli in the 241-AP Tank Farm. Particulate emissions were sampled.

296-A-42 This major stack exhausted filtered air from the tanks in the 241-AY and 241-AZ Tank Farms. Particulate emissions were sampled.

296-A-43 This minor stack exhausted filtered building ventilation air from the 702-AZ Building. Particulate emissions were sampled.

296-A-44 This major stack exhausted filtered air from the 241-AN tanks. It operates in conjunction with the 296-A-45 stack. Particulate emissions were sampled. In Table 2-1, emission and dose data for these two stacks are presented cumulatively because they exhaust a single point source.

296-A-45 This major stack exhausted filtered air from the 241-AN tanks. It operates in conjunction with the 296-A-44 stack. Particulate emissions were sampled. In Table 2-1, emission and dose data for these two stacks are presented cumulatively because they exhaust a single point source.

296-A-46 This major stack exhausted filtered air from the 241-AW tanks. It operates in conjunction with the 296-A-47 stack. Particulate emissions were sampled. In Table 2-1, emission and dose data for these two stacks are presented cumulatively because they exhaust a single point source.

296-A-47 This major stack exhausted filtered air from the 241-AW tanks. It operates in conjunction with the 296-A-46 stack. Particulate emissions were sampled. In Table 2-1, emission and dose data for these two stacks are presented cumulatively because they exhaust a single point source.

296-P-45 This major stack, a portable exhauster, did not operate in 2013. It is permitted to operate as a major or minor emission unit, from which particulate emissions are sampled when operated.

296-P-47 This major stack, a portable exhauster, was used in support of waste retrieval in C Farm. Particulate emissions were sampled.

296-P-48 This major stack, a portable exhauster, was used in support of waste retrieval in C Farm. Particulate emissions were sampled.

296-P-107 This major stack, a portable exhauster, was used in support of waste retrieval in C Farm. Particulate emissions were sampled.

1.2.3.5 242-A Evaporator

The 242-A Evaporator is used to remove liquid from DST liquid mixed waste to produce a more concentrated waste stream, which gets transferred back to the Tank Farms. No evaporative campaigns were conducted in 2013.

296-A-21A This minor stack exhausted filtered air from the 242-A Building. Particulate emissions were sampled.

296-A-22 This minor stack exhausted filtered air from the 242-A Evaporator vessel ventilation system. During 242-A Evaporator campaigns, continuous sampling is required as well as measurement of radionuclides that could contribute greater than 10 percent of the potential total EDE defined in the applicable Notice of Construction (NOC). During non-campaign periods, the requirement is that only one sample a quarter be collected and analyzed for gross alpha and gross beta. Particulate emissions were sampled.

1.2.3.6 200 Area Effluent Treatment Facility

ETF treats mixed aqueous waste streams prior to their disposal at the State-Approved Land Disposal Site, also designated as the 616-A Crib.

296-E-1 This minor stack exhausted filtered air from the 2025-E Building and ETF processing vents. Particulate emissions were sampled.

1.2.3.7 Canister Storage Building

This facility stores irradiated fuel primarily from the 100-K Spent Fuel Storage Basins. The fuel is contained in specially engineered canisters housed in storage tubes within the facility. Before the 100-K fuel was received at CSB, it passed through the CVDF, where it was dried and packaged in canisters for shipment.

296-H-212 This major stack exhausted filtered air from the 212-H Building. Particulate emissions were sampled.

1.2.4 200 West Area Facilities

The 200 West Area contains facilities for laboratory analysis, for waste handling and disposal, and formerly for chemical separations and processing. Locations of radionuclide air emission discharge points in the 200 West Area are illustrated in Figure 1-4.

1.2.4.1 Reduction-Oxidation Plant

REDOX also is known as the 202-S Building and as S Plant. REDOX operated as a fuel reprocessing facility until it was shut down in 1967. It is currently in a surveillance and maintenance status.

291-S-1 The REDOX main stack exhausted filtered air from the REDOX canyon. Particulate emissions were sampled from this minor stack.

1.2.4.2 T Plant Complex

The T Plant Complex consists of two main structures: the 221-T Building and the 2706-T Building. The 221-T Building is one of the original fuel-processing facilities. The last fuel processed there was in 1956. The 221-T Building and the 2706-T Building are now used for the treatment, storage, repackaging, sampling, and verification of waste containers. Liquid waste was treated and stored in tank systems and radioactively contaminated equipment decontaminated in both structures.

291-T-1 This major stack exhausted filtered air from the 221-T Canyon, 224-T Process Cells, and process ventilation system. Particulate emissions were sampled.

296-T-7 This minor stack exhausted HEPA-filtered air from the 2706-T and 2706-TA Buildings when decontamination, treatment, storage, sampling, etc., activities were performed or other activities were underway that had the potential to increase airborne radionuclide contamination; otherwise, the stack does not operate. Particulate emissions were sampled.

1.2.4.3 Plutonium Finishing Plant

PFP was constructed to produce plutonium metal from plutonium nitrate received from T Plant, B Plant, REDOX, and PUREX Facilities. PFP also recovered plutonium, in the form of plutonium nitrate, from plutonium scrap. These missions have ended along with subsequent ones such as the safe and secure storing of special nuclear material (SNM) and the stabilizing of nuclear materials for long-term storage. Significant cleanup activities are now the focus at PFP. Only two stacks remain at PFP: one major, 291-Z-1, and one minor, 296-Z-15, both of which in 2013 were operated under CERCLA authority.

291-Z-1 This major stack exhausted filtered air from the 234-5Z, 236-Z, and 242-Z Buildings. Particulate emissions were sampled.

296-Z-15 This minor stack exhausted filtered air from the 243-Z Liquid Low-Level Waste Treatment Facility. Particulate emissions were sampled.

1.2.4.4 200 West Area Tank Farms

These tank farms hold high-level radioactive waste, consisting of sludge and saltcake in SSTs and liquids and slurry in DSTs.

296-P-22 This minor stack exhausted filtered air from annuli in the 241-SY-101, -102, and -103 Tanks. Particulate emissions were sampled.

296-P-23 This minor stack exhausted filtered air from tanks 241-SY-101, -102, and -103. Operation of this stack (designated as "B" train) alternated with 296-S-25 (designated as "A" train). Particulate emissions were sampled. In Table 2-2, emission and dose data for these two stacks are presented cumulatively because they exhaust a single point source.

296-P-43 This major stack, a portable exhauster, did not operate in 2013. When operated, particulate emissions are sampled.

296-P-44 This major stack, a portable exhauster, did not operate in 2013. When operated, particulate emissions are sampled.

296-S-25 This minor stack exhausted filtered air from tanks 241-SY-101, -102, and -103. Operation of this stack (designated as "A" train) alternated with 296-P-23 (designated as "B" train). Particulate emissions were sampled. In Table 2-2, emission and dose data for these two stacks are presented cumulatively because they exhaust the same point source.

1.2.4.5 200 West Area Evaporators

Two evaporators are in the 200 West Area: the 242-S Evaporator-Crystallizer Building and the 242-T Evaporator-Crystallizer Building. Both of these evaporators were shut down in the early 1980s. The evaporators were designed to remove most of the water from radioactive liquid waste, with the resulting slurry then rerouted to the Tank Farms for interim storage.

296-S-18 This minor stack did not operate in 2013. When operated, it exhausts filtered air from the 242-S Evaporator-Crystallizer Building and particulate emissions are sampled.

1.2.4.6 222-S Laboratory

The 222-S Laboratory provides chemical and radiochemical analytical support for Tank Farm waste characterization, research and development, environmental sample analysis, and Hanford operation and remediation projects.

296-S-16 This minor stack exhausted filtered air from the 219-S Waste Handling Facility waste tanks. Particulate emissions were sampled.

296-S-21 This major stack exhausted filtered air from 222-S Laboratory hoods, gloveboxes, hot-cells, and room ventilation system. Particulate emissions were sampled.

296-S-23 This minor stack exhausted filtered air from the 219-S Waste Handling Facility Sample Gallery Hood. To verify low emissions from this stack, nondestructive analysis of the primary HEPA filter is performed every odd-numbered calendar year; analysis results are presented in Table 5-1, not Table 2-2 where other minor stack data are reported.

1.2.4.7 Waste Receiving and Processing Facility

WRAP is used for examining, assaying, characterizing, and repackaging waste, principally transuranic waste.

296-W-4 This major stack exhausted filtered air from WRAP. Particulate emissions were sampled.

1.2.5 300 Area Facilities

The 300 Area consists primarily of laboratories, research facilities, a radioactive liquid waste handling facility, and several inactive facilities associated with prior Hanford Site missions. Many of these facilities have been demolished as part of CERLCA cleanup activities conducted in the 300 Area. Locations of emission points in the 300 Area are illustrated in Figure 1-5.

1.2.5.1 318 Radiological Calibrations Laboratory

The Radiological Calibrations Laboratory has the capacity for work with Type I and Type II sealed sources and small technical service and research purposes. Room 126 in the 318 Building is equipped with a fume hood that exhausts air flow through a single-pass HEPA filter system to provide air emission controls and help manage radioactive air releases.

EP-318-01-S This minor stack exhausted emissions from a single fume hood. Particulate emissions were sampled.

1.2.5.2 324 Waste Technology Engineering Laboratory

The building contains laboratories that were used for chemical and process development activities, and is now undergoing clean-out and deactivation under CERCLA.

EP-324-01-S This major stack exhausted filtered building air. Particulate emissions were sampled.

1.2.5.3 325 Radiochemical Processing Laboratory

The Radiochemical Processing Laboratory (RPL) manages radioactive inventory to the room, area, and building. The RPL has the capacity for handling Type I and Type II sealed radioactive materials sources, sealed sources, unsealed radioactive sources in the form of fissionable materials, SNM, and high-toxicity radioactive materials. Inventory of these materials shall not exceed the allowable limits of a Facility Use Agreement (FUA). The building is operated as a major emission unit and ventilated through a series of HEPA filters. Its emissions were sampled by silica gel and record samples.

EP-325-01-S This major stack exhausted filtered building air. Emissions were sampled using a record particulate sampler and a tritium sampler.

1.2.5.4 331 Life Sciences Laboratory I

The Life Sciences Laboratory I has the capacity for handling Type I and Type II sealed-source radioactive materials and unsealed radioactive sources such as fissionable materials and SNM. Inventory of these materials shall not exceed the allowable limits of an FUA. The building is operated as a major emission unit and ventilated through single-stage HEPA filters. Its emissions were sampled by record samples.

EP-331-01-V This major vent exhausted filtered building ventilation air. Particulate emissions were sampled.

EP-331-09-S This minor stack did not operate in 2013. When it does operate, emissions will be determined using calculations based on Appendix D of 40 CFR 61 in lieu of monitoring.

1.2.6 400 Area Facilities

The 400 Area consists of the deactivated FFTF, the Maintenance and Storage Facility (MASF), and the Fuels Materials Examination Facility. Locations of 400 Area emission points are illustrated in Figure 1-6.

1.2.6.1 Fast Flux Test Facility

Deactivation of FFTF was completed in June 2009. Located in the 400 Area, it formally operated as a 400–megawatt thermal, sodium-cooled, low-pressure, high-temperature reactor plant, which had been constructed for irradiation testing of breeder reactor fuels and materials.

FFTF-CB-EX This minor stack, also referred to as the Combined Exhaust, is the subject of a continuing agreement with the Washington State Department of Health (WDOH). The agreement allows the discontinuance of emission sampling and in its place the use of calculated emissions based on residual contamination within the FFTF primary piping systems to estimate radioactive material emitted annually.

1.2.6.2 Maintenance and Storage Facility

MASF, or the 437 Building, is a multipurpose service center supporting the specialized maintenance and storage requirements of FFTF. MASF provides the capability for decontamination, repair, and storage of non-fueled components and hardware for FFTF, as well as housing mockups and related training for such actions as 100-K basin sludge retrieval.

437-MN&ST This minor stack exhausted filtered air from MASF. Particulate emissions were sampled.

437-1-61 This minor stack exhausted filtered air from MASF. Particulate emissions were sampled.

1.2.7 600 Area Facilities

In the 600 Area, WSCF emits or has the potential to emit radionuclides. For dose modeling purposes, WSCF was regarded as located in the 200 West Area because of its close proximity to the main entrance to that Area. Hence, WSCF is shown in Figure 1-4.

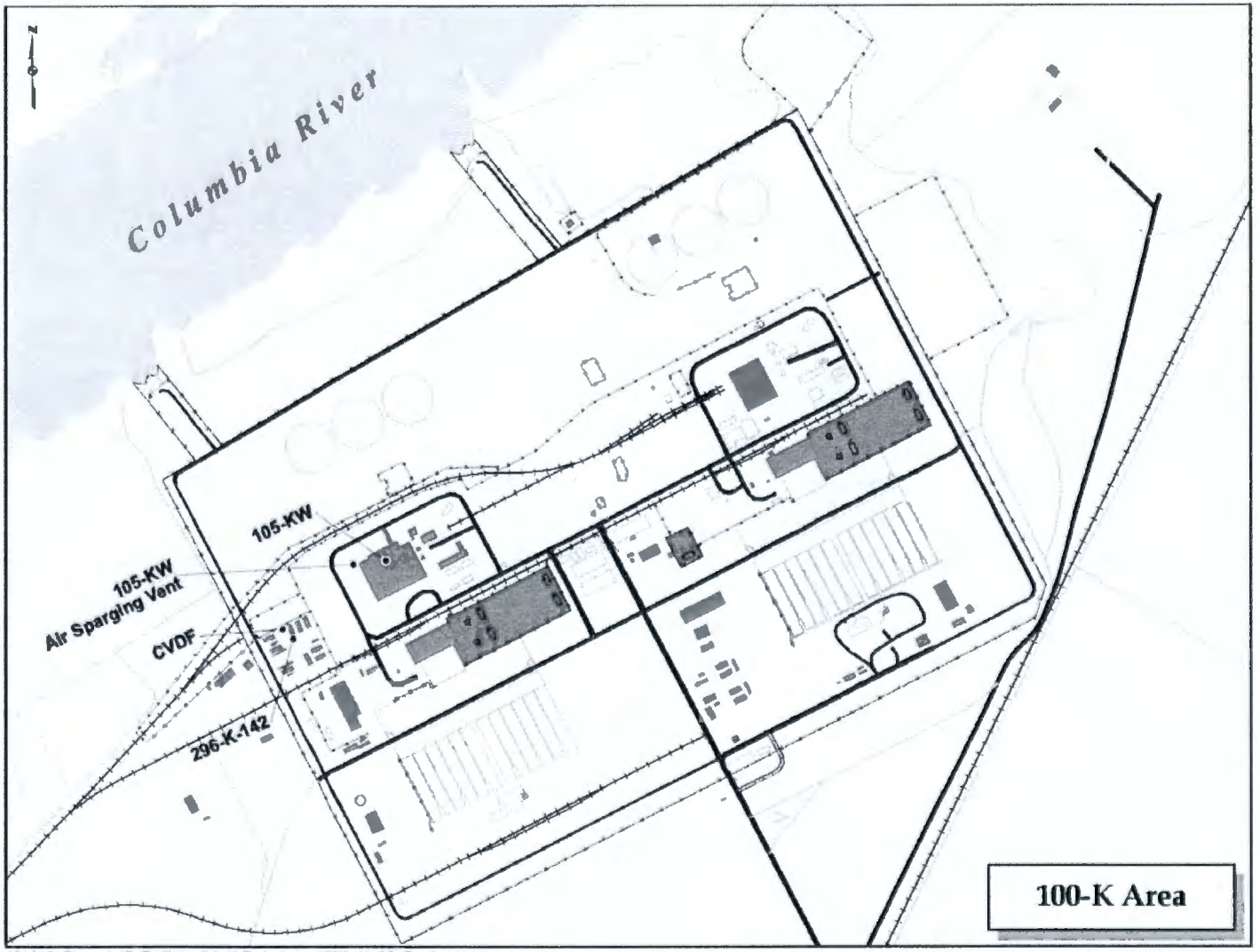
1.2.7.1 Waste Sampling and Characterization Facility

WSCF provides low-level radiological and chemical analyses on various types of samples and sample media. The majority of the analyzed samples are used to determine compliance with the requirements of environmental regulations and DOE Orders.

696-W-1 This minor stack exhausted filtered air from the analytical laboratory, on the main floor of the 6266 Building. Particulate emissions were sampled.

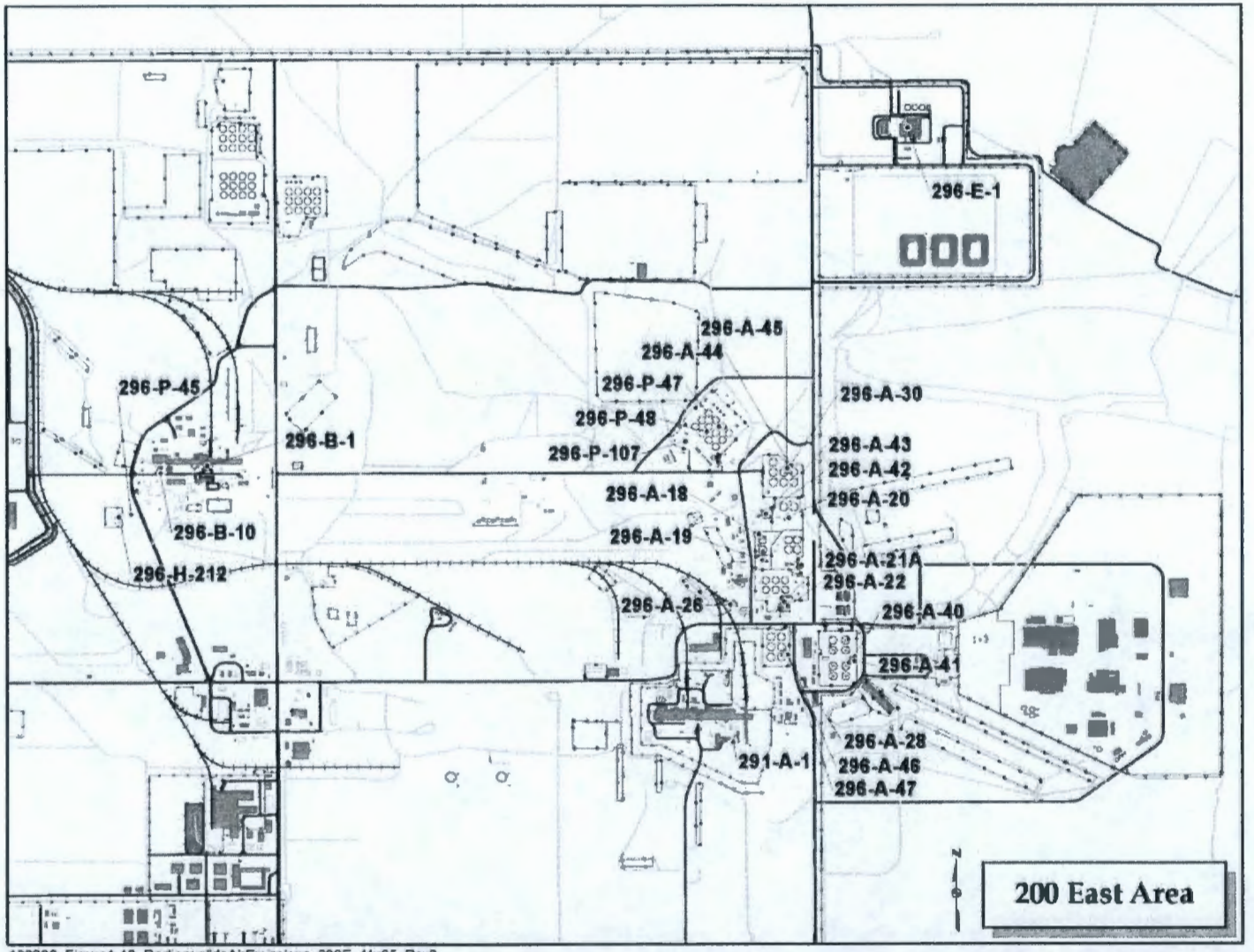
696-W-2 This minor stack exhausted filtered air from the Nuclear Spectroscopy Laboratory in the 6266 Building. Particulate emissions were sampled.

Figure 1-2. 100-K Area Radionuclide Emission Point Sources.



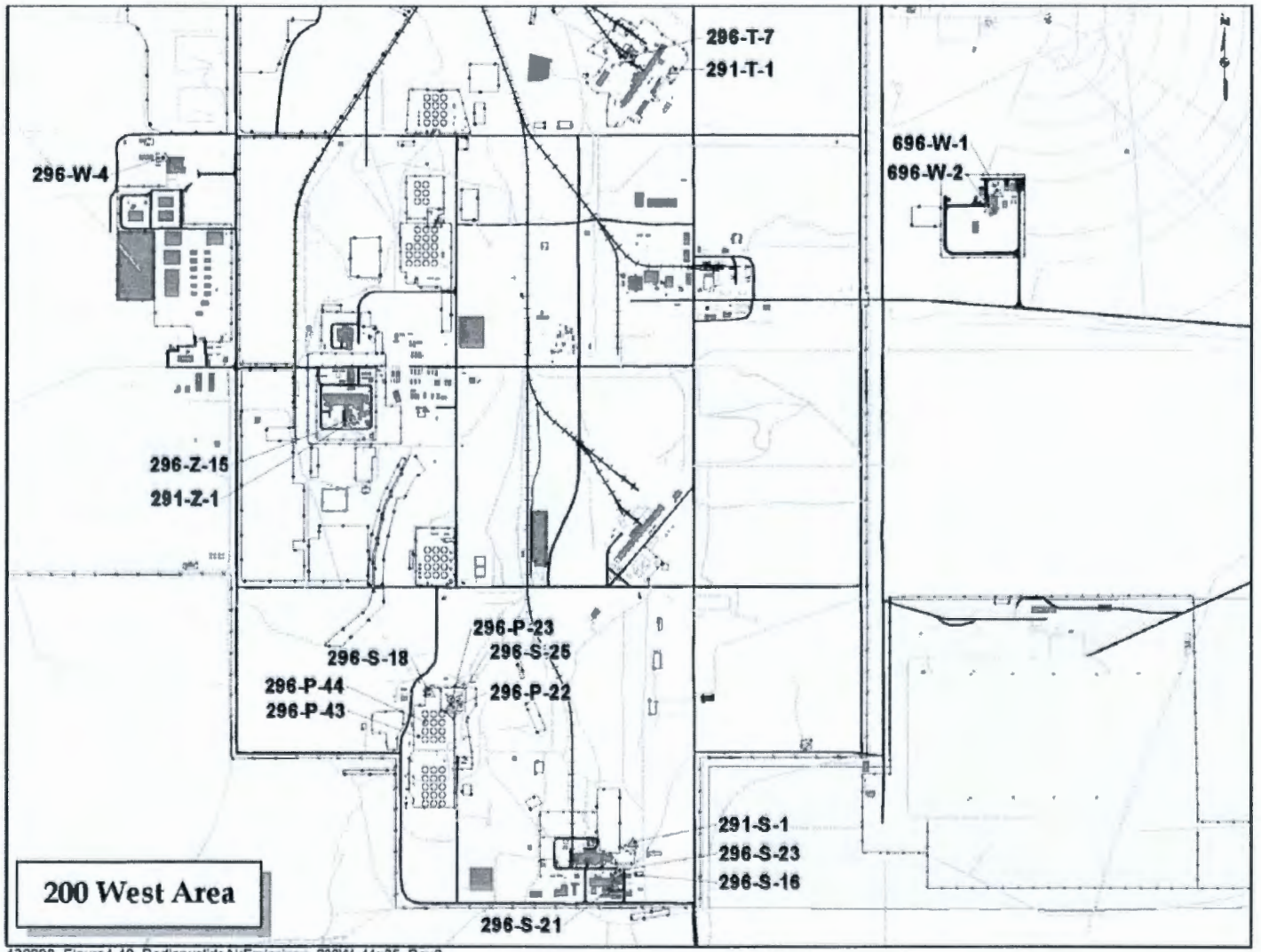
130208_Figure 1-17_RadionuclideAirEmissions_100K_11x85_Rev 1

Figure 1-3. 200 East Area Radionuclide Emission Point Sources.



130208_Figure1-18_RadionuclideAirEmissions_200E_11x85_Rev3

Figure 1-4. 200 West Area Radionuclide Emission Point Sources.



130208_Figure 1-19_RadionuclideAirEmissions_200W_11x85_Rev2

Figure 1-5. 300 Area Radionuclide Emission Point Sources.

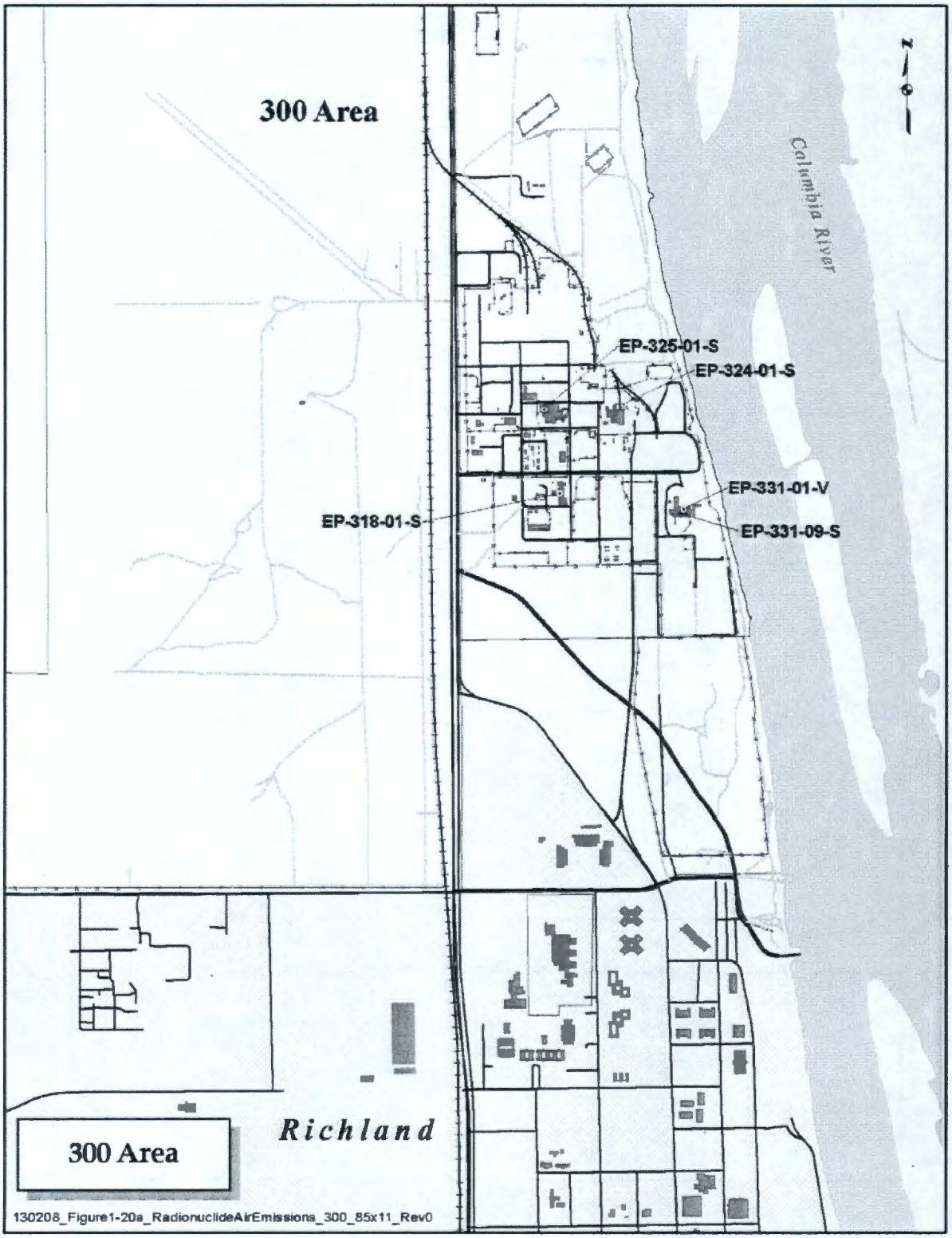
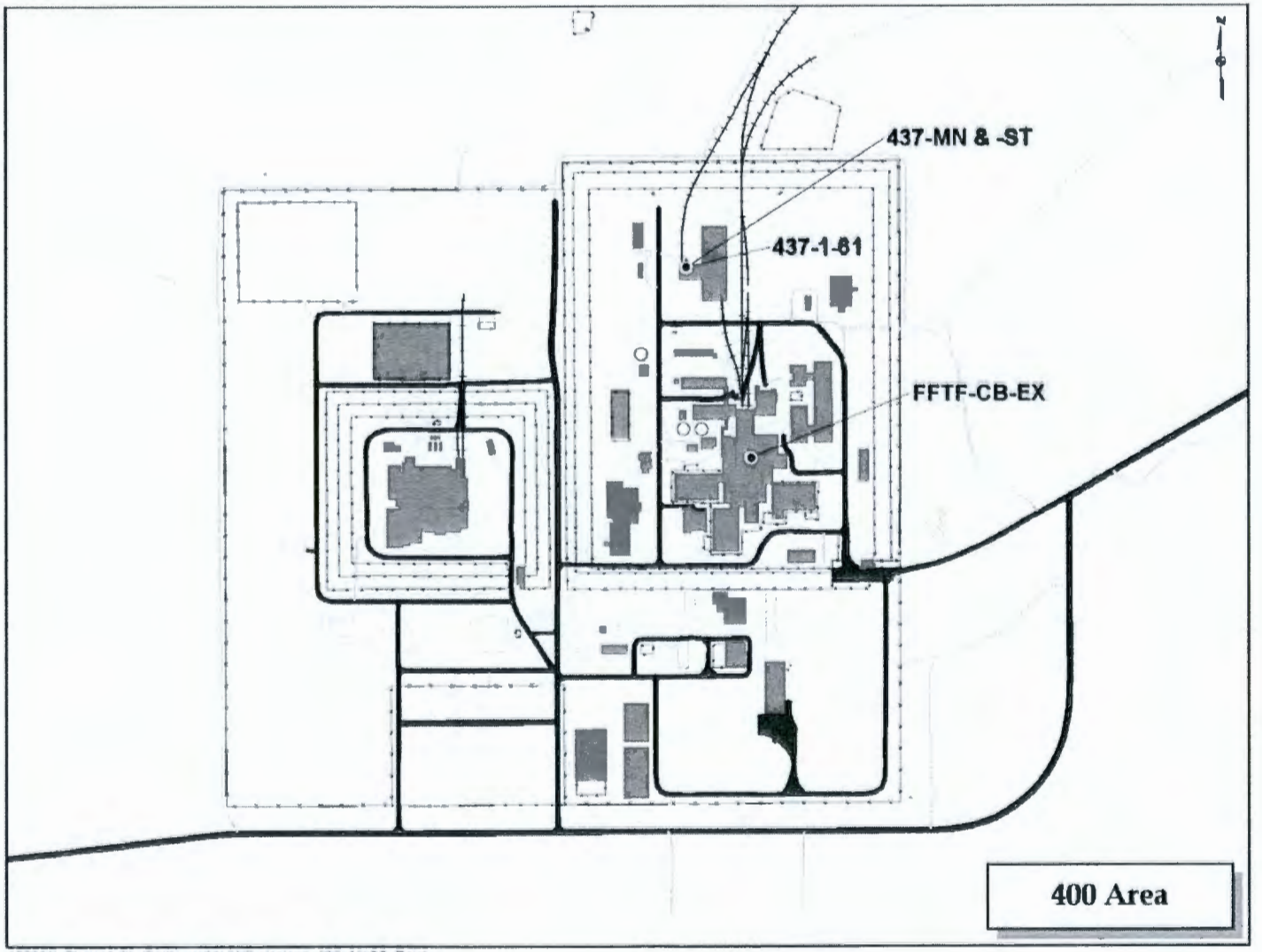


Figure 1-6. 400 Area Radionuclide Emission Point Sources.



130208_Figure1-21_RadionuclideAirEmissions_400_11x85_Rev1

2.0 RADIONUCLIDE AIR EMISSION DATA FOR POINT SOURCES

This section presents information on point sources of radionuclide emissions at the Hanford Site. The point sources listed are actively ventilated stacks using electrically powered exhausters and from which emissions are discharged under controlled conditions. The criteria for reporting point-source radioactive emissions in this report are in Section 1.2. Data on radionuclides emitted from point sources in 2013 are shown in Tables 2-1 and 2-2.

Tables 2-1 and 2-2 display emission data of 21 major and 26 minor point sources, respectively, that operated during 2013, other than briefly for annual testing. Several point sources listed did not operate in 2013, and among them are a few that should never operate again but have not yet been officially and permanently deactivated. The data include total releases in 2013 of radionuclides or types of radioactivity from each point source and the consequent radiological doses from those releases. Tables 2-3 and 2-4 present information on stack heights and in-place abatement technology.

Each emission point is assigned to the major operational area in which it is located (i.e., 100, 200 East, 200 West, 300, or 400 Areas), except for two minor stacks in the 600 Area, near the main entrance to the 200 West Area. For each of the operational areas, a nearest location (e.g., dwelling, business [which can be on an unrestricted area of the Hanford Site], school, or office) relative to that area is determined for a real or hypothetical public receptor who has the potential of receiving the maximum exposure to emissions from that area. A common distance to that nearest public receptor is applied to all the emission points within an operational area; the two stacks in the 600 Area are treated for dose modeling as though located in the 200 West Area. Thus, each of the five operational areas has assigned to it a respective location of a nearest public receptor. Radioactive doses calculated for these receptors are used to determine the regulatory category of each emission point source (i.e., whether it is major or minor) as well as requisite monitoring requirements. Information on these nearest receptors is in Table 2-5, including distances to the nearest farms that produce milk, meat, and vegetables.

In contrast to the five nearest public receptors is the Hanford Site MEI, a member of the public who hypothetically receives the highest calculated radiological dose attributable to exposure to all combined emissions from the Hanford Site in one calendar year. Selection of the annual MEI is contingent on the MEI's place of residence or employment (**Note:** A place of business may be at a location on the Hanford Site to which access is unrestricted, such as the Laser Interferometer Gravitational Wave Observatory [LIGO]). Emission data used in the calculations represent those from all point and fugitive sources in the five operational areas and in the 600 Area. From 2005 through 2011, the MEI had been a resident on a farm near Sagemoor Road, Franklin County, directly across the Columbia River from the Hanford Site 300 Area. For 2004, the MEI location was Ringold, also the site of the MEI from 1990 through 1992. From 1993 through 1999, the MEI was at the Sagemoor Road location. In 2000 and 2001, the location of the MEI shifted to two different locations within the 300 Area where non-DOE-related employment existed. Those businesses ended in early 2002.

The MEI for 2013 was the same as identified in 2012: an employee at the PNNL Site Physical Sciences Facility (PSF), an offsite business located at 638 Horn Rapids Road in north Richland, Benton County, Washington, directly south of the Hanford Site 300 Area. PSF is on the DOE-PNSO PNNL Campus, separate from though adjacent to the Hanford Site.[1]

[1]Selection of PSF as the location of the Hanford Site MEI for 2013 was a conservative choice based on the meteorology and emission rates ascribing the highest dose estimate to the PSF among other locations considered.

The radiological dose to the MEI was calculated using the dose-modeling program Clean Air Act Assessment Package 1988-Personal Computer (CAP88-PC) Version 3 (EPA 2013, *CAP88-PC Version 3.0 User Guide*), approved by the EPA. This dose value is used in determining the status of Hanford Site compliance with the dose standard in Subpart H of 40 CFR 61 of 10 mrem/yr EDE to any member of the public, as well as to the dose standard in WAC 246-267, which is also 10 mrem/yr EDE to any member of the public.

Table 2-1. Hanford Site Radionuclide Air Emissions from Major Point Sources in 2013.
(radiological dose potential of >0.1 mrem/yr EDE to nearest public receptor)[a] (6 sheets)

Stack (facility; contractor; EDP code)[b]	Average operation flow rate,[c] ft^3/min (m^3/s)	Volume, ft^3 (m^3)	Radionuclide[d] or type of radioactivity	Average operating concentration,[e] µCi/mL	Emissions, Ci	EDE to MEI,[f] mrem
			100 Areas			
296-K-142	16,100	8.5 E+09	^{90}Sr	≤0	0	0
(CVDF; CHPRC;	(7.60)	(2.4 E+08)	^{137}Cs	≤0	0	0
Y201)			^{238}Pu	≤0	0	0
			$^{239/240}Pu$	≤0	0	0
			^{241}Pu	≤0	0	0
			^{241}Am	≤0	0	0
			gross α	1.1 E–16	4.8 E–08	2.4 E–08
			gross β	4.3 E–16	1.8 E–07	6.5 E–09
					296-K-142 total dose:	3.1 E–08
			200 East Area			
291-A-1	25,814	1.4 E+10	^{129}I	1.7 E–12	7.4 E–04	2.1 E–04
(PUREX Plant;	(12.18)	(3.8 E+08)	^{238}Pu	≤0	0	0
CHPRC; A006)			$^{239/240}Pu$	3.6 E–17	2.8 E–08	1.7 E–08
			^{241}Am	3.1 E–17	2.4 E–08	1.2 E–08
			gross α	2.4 E–16	1.9 E–07	1.1 E–07
			gross β	1.1 E–15	8.7 E–07	4.1 E–08
					291-A-1 total dose:	2.1 E–04
296-A-19	700	3.7 E+08	^{90}Sr	7.9 E–17	1.1 E–09	5.2 E–11
(TF; WRPS; E061)	(0.33)	(1.0 E+07)	^{137}Cs	≤0	0	0
			^{241}Am	≤0	0	0
			gross α	2.8 E–16	3.9 E–09	2.3 E–09
			gross β	2.3 E–15	3.3 E–08	1.6 E–09
					296-A-19 total dose:	4.0 E–09
296-A-42	826	4.3 E+08	^{90}Sr	8.3 E–17	1.4 E–09	6.6 E–11
(TF; WRPS; E147)	(0.39)	(1.2 E+07)	^{137}Cs	≤0	0	0
			^{238}Pu	≤0	0	0
			$^{239/240}Pu$	≤0	0	0
			^{241}Am	≤0	0	0
			gross α	4.2 E–17	7.1 E–10	4.2 E–10
			gross β	1.3 E–15	2.1 E–08	9.9 E–10
					296-A-42 total dose:	1.5 E–09

Table 2-1. Hanford Site Radionuclide Air Emissions from Major Point Sources in 2013.
(radiological dose potential of >0.1 mrem/yr EDE to nearest public receptor)[a] (6 sheets)

Stack (facility; contractor; EDP code)[b]	Average operation flow rate,[c] ft^3/min (m^3/s)	Volume, ft^3 (m^3)	Radionuclide[d] or type of radioactivity	Average operating concentration,[e] µCi/mL	Emissions, Ci	EDE to MEI,[f] mrem
296-A-44 and 296-A-45 (TF; WRPS; E920 and E922; [these two stacks exhaust the same source])	1,838 (0.87)	9.7 E+08 (2.7 E+07)	^{90}Sr	1.1 E–16	4.2 E–09	2.0 E–10
			^{90}Y	1.1 E–16	4.2 E–09	1.7 E–13
			^{134}Cs	≤0	0	0
			^{137}Cs	1.2 E–16	4.4 E–09	1.2 E–10
			^{231}Pa	≤0	0	0
			^{238}Pu	≤0	0	0
			$^{239/240}Pu$	≤0	0	0
			^{241}Pu	≤0	0	0
			^{241}Am	2.2 E–18	8.3 E–11	4.0 E–11
			gross α	3.8 E–16	1.4 E–08	8.3 E–09
			gross β	3.3 E–15	1.2 E–07	5.6 E–09
					296-A-44 and 296-A-45 total dose:	1.4 E–08
296-A-46 and 296-A-47 (TF; WRPS; E924 and E926; respectively [these two stacks exhaust the same source])	862 (0.41)	4.5 E+08 (1.3 E+07)	^{90}Sr	1.4 E–16	2.4 E–09	1.0 E–10
			^{90}Y	1.4 E–16	2.4 E–09	9.8 E–14
			^{134}Cs	≤0	0	0
			^{137}Cs	≤0	0	0
			^{231}Pa	≤0	0	0
			^{238}Pu	≤0	0	0
			$^{239/240}Pu$	≤0	0	0
			^{241}Pu	≤0	0	0
			^{241}Am	≤0	0	0
			gross α	2.0 E–16	3.5 E–09	2.1 E–09
			gross β	7.7 E–16	1.4 E–08	6.6 E–10
					296-A-46 and 296-A-47 total dose:	2.9 E–09
296-B-1 (B Plant; CHPRC; B001)	15,282 (7.21)	8.0 E+09 (2.3 E+08)	**^{90}Sr**	4.3 E–17	1.2 E–08	5.6 E–10
			^{137}Cs	≤0	0	0
			gross α	3.6 E–17	1.0 E–08	5.9 E–09
			gross β	3.8 E–16	1.1 E–07	5.2 E–09
					296-B-1 total dose:	1.2 E–08
296-B-10 (WESF; CHPRC; B748)	24,390 (11.51)	1.3 E+10 (3.6 E+08)	^{90}Sr	3.1 E–13	1.8 E–04	8.5 E–06
			^{137}Cs	1.6 E–13	9.2 E–05	2.5 E–06
			gross α	5.4 E–16	3.2 E–07	1.9 E–07
			gross β	7.8 E–13	4.5 E–04	2.1 E–05
					296-B-10 total dose:	3.2 E–05

Table 2-1. Hanford Site Radionuclide Air Emissions from Major Point Sources in 2013.
(radiological dose potential of >0.1 mrem/yr EDE to nearest public receptor)[a] (6 sheets)

Stack (facility; contractor; EDP code)[b]	Average operation flow rate,[c] ft^3/min (m^3/s)	Volume, ft^3 (m^3)	Radionuclide[d] or type of radioactivity	Average operating concentration,[e] µCi/mL	Emissions, Ci	EDE to MEI,[f] mrem
296-H-212 (CSB; CHPRC; C601)	9,000 (4.25)	4.7 E+09 (1.3 E+08)	^{90}Sr	≤0	0	0
			^{137}Cs	≤0	0	0
			^{238}Pu	≤0	0	0
			$^{239/240}Pu$	1.9 E–19	3.1 E–10	1.8 E–11
			^{241}Pu	≤0	0	0
			^{241}Am	≤0	0	0
			gross α	6.8 E–17	1.1 E–08	6.5 E–09
			gross β	3.8 E–16	6.1 E–08	2.9 E–09
					296-H-212 total dose:	9.4 E–09
296-P-45 (TF; WRPS; E047)			did not operate			
296-P-47 (TF; WRPS; E096)	191 (0.09)	1.0 E+08 (2.8 E+06)	^{90}Sr	7.0 E–15	2.7 E–09	1.3 E–10
			^{137}Cs	≤0	0	0
			gross α	1.8 E–16	7.1 E–10	4.2 E–10
			gross β	1.5 E–15	5.7 E–09	2.7 E–10
					296-P-47 total dose:	8.2 E–10
296-P-48 (TF; WRPS; E098)	65 (0.03)	3.4 E+07 (9.7 E+05)	^{90}Sr	≤0	0	0
			^{137}Cs	≤0	0	0
			gross α	4.4 E–16	5.8 E–10	3.4 E–10
			gross β	2.6 E–15	3.5 E–09	1.6 E–10
					296-P-48 total dose:	5.0 E–10
296-P-107 (TF; WRPS; E104)	1,621 (0.76)	5.6 E+08 (1.6 E+07)	^{90}Sr	3.2 E–16	7.0 E–09	3.3 E–10
			^{137}Cs	≤0	0	0
			gross α	7.6 E–17	1.7 E–09	1.0 E–09
			gross β	1.4 E–15	3.0 E–08	1.4 E–09
					296-P-107 total dose:	2.7 E–09
200 West Area						
291-T-1 (221-T; CHPRC; T785)	40,000 (18.88)	2.1 E+10 (6.0 E+08)	^{90}Sr	1.0 E–15	7.7 E–07	3.3 E–08
			^{137}Cs	1.2 E–15	9.0 E–07	2.3 E–08
			^{238}Pu	2.6 E–17	1.9 E–08	9.1 E–09
			$^{239/240}Pu$	3.7 E–15	2.8 E–06	1.5 E–06
			^{241}Am	2.4 E–16	1.8 E–07	7.7 E–08
			gross α	1.2 E–15	9.0 E–07	4.8 E–07
			gross β	2.0 E–15	1.5 E–06	6.5 E–08
					291-T-1 total dose:	2.2 E–06

Table 2-1. Hanford Site Radionuclide Air Emissions from Major Point Sources in 2013.
(radiological dose potential of >0.1 mrem/yr EDE to nearest public receptor)[a] (6 sheets)

Stack (facility; contractor; EDP code)[b]	Average operation flow rate,[c] ft^3/min (m^3/s)	Volume, ft^3 (m^3)	Radionuclide[d] or type of radioactivity	Average operating concentration,[e] µCi/mL	Emissions, Ci	EDE to MEI,[f] mrem
291-Z-1 (PFP; CHPRC; Z810 [under CERCLA[g]])	290,000 (136.86)	1.5 E+11 (4.3 E+09)	**^{238}Pu**	1.3 E–17	6.4 E–08	3.1 E–08
			$^{239/240}$Pu	2.9 E–15	1.5 E–05	7.9 E–05
			^{241}Pu	2.0 E–15	5.2 E–06	4.9 E–08
			^{241}Am	6.8 E–16	3.4 E–06	1.5 E–06
			gross α	5.4 E–15	2.7 E–05	1.4 E–05
			gross β	1.5 E–15	7.5 E–06	3.2 E–07
					291-Z-1 total dose:	2.4 E–05
296-P-43 (TF; WRPS; E045)			did not operate			
296-P-44 (TF; WRPS; E046)			did not operate			
296-S-21 (222-S; WRPS; S289)	78,177 (36.89)	4.1 E+10 (1.2 E+09)	**^{90}Sr**	≤0	0	0
			^{137}Cs	≤0	0	0
			^{238}Pu	7.2 E–18	1.1 E–08	5.3 E–09
			$^{239/240}$Pu	6.5 E–18	1.0 E–08	5.3 E–09
			^{241}Am	≤0	0	0
			gross α	1.3 E–16	2.1 E–07	1.1 E–07
			gross β	7.1 E–16	1.1 E–06	4.7 E–08
					296-S-21 total dose:	1.7 E–07
296-W-4 (WRAP; CHPRC; W123)	14,857 (7.01)	7.8 E+09 (2.2 E+08)	^{90}Sr	1.2 E–16	3.6 E–08	1.5 E–09
			^{137}Cs	≤0	0	0
			^{238}Pu	≤0	0	0
			$^{239/240}$Pu	≤0	0	0
			^{241}Pu	≤0	0	0
			^{241}Am	≤0	0	0
			gross α	2.5 E–17	7.6 E–09	4.0 E–09
			gross β	2.3 E–16	7.1 E–08	3.1 E–09
					296-W-4 total dose:	8.6 E–09

Table 2-1. Hanford Site Radionuclide Air Emissions from Major Point Sources in 2013.
(radiological dose potential of >0.1 mrem/yr EDE to nearest public receptor)[a] (6 sheets)

Stack (facility; contractor; EDP code)[b]	Average operation flow rate,[c] ft^3/min (m^3/s)	Volume, ft^3 (m^3)	Radionuclide[d] or type of radioactivity	Average operating concentration,[e] µCi/mL	Emissions, Ci	EDE to MEI,[f] mrem
			300 Area			
EP-324-01-S	50,366	2.6 E+10	^{90}Sr	5.6 E–17	4.9 E–08	1.7 E–07
(324 Building; WCH;	(23.77)	(7.5 E+08)	^{137}Cs	≤0	0	0
F025			^{238}Pu	≤0	0	0
[under CERCLA])			$^{239/240}Pu$	≤0	0	0
			^{241}Am	≤0	0	0
			gross α	5.6 E–17	4.9 E–08	2.6 E–06
			gross β	2.6 E–16	2.3 E–07	7.8 E–07
					EP-324-01–S total dose:	3.5 E–06
EP-325-01-S	141,100	7.4 E+10	^{3}H (HT)	2.7 E–08	5.7 E+01	1.5855 E–02
(325 Building; PNNL; NA)	(66.6)	(2.1 E+09)	^{3}H (HTO)	9.2 E–08	1.9 E+02	1.1282 E–01
			^{14}C	4.8 E–16	1.0 E–06[i]	2.6 E–08
			^{54}Mn	≤0	0	0
			^{85}Kr	2.6 E–12	5.5 E–03[i]	5.2 E–09
			^{90}Sr	1.3 E–17	2.7 E–08	9.1 E–08
			^{99}Tc	7.6 E–16	1.6 E–06[j]	1.5 E–06
			^{137}Cs	3.2 E–18	6.7 E–09	1.3 E–08
			^{152}Eu	6.4 E–18	1.3 E–08[j]	2.2 E–09
			^{154}Eu	1.2 E–16	2.6 E–07[j]	4.9 E–08
			^{153}Gd	2.6 E–20	5.4 E–11[j]	6.3 E–13
			^{226}Ra	1.1 E–19	2.3 E–10[j]	2.2 E–09
			^{220}Rn	1.2 E–07	2.5 E+02[h]	[see Table 3-5]
			^{227}Ac	3.5 E–20	7.3 E–11[j]	5.6 E–09
			^{232}U	1.4 E–19	2.9 E–10[j]	3.2 E–09
			^{233}U	1.5 E–18	3.1 E–09[j]	1.3 E–08
			^{238}Pu	1.1 E–19	2.3 E–10	1.1 E–08
			$^{239/240}Pu$	2.3 E–18	4.7 E–09	2.5 E–07
			^{241}Pu	9.4 E–17	2.0 E–07	1.9 E–07
			^{241}Am	1.1 E–19	2.3 E–10	1.0 E–08
			^{243}Am	1.2 E–17	2.5 E–08	1.1 E–06
			$^{243/244}Cm$	≤0	0	0
			gross α	9.8 E–18	2.1 E–08	1.1 E–06
			gross β	1.1 E–16	2.4 E–07	8.0 E–07
					EP-325-01–S total dose:	1.2868 E–01

Table 2-1. Hanford Site Radionuclide Air Emissions from Major Point Sources in 2013.
(radiological dose potential of >0.1 mrem/yr EDE to nearest public receptor)[a] (6 sheets)

Stack (facility; contractor; EDP code)[b]	Average operation flow rate,[c] ft^3/min (m^3/s)	Volume, ft^3 (m^3)	Radionuclide[d] or type of radioactivity	Average operating concentration,[e] µCi/mL	Emissions, Ci	EDE to MEI,[f] mrem
EP-331-01-V	66,900	3.5 E+10	**^{137}Cs**	≤0	0	0
(331 Building; PNNL; NA)	(31.6)	(1.0 E+09)	^{237}Np	2.6 E–19	2.6 E–10	6.4 E–09
			^{238}Pu	≤0	0	0
			$^{239/240}$Pu	2.0 E–18	2.0 E–09	1.0 E–07
			^{241}Am	≤0	0	0
			^{243}Am	4.0 E–17	4.0 E-08[j]	1.8 E–06
			gross α	5.0 E–17	4.9 E–08	2.6 E–06
			gross β	2.4 E–16	2.4 E–07	8.2 E–07
					EP-331-01–V total dose:	5.3 E–06

General definitions: ≤0 = analytical result equal to level of laboratory ambient background radioactivity or less than that level, which in practical terms means the radionuclide or type of radioactivity was not detected in the sample of the emission collected; Ci = curie; 1 Ci = 3.7 E+10 becquerels (Bq); ft^3 = cubic feet; HT is tritium, or elemental tritium, in the form of an incondensable gas; HTO is tritiated water vapor, or tritium in the form of condensable water vapor; m^3 = cubic meters; min = minute; mrem = millirem; NA = not applicable; s = second; yr = year.

[a] Determining the potential prospective dose impact of each point source necessitated using nearest public receptors, who may differ from the annually determined Hanford Site MEI.

[b] Abbreviations and acronyms in this column are: CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980; CHPRC = CH2M HILL Plateau Remediation Company; CSB = Canister Storage Building; CVDF = Cold Vacuum Drying Facility; EDP code = electronic data processing code, used in chain-of-custody activities to identify sampling locations; PNNL = Pacific Northwest National Laboratory; PFP = Plutonium Finishing Plant; PUREX = Plutonium-Uranium Extraction; TF = Tank Farms; WCH = Washington Closure Hanford, LLC; WESF = Waste Encapsulation and Storage Facility; WRAP = Waste Receiving and Processing Facility; WRPS = Washington River Protection Solutions, LLC.

[c] Reflects stack flow rate averaged over time of stack operation or averaged over the calendar year.

[d] Radionuclides in bold typeface and within a shaded cell identify those required by 40 CFR 61, Subpart H, for mandatory sampling and analysis.

[e] Reflects concentration averaged over time of stack operation.

[f] EDE for MEI = effective dose equivalent for the maximally exposed individual; for calendar year 2013, the MEI was located at PSF, in north Richland, Benton County, directly south of the Hanford Site 300 Area.

[g] Emissions from this point source are associated with cleanup operations conducted under the authority of CERCLA. Reporting those emissions in Table 2-1 demonstrates compliance with the monitoring requirements of 40 CFR 61, Subpart H, a substantively equivalent law (i.e., "applicable or relevant and appropriate requirement") as defined by CERCLA.

[h] Release value conservatively calculated based on release and use records, not actually measured.

[i] Release value based on release records from Radioactive Gas Inventory database.

[j] Release value is calculated using Appendix D method of 40 CFR 61 and material inventories of 2013.

Table 2-2. Hanford Site Radionuclide Air Emissions from Minor Point Sources in 2013.
(radiological dose potential of <0.1 mrem/yr EDE to nearest public receptor)[a] (3 sheets)

Stack (facility; contractor; EDP code)[b]	Average operation flow rate,[c] ft^3/min (m^3/s)	Volume, ft^3 (m^3)	Radionuclide or type of radioactivity	Average operating concentration,[d] µCi/mL	Emissions, Ci	EDE to MEI,[e] mrem
			100 Areas			
105-KW Basin	8,700	4.6 E+09	^{90}Sr	2.0 E–14	2.9 E–06	1.0 E–07
(100-K Area; CHPRC; Y236	(4.11)	(1.3 E+08)	^{137}Cs	2.4 E–14	3.4 E–06	7.1 E–08
under CERCLA[f])			^{154}Eu	1.7 E–16	2.4 E–08	4.6 E–11
			^{238}Pu	1.7 E–15	2.5 E–07	1.1 E–07
			$^{239/240}Pu$	1.1 E–14	1.6 E–06	8.0 E–07
			^{241}Pu	7.1 E–14	1.0 E–05	9.1 E–08
			^{241}Am	1.1 E–14	1.5 E–06	6.3 E–07
			gross α	2.5 E–14	3.5 E–06	1.8 E–06
			gross β	8.9 E–14	1.3 E–05	4.7 E–07
					105-KW Basin total dose:	4.1 E–06
			200 East Area			
296-A-18	833	4.4 E+08	gross α	1.6 E–15	2.8 E–08	1.7 E–08
(TF; WRPS; E060)	(0.39)	(1.2 E+07)	gross β	4.9 E–15	8.4 E–08	3.9 E–09
					296-A-18 total dose:	2.1 E–08
296-A-20	1,935	1.0 E+09	gross α	1.8 E–16	6.1 E–09	3.6 E–09
(TF; WRPS; E197)	(0.91)	(2.9 E+07)	gross β	7.9 E–16	2.7 E–08	1.3 E–09
					296–A–20 total dose:	4.9 E–09
296-A-21A	17,974	9.4 E+09	gross α	1.5 E–16	5.3 E–08	3.1 E–08
(TF; WRPS; E651)	(8.48)	(2.7 E+08)	gross β	1.5 E–16	5.6 E–08	2.6 E–09
					296–A–21A total dose:	3.4 E–08
296-A-22	491	2.6 E+08	gross α	2.0 E–16	1.9 E–09	1.1 E–09
(TF; WRPS; E0643;	(0.23)	(7.3 E+06)	gross β	1.5 E–15	1.4 E–08	6.6 E–10
					296-A-22 total dose:	1.8 E–09
296-A-26 (TF; WRPS; E297)			did not operate			
296-A-28	3,467	1.8 E+09	gross α	5.7 E–16	6.3 E–08	3.7 E–08
(TF; WRPS; E272)	(1.64)	**(5.2 E+07)**	gross β	2.0 E–15	2.2 E–07	1.0 E–08
					296-A-28 total dose:	4.7 E–08
296-A-30	2,318	1.2 E+09	gross α	1.1 E–15	7.0 E–08	4.1 E–08
(TF; WRPS; E903)	(1.09`)	(3.4 E+07)	gross β	7.7 E–15	4.8 E–07	2.3 E–08
					296-A-30 total dose:	6.4 E–08
296-A-40	717	3.8 E+09	gross α	1.7 E–16	2.2 E–09	1.3 E–09
(TF; WRPS; E013)	(0.34)	(1.1 E+07)	gross β	7.1 E–16	9.4 E–09	4.4 E–10
					296-A-40 total dose:	1.7 E–09

Table 2-2. Hanford Site Radionuclide Air Emissions from Minor Point Sources in 2013.
(radiological dose potential of <0.1 mrem/yr EDE to nearest public receptor)[a] (3 sheets)

Stack (facility; contractor; EDP code)[b]	Average operation flow rate,[c] ft^3/min (m^3/s)	Volume, ft^3 (m^3)	Radionuclide or type of radioactivity	Average operating concentration,[d] µCi/mL	Emissions, Ci	EDE to MEI,[e] mrem
296-A-41	5,795	3.0 E+09	gross α	1.5 E–16	1.6 E–08	9.4 E–09
(TF; WRPS; E015)	(2.73)	(8.6 E+07)	gross β	5.0 E–16	5.4 E–08	2.5 E–09
					296-A-41 total dose:	1.2 E–08
296-A-43	645	1.4 E+08	gross α	≤0	0	0
(TF; WRPS; E148)	(0.30)	(4.0 E+06)	gross β	3.4 E–16	1.9 E–09	8.9 E–11
					296-A-43 total dose:	8.9 E–11
296-E-1	51,000	2.7 E+10	gross α	1.6 E–16	1.7 E–07	1.0 E–07
(ETF; CHPRC; E036)	(24.07)	(7.6 E+08)	gross β	9.0 E–16	9.3 E–07	4.4 E–08
					296-E-1 total dose:	1.4 E–07
			200 West Area			
291-S-1	18,426	9.7 E+09	gross α	3.3 E–16	1.2 E–07	6.4 E–08
(REDOX Plant; CHPRC; S006)	(8.70)	(2.7 E+08)	gross β	1.9 E–15	7.1 E–07	3.1 E–08
					291-S-1 total dose:	9.5 E–08
296-P-22	693	3.6 E+08	gross α	1.8 E–16	2.3 E–09	1.2 E–09
(TF; WRPS; W191)	(0.33)	(1.0 E+07)	gross β	5.8 E–15	7.4 E–09	3.2 E–10
					296-P-22 total dose:	1.5 E–09
296-P-23 (W190) **and 296-S-25** (W145) (TF; WRPS) [stacks alternate exhausting a single source]	800 (0.38)	4.2 E+08 (1.2 E+07)	gross α	7.9 E–17	1.2 E–09	6.4 E–10
			gross β	6.1 E–16	9.7 E–09	4.2 E–10
					296-P-23 and 296-S-25 total dose:	1.1 E–09
296-S-16	20	1.1 E+07	gross α	1.1 E–15	4.4 E–10	2.3 E–10
(219-5; WRPS; S264)	(0.01)	(3.0 E+05)	gross β	7.1 E–15	2.9 E–09	1.2 E–10
					296-S-16 total dose:	3.5 E–10
296-S-18 (TF; WRPS; W096)			did not operate			
296-T-7	110	5.8 E+07	^{137}Cs	≤0	0	0
(2706-T; CHPRC; T154)	(0.05)	(1.6 E+06)	gross β	≤0	0	0
			gross α	≤0	0	0
					296-T-7 total dose:	0
296-Z-15	1,357	7.2 E+08	gross α	≤0	0	0
(PFP; CHPRC; Z915)	(0.64)	(2.0 E+07)	gross β	1.0 E–16	2.7 E–09	1.2 E–10
[under CERCLA[f]]					**296-Z-15 total dose:**	1.2 E–10
			300 Area			
EP-318-01-S	594	3.12 E+08	gross α	1.5 E–19	1.3 E–12	6.9 E–11
(318 Building; PNNL; NA)	(0.28)	(8.84 E+06)	gross β	3.9 E–16	3.5 E–09	1.2 E–08
					EP-318-01-S total dose:	1.2 E–08
EP-331-09-S (331 Building; PNNL; NA)			did not operate			

Table 2-2. Hanford Site Radionuclide Air Emissions from Minor Point Sources in 2013.
(radiological dose potential of <0.1 mrem/yr EDE to nearest public receptor)[a] (3 sheets)

Stack (facility; contractor; EDP code)[b]	Average operation flow rate,[c] ft^3/min (m^3/s)	Volume, ft^3 (m^3)	Radionuclide or type of radioactivity	Average operating concentration,[d] µCi/mL	Emissions, Ci	EDE to MEI,[e] mrem
			600 Area			
437-1-61	12,600	6.6 E+09	gross α	1.3 E–16	3.3 E–08	1.8 E–07
(MASF; CHPRC; F019)	(5.95)	(1.9 E+08)	gross β	6.7 E–16	1.7 E–07	3.4 E–08
					437-1-61 total dose:	2.1 E–07
437-MN&ST	4,500	2.4 E+09	gross α	1.5 E–16	1.5 E–07	8.1 E–07
(MASF; CHPRC; F014)	(2.12)	(6.7 E+07)	gross β	2.1 E–14	2.2 E–06	4.4 E–07
					437-MN&ST total dose:	1.2 E–06
FFTF-CB-EX	NA	NA	^{3}H (HTO)	NA	1.8 E–03[g]	5.9 E–08
(MASF; CHPRC; F011)			^{22}Na	NA	1.4 E–09[g]	6.2 E–11
[**Note:** No measured flow from stack. Curie values derive from residual radioactive sodium in FFTF reactor primary coolant piping system, not analyzed emission samples.]			^{137}Cs	NA	6.7 E–13[g]	1.3 E–13
			^{239}Pu	NA	9.1 E–15[g]	4.9 E–14
					FFTF-CB-EX total dose:	5.9 E–08
696-W-1	50,930	2.7 E+10	gross α	8.2 E–17	8.5 E–08	4.5 E–08
(WSCF; MSA; W010)	(24.04)	(7.6 E+08)	gross β	4.1 E–16	4.3 E–07	1.8 E–08
					696-W-1 total dose:	6.3 E–08
696-W-2	1,054	5.5 E+08	gross α	≤0	0	0
(WSCF; MSA; W011)	(0.50)	(1.6 E+07)	gross β	3.1 E–16	6.6 E–09	2.8 E–10
					696-W-2 total dose:	2.8 E–10

General definitions: ≤ = analytical result equal to level of laboratory ambient background radioactivity or less than that level, which in practical terms means the radionuclide or type of radioactivity was not detected in the sample of the emission collected; Ci = curie; 1 Ci = 3.7 E+10 becquerels (Bq); ft^3 = cubic feet; HTO is tritiated water vapor, or tritium in the form of condensable water vapor; m^3 = cubic meter; min = minute; = mrem = millirem; NA = not applicable; s = second; yr = year.

[a]Determining the potential prospective dose impact of each point source necessitated using nearest public receptors, who may differ from the annually determined Hanford Site MEI

[b]Abbreviations and acronyms in this column are: CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980; CHPRC = CH2M HILL Plateau Remediation Company; EDP code = electronic data processing code, used in chain-of-custody activities to identify sampling locations; ETF = 200 Area Effluent Treatment Facility; FFTF = Fast Flux Test Facility; MASF = Maintenance and Storage Facility; MSA = Mission Support Alliance, LLC; PNNL = Pacific Northwest National Laboratory; PFP = Plutonium Finishing Plant; TF = Tanks Farms; WCH = Washington Closure Hanford, LLC; WRPS = Washington River Protection Solutions, LLC; and WSCF = Waste Sampling and Characterization Facility.

[c]Reflects stack flow rate averaged over time of stack operation or averaged over the calendar year.

[d]Reflects concentration averaged over time of stack operation.

[e]EDE for MEI = effective dose equivalent for the maximally exposed individual; for calendar year 2013, the MEI was located at PSF, in north Richland, Benton County, directly south of the Hanford Site 300 Area.

[f]Emissions from this point source are associated with cleanup operations conducted under the authority of CERCLA. Reporting those emissions in Table 2-2 demonstrates compliance with the requirements of 40 CFR 61, Subpart H, a substantively equivalent law (i.e., "applicable or relevant and appropriate requirement") as defined by CERCLA.

[g]Value based on estimates of residual sodium in FFTF reactor primary coolant piping system.

Table 2-3. Hanford Site Major Stack Heights and Abatement Technology.

Stack	Discharge height, ft (m)	Abatement technology[a]
100 Area Major Point Sources		
105-KW Air Sparging Vent	48 (14.6)	HEPA (1)
296-K-142	90 (27.4)	HEPAs (4 and 1 two-stage), isolation dampers (4), fans (8), prefilter
200 East Area Major Point Sources		
291-A-1	200 (61)	HEPAs (2 in series), deep-bed fiberglass filter, fans (2 in parallel)
296-A-19	12.9 (3.9)	HEPAs (2 in series), fan, heater
296-A-42	55 (16.8)	HEPAs (2 in series, chiller, condenser, high-efficiency mist eliminator, heater, fan
296-A-44	28 (8.6)	HEPAs (2 in series), deentrainer, heater, prefilter, fan
296-A-45	28 (8.6)	HEPAs (2 in series), deentrainer, heater, prefilter, fan
296-A-46	28 (8.6)	HEPAs (2 in series), deentrainer, heater, prefilter, fan
296-A-47	28 (8.6)	HEPAs (2 in series), deentrainer, heater, prefilter, fan
296-B-1	90 (27.4)	HEPAs (4 in 2 trains; 2 banks in each train), prefilters (2 trains, one bank in each train), 2 fans
296-B-10	75 (22.9)	HEPAs and prefilters (2 in series, 2 in parallel), fan (2), demister, heater, impingement vanes
296-H-212	75 (22.9)	HEPAs (2 double-stage in parallel), fans (2 in parallel)
296-P-45	21 (6.4)	HEPAs (2 in series), prefilter, heater, fan, demister
296-P-47	40 (12.2)	HEPAs (2 in series), heater, demister, prefilters, fan
296-P-48	40 (12.2)	HEPAs (2 in series), deentrainer, heater, prefilter, fan
296-P-107	28 (8.5)	HEPAs (2 in series), deentrainers, heater, prefilter, fan
200 West Area Major Point Sources		
296-P-43	21 (6.4)	HEPAs (2 in series), prefilter, heater, fan, demister
296-P-44	21 (6.4)	HEPAs (2 in series), prefilter, heater, fan, demister
296-S-21	68 (20.7)	HEPAs (3 in series for Hot Cells and 1 for Lab Complex), fan (3 in parallel for Hot Cells, 1 backup)
291-T-1	200 (61)	HEPAs (2 in series), prefilters, fan (2 in parallel)
296-W-4	47 (14.2)	HEPAs (redundant system of 2 banks in parallel), prefilters, fans (4)
291-Z-1	200 (61)	HEPAs and fans (multiple parallel banks of each)
300 Area Major Point Sources		
EP-324-01-S	150 (46)	HEPA, fan
EP-325-01-S	89 (27.1)	HEPA (2 in series), fan
EP-331-01-V	62 (18.9)	HEPA, fans (3 in parallel: 1 operational, 2 as backups)

[a]The operational efficiency of HEPA filters is $\geq$99.95%. The operational efficiencies of the other abatement technology are not known with certitude.

Table 2-4. Hanford Site Minor Stack Heights and Abatement Technology.

Stack	Discharge height, ft (m)	Abatement technology[a]
		100 Areas
105-KW Basin	42 (12.8)	None
		200 East Area
296-A-18	12.5 (3.8)	HEPAs (2 in series), fan heater
296-A-20	15.7 (4.8)	HEPAs (2 in series), fan, radial damper, heater, two trains in parallel flow paths
296-A-21A	50 (15.2)	HEPAs (3 in parallel: 2 operating, 1 in standby), prefilters (3 in parallel: 2 operating, 1 in standby), fans (2: 1 operating, 1 in standby)
296-A-22	63.6 (19.4)	HEPAs (2 in series), prefilter, heater, deentrainer, fan
296-A-26	27 (8.2)	HEPAs (2), fan, deentrainer (2), heater
296-A-28	23.5 (7.1)	HEPAs (2 in series), fan, deentrainer, heater; two trains in parallel flow paths
296-A-30	23.4 (7.1)	HEPAs (2), deentrainer, heater, fan; two trains in parallel flow paths
296-A-40	19.6 (6.0)	HEPAs (2 in series), prefilter, fan, heater; two trains in parallel flow paths
296-A-41	29.2 (8.9)	HEPAs (2 in series), fan, heater; two trains in parallel flow paths
296-A-43	35.5 (10.8)	HEPA, prefilter, fan, isolation damper; two trains in parallel flow paths
296-E-1	51 (15.5)	HEPAs and fans (5 and 3, in different configurations, respectively)
		200 West Area
291-S-1	200 (61)	sand filter, fans (2 in parallel)
296-P-22	13.2 (4.0)	HEPAs (2 in series), fan
296-P-23	17.3 (5.3)	HEPAs (2 in series), deentrainer, prefilter, heater, fan
296-S-16	12.5 (3.8)	HEPA, fan
296-S-23	21.5 (6.6)	HEPAs (2 in series), prefilter, fan
296-S-25	19 (5.8)	HEPAs (2 in series), fan, prefilter, heater, deentrainer
296-T-7	28 (8.5)	HEPAs (2 in series), demister, heater, prefilter, fan
296-Z-15	42 (12.8)	HEPAs, fan
		300 Area
EP-318-01-S	29 (8.8)	HEPA, exhaust fan
EP-318-09-S	46 (14)	none
		400 Area
437-1-61	38.4 (11.7)	HEPAs, prefilters, fan
437-MN&ST	30 (9.1)	HEPA (at least 4 in different configurations, fans (2), prefilters (3)
FFTF-CB-EX	47 (14.3)	fans (2 in parallel, intermittent use; 1 individually, intermittent use)
		600 Area
696-W-1	25 (7.6)	HEPA (2 in parallel), prefilters (2 in parallel), fans (2 in parallel)
696-W-2	32 (9.8)	HEPA (2 in parallel), prefilters (2 in parallel), fan, standby fan

[a]The operational efficiency of HEPA filters is $\geq$99.95% and of sand filters, $\geq$98%. The operational efficiencies of the other abatement technology are not known with certitude.

Table 2-5. Distances and Directions from Hanford Site Operational Areas to Receptors at Respective Nearest Residences and Farms.[a]

Receptor		Distance (km [mi]) and direction from Hanford Site operational area[b]				
		100 Area	200 East Area	200 West Area	300 Area	400 Area
Hanford Site MEI[c]		41.2 (25.6) SE	28.8 (17.9) SE	35.1 (21.8) SE	1.8 (1.1) S	11.2 (7.0) SE
Offsite receptor	Sagemoor Road[d]	40.6 (25.2) SE	28.3 (17.6) SE	35.1 (21.8) SE	1.4 (0.87) E	10.8 (6.7) SE
	Nearest	8.9 (5.6) NNW	21.2 (13.2) E	13.7 (8.5) W	1.4 (0.87) E	8.6 (5.5) E
	Nearest in prevailing wind	24.2 (15.1) E	21.6 (13.5) ESE	22.0 (13.8) SE	1.8 (1.1) S	9.1 (5.7) SE
Onsite public receptor	Nearest[e]	26.1 (16.2) SE	13.5 (8.4) SE	22.2 (12.6) SE	12.3 (7.6) NNW	4.3 (2.7) WNW
	Nearest in prevailing wind	26.1 (16.2) SE	16.7 (10.4) ESE	22.2 (12.6) SE	14.0 (8.8) NW	4.4 (2.7) NNE
Vegetable-producing farm	Nearest	9.8 (6.1) NW	21.1 (13.1) E	17.7 (11.0) NW	3.2 (2.0) E	10.5 (6.5) ESE
	Nearest in prevailing wind	24.9 (15.5) E	21.1 (13.1) E	29.9 (18.6) SE	4.0 (2.5) NE	12.6 (7.8) SE
Milk-producing farm	Nearest	34.9 (21.7) E	29.1 (18.2) ENE	34.6 (21.5) S	5.8 (3.6) ESE	13.5 (8.3) E
	Nearest in prevailing wind	34.9 (21.7) E	30.6 (19.0) ESE	38.9 (24.2) ESE	9.2 (5.7) NE	15.3 (9.5) SE
Meat-producing farm	Nearest	11.2 (7.0) NNW	20.9 (13.0) WNW	17.7 (11.0) WSW	2.7 (1.7) ESE	12.2 (7.6) SE
	Nearest in prevailing wind	31.4 (19.5) ESE	24.0 (14.9) E	27.0 (16.8) SE	8.0 (5.0) NE	12.2 (7.6) SE

[a]The definition of residence includes dwelling, school, business, and office.

[b]All emission points within an emission Area are assigned a single distance to the nearest receptor; km = kilometer; mi = mile.

[c]An offsite business, PNNL Site PSF, directly south of the Hanford Site 300 Area.

[d]A member of the public who lives at a residence near Sagemoor Road, in Franklin County, directly across the Columbia River from the Hanford Site 300 Area. This location had been the MEI from 2005-2011.

[e]The nearest onsite receptor is employed at LIGO. This receptor, who from year to year could be but is not necessarily the MEI, is a member of the public not employed by DOE or its contractors and who works on the Hanford Site at a location to which access is not controlled by DOE. For radiological dose impacts from emissions in 2013, numerous offsite public receptors and onsite public receptors were evaluated. The evaluations determined that an offsite receptor at PSF, in north Richland, received the maximum dose due to air emissions from all Hanford Site sources during 2013. For onsite receptors, two employment locations were evaluated: LIGO and ENCGS.

3.0 POINT-SOURCE EMISSION DOSE ASSESSMENTS

3.1 DESCRIPTION OF POINT-SOURCE EMISSIONS DOSE MODEL

The year 1990 was the first year this annual report format was required to comply with the revised National Emission Standard for Hazardous Air Pollutants (NESHAP) for radionuclide emissions from DOE facilities, described in 54 Federal Register 16965, December 15, 1989. Since 2007, Clean Air Act Assessment Package-1988 (CAP88-PC) Version 3 has been used to determine the compliance status of Hanford Site radionuclide air emissions with the 10 mrem/yr EDE standard of 40 CFR 61 Subpart H and of WAC 246-247. The 2013 revision of *CAP88-PC Version 3 User Guide* (EPA 2013) was used for this report. Doses from 1990 through 1992 were modeled using CAP-88, an early mainframe version of the program. Doses from 1993 through 2006 were modeled using CAP88-PC Version 1 (EPA 1992), the first desktop-computer version of CAP-88; it also placed greater reliance on default parameters.

Because the Hanford Site has numerous and widely separated emission points, it is necessary to determine the point at which the maximum dose would be received from the combined air emissions released from all locations (see DOE/RL-2007-53, *Methods for Calculating Doses to Demonstrate Compliance with Air Pathway Radiation Dose Standards at the Hanford Site*). To model the doses from those emissions, each of the five major operational areas is assigned within it a single reference facility having an emission point that typically is the source of maximum emissions from that area to the Hanford Site MEI. The straight-line distances and directions to the MEI from each of the five reference facilities are used in the dose calculations, which include annual meteorological data (refer to Appendix A). In 2013, those reference facilities were the 105-KE Building in the 100 Areas; the PUREX Facility in the 200 East Area; PFP in the 200 West Area; the 324 Building in the 300 Area; and FFTF in the 400 Area. Other than two minor stacks at WSCF, no other point sources are located in the 600 Area (releases from these two stacks are considered in the dose model as having emanated from the 200 West Area). Dose attributable to fugitive emissions originating from the 600 Area are discussed in Section 4.0.

For reports from 1990 through 1999, only offsite members of the public had been evaluated for dose. During this period, the annual MEI resided at these locations: from 1990 through 1992, Ringold, in Franklin County, east-southeast of the 200 Areas and northeast of the 300 Area; from 1993 through 1999, near Sagemoor Road, directly east and across the Columbia River from the 300 Area. Starting with the report for 2000, a new category of members of the public was evaluated in determining the MEI: non-DOE employees at work locations within the Hanford Site boundary. Private-sector reindustrialization at the Hanford Site forced a broadening of the MEI definition to include members of the public not employed by DOE and whose workplace is within the boundaries of the Hanford Site yet outside DOE-controlled areas. Under this new definition, the MEI location for 2000 shifted from what would have been the offsite residence near Sagemoor Road to a Washington State University (WSU) laboratory in the 300 Area, north of Richland. In 2001, the location changed to the 313 Building, also in the 300 Area. In early 2002, non-DOE employment at the WSU laboratory and the 313 Building ceased, causing the MEI to shift back to the offsite Sagemoor Road location in 2002 and 2003. For 2004, the MEI location shifted to Ringold, owing mainly to reduced point-source emissions of ^{3}H from the 300 Area. For 2005, the MEI location returned to the Sagemoor Road residence, where it remained through 2011 primarily due to consistently higher point-source emissions of ^{3}H from the 300 Area. In 2012 and 2013, meteorological conditions differed enough compared to recent earlier years to result in a greater impact to potential receptors in north Richland, south of the 300 Area. As a consequence, PSF was determined to be the location of the MEI. The location is on the DOE PNNL Site, which is adjacent to the Hanford Site. Due to separate radiological air emission permits issued by the State of Washington and separate air emission monitoring programs managed by the Hanford Site and the PNNL Site, the facilities on the

PNNL Site were considered to be offsite business locations for purposes of the Hanford Site determination of compliance with 40 CFR Subpart H and WAC 246-247.

The principal locations evaluated for the MEI are shown in Figure 3-1.

Figure 3-1. Locations of Hanford Site Maximally Exposed Individual and Other Evaluated Receptor Locations for 2013.

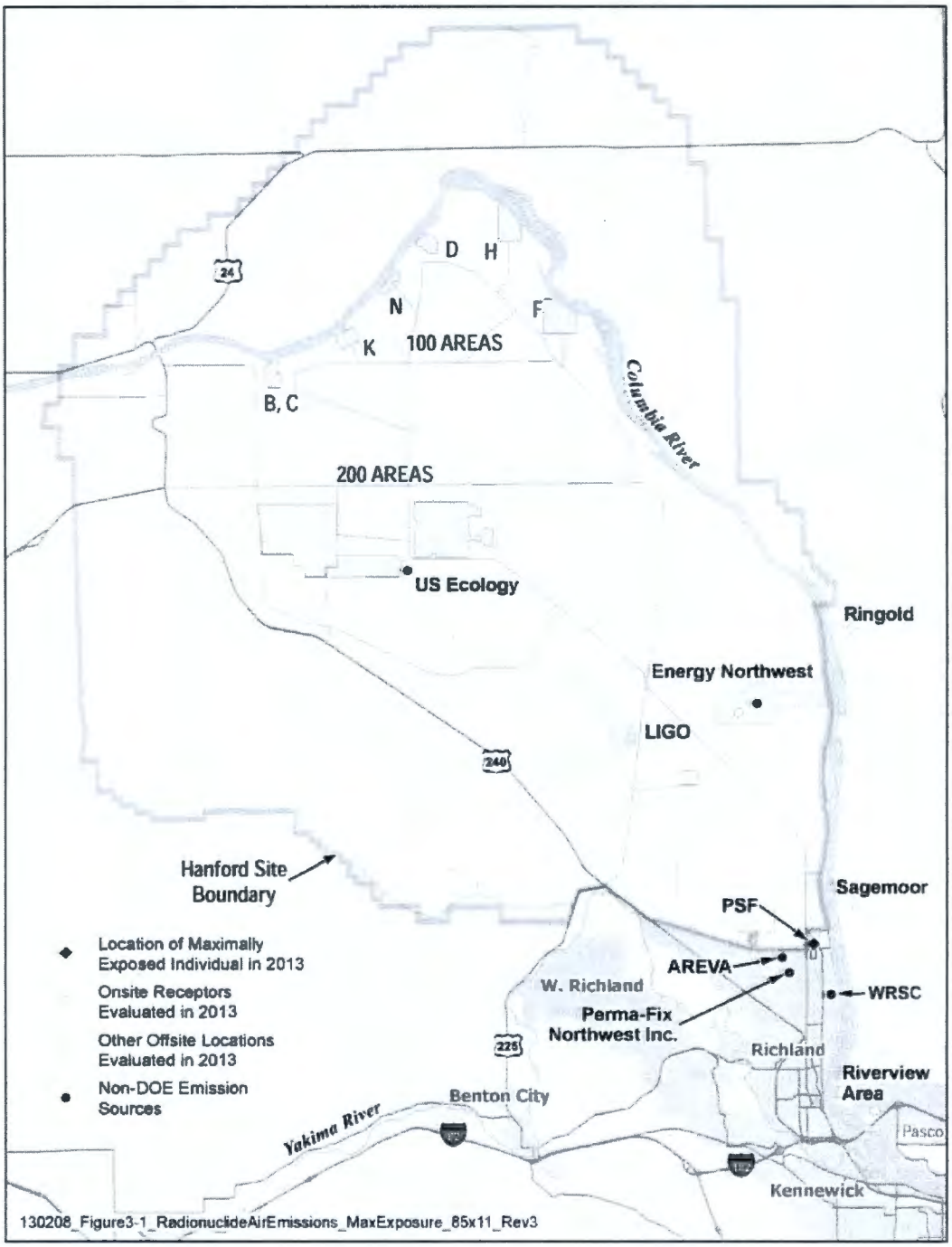
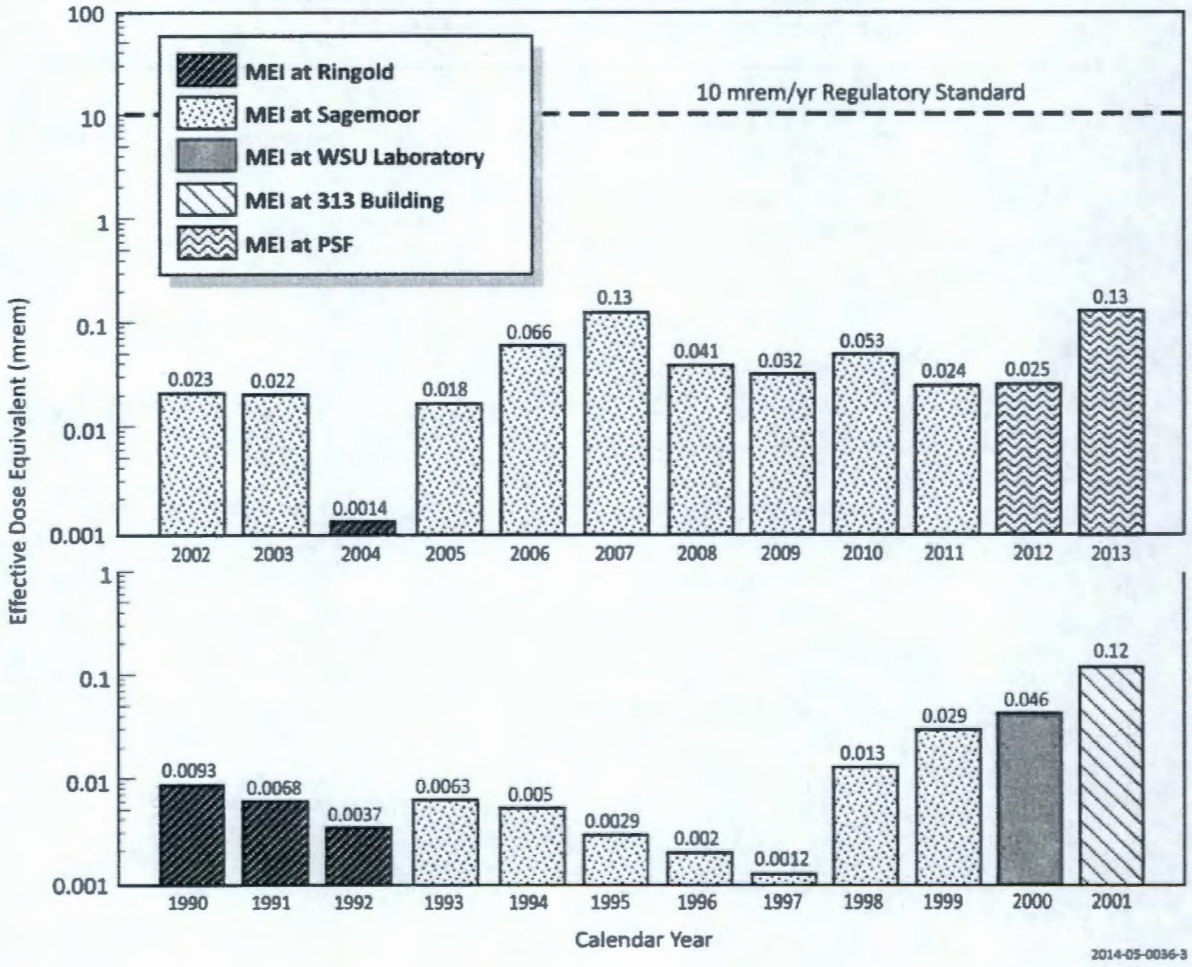


Figure 3-2 displays the MEI doses attributable to radionuclide emissions from Hanford Site point sources from 1990 through 2013.

Figure 3–2. Doses to the Maximally Exposed Individual Due to Point–Source Emissions of Radionuclides from the Hanford Site, 1990 through 2013.



3.2 SUMMARY OF INPUT PARAMETERS

Dose calculations were performed using established standard parameters for the Hanford Site and its environment (DOE/RL–2007–53, *Methods for Calculating Doses to Demonstrate Compliance with Air Pathway Radiation Dose Standards at the Hanford Site*). Point–source emission data by radionuclide and operational area (Table 3–1) were used in the dose calculations. The calculations used an effective discharge height of 33 ft (10 m) for all release locations other than the 200 Area facilities, which were assumed to have an effective release height of 292 ft (89 m; DOE/RL–2006–29, Rev. 1, *Calculating Potential–to–Emit Radiological Releases and Doses*). In all but one case, emissions reported as gross alpha or gross beta were evaluated as $^{239/240}$Pu or ^{90}Sr, respectively. The one exception is for gross beta emissions from the 400 Area: Based on facility–specific information, they were modeled as ^{137}Cs.

Additional data used for dose calculations are in Appendix A; all other radionuclide–specific parameters used were default values in CAP88–PC data libraries. Maximum individual exposure and consumption

Table 3–1. Hanford Site Radionuclide Air Emissions from Point Sources in 2013.

Radionuclide	Releases, Ci					
	100 Areas	200 East Area	200 West Area	300 Area	400 Area	Total
^{3}H (as HT)[a]	NA	NA	NA	5.71 E+01	NA	5.71 E+01
^{3}H (as HTO)[b]	NA	NA	NA	1.93 E+02	1.8 E–03[c]	1.93 E+02
^{14}C	NA	NA	NA	1.0 E–06[d]	NA	1.0 E–06
^{22}Na	NA	NA	NA	NA	1.4 E–09[c]	1.4 E–09
^{54}Mn	NA	NA	NA	ND	NA	ND
^{85}Kr	NA	NA	NA	5.5 E–03[d]	NA	5.5 E–03
^{90}Y	NA	6.6 E–09	NA	NA	NA	6.6 E–09
^{90}Sr	1.6 E–05[e]	6.4 E–04[e]	1.2 E–05[e]	7.8 E–07[e]	NA	6.7 E–04
^{99}Tc	NA	NA	NA	1.6 E–06[f]	NA	1.6 E–06
^{129}I	NA	7.4 E–04	NA	NA	NA	7.4 E–04
^{134}Cs	NA	ND	NA	NA	NA	ND
^{137}Cs	3.4 E–06	9.2 E–05	9.0 E–07	6.7 E–09	2.3 E–06[e]	9.9 E–05
^{152}Eu	ND	ND	ND	1.3 E–08[f]	NA	1.3 E–08
^{154}Eu	2.4 E–08	ND	ND	2.6 E–07[f]	NA	2.8 E–07
^{153}Gd	NA	NA	NA	5.4 E–11[f]	NA	5.4 E–11
^{220}Rn	NA	NA	NA	2.5 E+02[g]	NA	2.5 E+02
^{226}Ra	NA	NA	NA	2.3 E–10[f]	NA	2.3 E–10
^{227}Ac	NA	NA	NA	7.3 E–11[f]	NA	7.3 E–11
^{231}Pa	NA	ND	NA	NA	NA	ND
^{232}U	NA	NA	NA	2.9 E–10[f]	NA	2.9 E–10
^{233}U	NA	NA	NA	3.1 E–09[f]	NA	3.1 E–09
^{237}Np	NA	NA	NA	2.6 E–10	NA	2.6 E–10
^{238}Pu	2.5 E–07	ND	9.5 E–08	2.3 E–10	NA	3.5 E–07
$^{239/240}Pu$	5.2 E–06[h]	1.0 E–06[h]	4.6 E–05[h]	1.3 E–07[h]	1.9 E–07[i]	5.3 E–05
^{241}Pu	1.0 E–05	ND	5.2 E–06	2.0 E–07	NA	1.5 E–05
^{241}Am	1.5 E–06	2.4 E–08	3.6 E–06	2.3 E–10	NA	5.1 E–06
^{243}Am	NA	NA	NA	6.5 E–08[f]	NA	6.5 E–08
$^{243/244}Cm$	NA	NA	NA	ND	NA	ND

1 Ci = 1 curie = 3.7 E+10 becquerels (Bq); 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); NM = not measured.

[a]HT = tritium in the form of incondensable gas.

[b]HTO = tritium in the form of incondensable water vapor.

[c]Release from the FFTF-CB-EX stack that is based on estimated radionuclide inventory in residual sodium within the FFTF reactor primary coolant piping systems.

[d]Release based on release records from Radioactive Gas Inventory database.

[e]This release value includes data on gross beta emissions.

[f]Release calculation based on material inventory of 2013 and on Appendix D method of 40 CFR 61; for ^{243}Am, its release was both measured (i.e., 2.51 E–08 Ci from PNNL's EP-325-01-S stack) and calculated using Appendix D (i.e., 3.99 E–08 Ci from PNNL's EP-331-01-V vent).

[g]Release value conservatively calculated, not actually measured.

[h]This release value includes data on gross alpha emissions.

[i]This release value consists of a combination of gross alpha emissions construed as $^{239/240}Pu$ for dose modeling purposes for the 437-1-61 and 437-MN&ST stacks and from a calculated $^{239/240}Pu$ emission value for the FFTF-CB-EX stack related to residual radioactive material in the FFTF reactor primary coolant system piping.

parameters were those determined previously for the Hanford Site. The entire hypothetical MEI diet was constructed using the "local" food production option in CAP88–PC for ingestion–pathway parameters. Such an ingestion assumption greatly overestimates the ingestion dose of the 2013 MEI, a business receptor. For locations within the Hanford Site boundary, the ingestion dose was estimated using average individual parameters for the 80–km (50–mi) assessment area. Radionuclide air concentrations at receptor locations were determined using site–specific meteorological data for each representative release location. Joint–frequency distributions and CAP88–PC wind files were prepared from data collected at weather stations in each of the operational areas and represent the average of hourly data taken during 2013.

3.3 COMPLIANCE ASSESSMENT

3.3.1 40 CFR 61, Subpart H: Regulatory Standard

The regulatory standard for a maximum dose to any member of the public is 10 mrem/yr EDE. The standard is in 40 CFR 61, Subpart H, and applies to radionuclide air emissions, other than radon, from DOE facilities. For calendar year 2013, the Hanford Site MEI location was at PSF, an offsite business on the PNNL Site in north Richland, Benton County, Washington, directly south of the Hanford Site 300 Area. The combined dose to the MEI from routine and nonroutine Hanford Site point–source emissions was 0.13 mrem (0.0013 mSv) EDE. The majority of that dose (i.e., 99.8 percent) is attributable to ^{3}H point–source emissions from the 300 Area (Table 3–2).

3.3.2 Washington Administrative Code 246–247

For Hanford Site radionuclide air emissions, Washington State in WAC 246–247–040(1) has adopted the federal dose standard of 10 mrem/yr EDE found in Subpart H of 40 CFR 61. In addition to the maximum dose attributable to radionuclides emitted from point sources, WAC 246–247–040(6) requires that the dose to the MEI also include doses attributable to fugitive emissions, radon (refer to Section 3.6.3), and to nonroutine events (refer to Section 3.5). Sampling data from ambient air samplers stationed at the perimeter of the Hanford Site were used to estimate emissions from fugitive sources. The reportable fugitive emission dose was calculated for the MEI at PSF because that is the location of the MEI for emissions from point sources (refer to Section 4.0 for a further discussion on the basis for this). The MEI doses from any releases of two radon isotopes are discussed in Section 3.6.3. No known instances of significant nonroutine emissions occurred in 2013, and no nonsignificant nonroutine emission had any discernible contribution to the cumulative emissions from the Hanford Site. Thus, the total dose to the MEI at PSF in 2013 from all Hanford Site radionuclide emissions, including routine emissions from point sources, fugitive sources, and radon, as well as nonroutine emissions was 0.25 mrem (0.0025 mSv) EDE. This total dose is the sum of doses from Hanford Site point sources (i.e., 0.13 mrem [0.0013 mSv] EDE), fugitive sources (i.e., 0.055 mrem [0.00055 mSv] EDE), and radon source (i.e., 0.063 mrem [0.00063 mSv] EDE).

The dose to an individual at an actual residential location more realistically indicates the maximum dose that an individual at a self-sufficient farm might incur. The total dose to the historic Hanford Site MEI location at Sagemoor Road from all Hanford Site radionuclide emissions from point sources, fugitive sources, and radon, as well as nonroutine emissions, was 0.24 mrem (0.0024 mSv) EDE. This total dose is the sum from Hanford Site points sources (i.e., 0.12 mrem [0.0012 mSv] EDE), fugitive sources (i.e., 0.055 mrem [0.00055 mSv] EDE), and radon sources (i.e., 0.060 mrem [0.00060 mSv] EDE).

Table 3–2. CAP88–PC Effective Dose Equivalent Estimates for the Maximally Exposed Individual at PSF, Resulting from Hanford Site Point–Source Radionuclide Air Emissions in 2013.

Radionuclide	Distances, directions, and effective dose equivalent (mrem) to offsite MEI, by radionuclide and operational area[a]					EDE (40 CFR 61, Subpart H) by radionuclide	
	100 Area	200 East Area	200 West Area	300 Area	400 Area	EDE total (mrem)	Percent of EDE total
	41 km[a] SE	29 km SE	35 km SE	1.8 km S	11 km SE		
^{3}H (HT)	NA	NA	NA	1.6 E–02	NA	1.6 E–02	12.293
^{3}H (HTO)	NA	NA	NA	1.1 E–01	1.3 E–07	1.1 E–01	87.479
^{14}C	NA	NA	NA	2.6 E–08	NA	2.6 E–08	<0.001
^{22}Na	NA	NA	NA	NA	6.2 E–11	6.2 E–11	<0.001
^{54}Mn	NA	NA	NA	ND	NA	ND	0
^{85}Kr	NA	NA	NA	5.2 E–09	NA	5.2 E–09	<0.001
^{90}Sr	5.7 E–07[b]	3.0 E–05[b]	5.1 E–07[b]	2.7 E–06[b]	NA	3.4 E–05	0.026
^{90}Y	NA	2.8 E–13	NA	NA	NA	2.8 E–13	<0.001
^{99}Tc	NA	NA	NA	1.5 E–06	NA	1.5 E–06	0.001
^{129}I	NA	2.1 E–04	NA	NA	NA	2.1 E–04	0.166
^{134}Cs	ND	ND	ND	ND	NA	ND	0
^{137}Cs	7.1 E–08	2.5 E–06	2.2 E–08	1.3 E–08	4.7 E–07[b]	3.1 E–06	0.002
^{152}Eu	ND	ND	ND	2.2 E–09	NA	2.2 E–09	<0.001
^{154}Eu	4.7 E–11	ND	ND	4.9 E–08	NA	4.9 E–08	<0.001
^{153}Gd	NA	NA	NA	6.3 E–13	NA	6.3 E–13	<0.001
^{226}Ra	NA	NA	NA	2.2 E–09	NA	2.2 E–09	<0.001
^{227}Ac	NA	NA	NA	5.6 E–09	NA	5.6 E–09	<0.001
^{231}Pa	NA	ND	NA	NA	NA	ND	0
^{232}U	NA	NA	NA	3.2 E–09	NA	3.2 E–09	<0.001
^{233}U	NA	NA	NA	1.3 E–08	NA	1.3 E–08	<0.001
^{237}Np	NA	NA	NA	6.4 E–09	NA	6.4 E–09	<0.001
^{238}Pu	1.2 E–07	ND	4.6 E–08	1.1 E–08	NA	1.7 E–07	<0.001
$^{239/240}$Pu	2.6 E–06[c]	5.9 E–07[c]	2.4 E–05[c]	6.7 E–06[c]	1.0 E–06[c]	3.5 E–05	0.027
^{241}Pu	9.1 E–08	ND	4.9 E–08	1.9 E–07	NA	3.3 E–07	<0.001
^{241}Am	6.3 E–07	1.2 E–08	1.6 E–06	1.0 E–08	NA	2.2 E–06	0.002
^{243}Am	NA	NA	NA	2.9 E–06	NA	2.9 E–06	0.002
$^{243/244}$Cm	NA	NA	NA	ND	NA	ND	0
Dose totals	4.1 E–06	2.5 E–04	2.6 E–05	1.3 E–01	1.6 E–06	1.3 E–01	▼
Percent of total dose	0.003	0.192	0.020	99.783	0.001	▶ Percent total: 100	

[a]1 mrem = 0.01 mSv; 1 km = 0.621 mi.

[b]Dose includes data from gross beta emissions.

[c]Dose includes data from gross alpha emissions.

Note: Particulate radionuclides (i.e., excluding ^{3}H, ^{85}Kr, and ^{129}I) contributed 7.9 E–05 mrem, or 0.062%, of the total point–source dose.

Table 3–3 shows the contribution to the MEI dose in 2013 from each major stack, grouped by operational area.

Table 3–3. Doses from Hanford Site Major Point–Source Radionuclide Air Emissions in 2013.

Source identification (contractor)	Effective dose equivalent (mrem)[a]	Percent of total dose[b]
100-K Area		
296-K-142 (CHPRC)	3.1 E–08	0.000024
200 East Area		
291-A-1 (CHPRC)	2.1 E–04	0.16282
296-A-19 (WRPS)	4.0 E–09	<0.00001
296-A-42 (WRPS)	1.5 E–09	<0.00001
296-A-44/-45 (WRPS)	1.4 E–08	0.00001
296-A-46/-47 (WRPS)	2.9 E–09	<0.00001
296-B-1 (CHPRC)	1.2 E–08	<0.00001
296-B-10 (CHPRC)	3.2 E–05	0.02481
296-H-212 (CHPRC)	9.4 E–09	<0.00001
296-P-45 (WRPS)	DNO	NA
296-P-47 (WRPS)	8.2 E–10	<0.00001
296-P-48 (WRPS)	5.0 E–10	<0.00001
296-P-107 (WRPS)	2.7 E–09	<0.00001
200 West Area		
291-T-1 (CHPRC)	2.2 E–06	0.00171
291-Z-1 (CHPRC)	2.4 E–05	0.01861
296-P-43 (WRPS)	DNO	NA
296-P-44 (WRPS)	DNO	NA
296-S-21 (WRPS)	1.7 E–07	0.00013
296-W-4 (CHPRC)	8.6 E–09	<0.00001
300 Area		
EP-324-01-S (WCH)	3.5 E–06	0.00271
EP-325-01-S (PNNL)	1.2869 E–01[c]	99.78133[c]
EP-331-01-V (PNNL)	5.3 E–06	0.00411
Major point-source totals ▶	**≈ 2.5 E–02**	**≈ 100**

[a] 1 mrem = 1.0 E-02 mSv

[b] Of the ≈0.13 mrem total for all stacks, the portion of that from major stacks sans EP-325-01-S is 2.8 E–04 (0.21% of total stack dose) and from minor stacks, 6.1 E–06 mrem (0.0047% of total stack dose). Slightly varying totals are due to numerical rounding.

[c] Additional decimal places displayed because this is the dominant dose.

DNO = did not operate; NA = not applicable.

Table 3–4 ranks each stack by the dose attributable to its emissions compared to the Hanford Site MEI dose for calendar year 2013 of 0.13 mrem (0.0013 mSv) EDE from all point–source emissions.

Table 3–4. Ranking of Doses from Hanford Site Point–Source Radionuclide Air Emissions by Stack, Calendar Year 2013. (2 sheets)

Rank	Stack	Major or minor	Contractor	Operating area	EDE (mrem/yr)[a]	Percent of total dose
1	**EP-325-01-S**	**Major**	PNNL	300	1.2869 E–01	99.7813351[b]
2	**291-A-1**	**Major**	CHPRC	200 East	2.1 E–04	0.1628298
3	**296-B-10**	**Major**	CHPRC	200 East	3.2 E–05	0.0248122
4	**291-Z-1**	**Major**	CHPRC	200 West	2.4 E–05	0.0186091
5	**EP-331-01-V**	**Major**	PNNL	300	5.3 E–06	0.0044109
6	**EP-324-01-S**	**Major**	WCH	300	3.5 E–06	0.0027138
7	**291-T-1**	**Major**	CHPRC	200 West	2.2 E–06	0.0017058
8	437-MN&ST	minor	CHPRC	400	1.2 E–06	0.0009305
9	437-1-61	minor	CHPRC	400	2.1 E–07	0.0001628
10	296-E-1	minor	CHPRC	200 East	1.4 E–07	0.0001086
11	291-S-1	minor	CHPRC	200 West	9.5 E–08	0.0000737
12	296-A-30	minor	WRPS	200 East	6.4 E–08	0.0000496
13	696-W-1	minor	MSA	600	6.3 E–08	0.0000488
14	FFTF-CB-EX	minor	CHPRC	400	5.9 E–08	0.0000457
15	**296-S-21**	**Major**	WRPS	200 West	5.1 E–08	0.0000395
16	296-A-28	minor	WRPS	200 East	4.7 E–08	0.0000364
17	296-A-21A	minor	WRPS	200 East	3.4 E–08	0.0000264
18	105-KW Basin	minor	CHPRC	100-KW	3.1 E–08	0.0000240
19	**296-K-142**	**Major**	CHPRC	100-KW	3.1 E–08	0.0000240
20	**296-A-44/-45**	**Major**	WRPS	200 East	1.4 E–08	0.0000109
21	EP-318-01-S	minor	PNNL	300	1.2 E–08	0.0000093
21	296-A-41	minor	WRPS	200 East	1.2 E–08	0.0000093
21	**296-B-1**	**Major**	CHPRC	200 East	1.2 E–08	0.0000093
24	**296-H-212**	**Major**	CHPRC	200 East	9.4 E–09	0.0000073
25	**296-W-4**	**Major**	CHPRC	200 West	8.6 E–09	0.0000067
26	296-A-18	minor	WRPS	200 East	5.0 E–09	0.0000039
27	296-A-20	minor	WRPS	200 East	4.9 E–09	0.0000038
28	**296-A-19**	**Major**	WRPS	200 East	4.0 E–09	0.0000031
29	**296-A-46/-47**	**Major**	WRPS	200 East	2.9 E–09	0.0000022
30	**296-P-107**	**Major**	WRPS	200 East	2.7 E–09	0.0000021
31	296-A-22	minor	WRPS	200 East	1.8 E–09	0.0000014
32	296-A-40	minor	WRPS	200 East	1.7 E–09	0.0000013
33	296-P-22	minor	WRPS	200 East	1.5 E–09	0.0000012
33	**296-A-42**	**Major**	WRPS	200 East	1.5 E–09	0.0000012
35	296-P-23 & 296-S-25	minor	WRPS	200 West	1.1 E–09	0.0000009
36	**296-P-47**	**Major**	WRPS	200 East	8.2 E–10	0.0000006
37	**296-P-48**	**Major**	WRPS	200 East	5.0 E–10	0.0000004
38	296-S-16	minor	WRPS	200 West	3.5 E–10	0.0000003
39	696-W-2	minor	MSA	600	2.8 E–10	0.0000002

Table 3–4. Ranking of Doses from Hanford Site Point–Source Radionuclide Air Emissions by Stack, Calendar Year 2013. (2 sheets)

Rank	Stack	Major or minor	Contractor	Operating area	EDE (mrem/yr)[a]	Percent of total dose
40	296-Z-15	minor	CHPRC	200 West	1.2 E–10	0.0000001
41	296-A-43	minor	WRPS	200 East	8.9 E–11	0.0000001
42	296-T-7	minor	CHPRC	200 West	0	0
NA	296-A-26	minor	WRPS	200 East	DNO	NA
NA	**296-P-43**	**Major**	WRPS	200 West	DNO	NA
NA	**296-P-44**	**Major**	WRPS	200 West	DNO	NA
NA	**296-P-45**	**Major**	WRPS	200 West	DNO	NA
NA	296-S-18	minor	WRPS	200 West	DNO	NA
NA	EP-331-09-S	minor	PNNL	300 Area	DNO	NA
				Totals[c] ▶	**≈ 1.3 E-01**	**≈ 100**

[a]EDE = effective dose equivalent; 1 mrem = 1.0 E–02 mSv

[b]Extra decimal places are displayed for this stack because in comparison to all other stacks the largest percentage of the total dose is attributable to it.

[c]Slight differences in totals are due to rounding.

DNO = did not operate; NA = not applicable.

3.4 METEOROLOGICAL DATA

Radionuclide air emissions disperse once they enter the atmosphere. Atmospheric dispersion models predict the degree of dilution and the magnitude of resulting air concentrations at downwind locations. Site–specific measurements of the occurrence frequencies for wind speed, wind direction, and atmospheric stability are used in the models. The dispersion models yield annual average dispersion factors, in units of seconds per cubic meter (s/m^3). Combining these factors with annual average release rates yields predictions of average radionuclide air concentrations for the year. Meteorological data for 2013 are presented in Appendix A as joint frequency of wind speed, wind direction, and stability category for stations located at the 200, 300, and 400 Areas. In February 2013, the 100-K meteorological station was damaged and not available over the remainder of the year. For 2013, the 10-year average meteorological data (i.e., from 2002 through 2011) for the 100-K station was used for 100 Area emissions modeling.

3.5 NONROUTINE RELEASES OF RADIONUCLIDES TO THE ATMOSPHERE

No known instances of significant nonroutine emissions were reported in 2013. Any unreported nonroutine emissions would be part — and possibly an indistinguishable part — of the cumulative emissions from the Hanford Site. Such nonroutine emissions would have been detected at ambient air monitoring stations located onsite or along the Hanford Site perimeter were they of measurable concentration. The impacts of this type of emission would therefore be accounted for in the dose estimates for fugitive sources, as described in Section 4.2.

3.6 ADDITIONAL COMPLIANCE INFORMATION

3.6.1 Applicability of Stack Emissions Data to Air Emission Permits and Licenses

The portions of the Hanford Site MEI dose attributable to individual point sources as listed in Section 2.0 are appropriate for use in demonstrating the compliance of abated stack emissions with applicable terms of the Hanford Site Air Operating Permit, FF–01, and any underlying NOC approvals.

3.6.2 Construction Projects and Modifications Exempted from 40 CFR 61.96

No exemptions to the approval process under 40 CFR 61.96 were granted in 2013. In 1992, the EPA determined that some emission units at the Hanford Site were out of compliance with requirements in Subpart H of 40 CFR 61. As a result, a NESHAP Federal Facility Compliance Agreement (FFCA) was made between DOE–RL and EPA Region 10. In 1994, EPA stated it would not grant any exemptions until all FFCA milestones were completed, which occurred by the end of 2005. Since then, EPA has continued requiring approval for all construction or modification projects, including those with a radiological dose potential of less than 0.1 mrem/yr EDE.

3.6.3 Radon–220 and Radon–222 Emissions

Radon–220 was emitted from the 325 Building in the 300 Area via the EP-325-01-S major stack. The ^{220}Rn release value was conservatively calculated using a conservative engineering estimate and was not derived from actual emission sample measurements. Radon-222 was emitted from 300 Area stacks in recent years, but source project activities did not occur in 2013. Therefore, no ^{222}Rn was emitted as a result of Hanford Site activities in 2013. Radon is exempted from consideration in determining compliance with the dose standard of Subpart H of 40 CFR 61, yet is encompassed by state regulation WAC 246-247, which provides no exemption for radon: "Emissions of radionuclides in the air shall not cause a maximum effective dose equivalent of more than 10 mrem/yr to the whole body to any member of the public." The radon dose for 2013 to the MEI at PSF and to the historic MEI at Sagemoor Road is presented in Table 3-5.

Table 3-5. Emissions of ^{220}Rn from the EP-325-01-S Major Stack, in 2013.

Stack (facility; contractor)	Radionuclide	Emissions, Ci	EDE to MEI,[a] mrem	EDE to Sagemoor Road,[a] mrem
EP-325-01-S (325 Building; PNNL)	^{220}Rn	2.5 E+02[b]	6.3 E–02	6.0 E–02
NA	^{222}Rn	NA	0	0

[a]EDE = effective dose equivalent; MEI = maximally exposed individual, which in this case is at PSF, an offsite business on the PNNL Site, directly south of the Hanford Site 300 Area. This resident near Sagemoor Road resides in Franklin County, directly east of the 300 Area.

[b]Release value conservatively calculated based on release and use records, not actually measured.

4.0 FUGITIVE SOURCES OF EMISSIONS

For radiological dose effects to members of the public, Subpart H of 40 CFR 61 imposes a dose standard of 10 mrem/yr EDE, to which compliance is required for radionuclide emissions emanating from point and fugitive sources. Measuring and modeling these emissions are fundamental to demonstrating compliance with the standard.

Beginning in 1991, the Hanford Site has annually apprised regulators of its methods for estimating fugitive emissions and modeling the resulting doses to a member of the public. An EPA–funded guidance document on methods to estimate fugitive emissions (EPA 2004, *Methods for Estimating Fugitive Air Emissions of Radionuclides from Diffuse Sources at DOE Facilities*) is available. The Hanford Site method is summarized in that document, along with methods used at other DOE sites. The guidance document does not pass judgment on the methods, instead leaving individual sites free to choose a method most suitable to their unique operations, locations, and configurations.

> **Discussion**: For purposes of this report, the term fugitive emission refers to any potential source of radioactive material that is not actively monitored at the point of release. Such potential emission sources have been defined in various EPA and WDOH regulations as "diffuse," "fugitive," or "non–point" sources, arguably without definitions sufficient to guide a person to distinguish with certainty one type of emission from another. Thus, within this report, "fugitive emission" will also represent "diffuse emission" and "non–point emission." EPA defines fugitive emissions as "those emissions which could not reasonably pass through a stack, vent, or other functionally equivalent opening" (40 CFR 70.2, "State Operating Permit Programs"). WDOH similarly defines fugitive emissions, but with a significant qualification: "'Fugitive emissions' means radioactive air emissions which do not and could not reasonably pass through a stack, vent, or other functionally equivalent structure, and which are not feasible to directly measure and quantify" (WAC 246–247–030(12)). The WAC provides no definition of "non–point" sources; thus, such sources are assumed to be equivalent to diffuse sources as defined in DOE/EH–0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*: "Diffuse Source is a source or sources of radioactive contaminants (emissions) released into the atmosphere that do not have a defined point (origin) of release (i.e., non–point source). Such sources are also known as area sources." The dose–modeling method used at Hanford is not dependent on the regulatory distinctions among these types of sources for estimating fugitive emissions and their resulting contributions to the total dose from airborne radionuclides.

In general, fugitive sources of radioactive emissions are sources not actively ventilated, are not sealed to prevent the escape of volatile or resuspended radioactive material to the ambient air, and are not amenable to routine sampling in a controlled manner as stacks commonly are. Examples of sources of fugitive radioactive emissions are passively ventilated tank vents, vented containers, outdoor surface contamination areas, cracks between cover blocks, decommissioned buildings, etc. Emissions released from buildings to the ambient air via passive ventilation systems are also considered fugitive because they lack a measurable flow. Emissions from fugitive sources are monitored by the Hanford Site Near–Field Monitoring (NFM) and Far–Field Monitoring (FFM) Programs, as described in Section 4.1. These emissions mix with ambient air, which may also have added to it emissions from point sources. Fugitive emission sources in and around Hanford Site facilities are described in Section 4.3. That section also

describes the monitoring program and use of monitoring data for characterizing fugitive emissions and the estimated maximum EDE to the public attributable to those emissions.

Measuring emissions from point sources (i.e., generally stacks) is ordinarily a prescriptive process, using well–defined technical methods, as described in Subpart H of 40 CFR 61, or alternatives approved by EPA and WDOH, and includes applying atmospheric transport models to emissions measured at the facility stack. Subpart H monitoring methods, however, are not intended for or amenable to measuring fugitive emissions. Moreover, assessing offsite doses from fugitive emissions is not nearly as straightforward as it typically is for point sources. It is complicated by such factors as (1) the difficulty in accurately quantifying air flow from the source, (2) the greater complexity in the influences from meteorological conditions, and (3) distinguishing radionuclides released from fugitive sources from preexisting low concentrations of radionuclides in ambient air, the origins of which could be background radioactive material and radionuclides from point sources.

To address the shortcomings inherent in monitoring fugitive emissions, EPA and DOE developed a mutual inter–agency Memorandum of Understanding (MOU) ("Memorandum of Understanding Between the U.S. Environmental Protection Agency and the U.S. Department of Energy Concerning the Clean Air Act Emission Standards for Radionuclides 40 CFR Part 61 Including Subparts H, I, Q & T" [DOE 1995]). A principal agreement in this MOU was that the Subpart H dose standard applies not only to the radiological effects from point–source emissions but from fugitive emissions as well. A further aspect of this agreement is that DOE facilities nationwide were to develop methods for evaluating fugitive emissions. Before the MOU was published, the Hanford Site had developed such a method, and thus has been in compliance with that condition in the MOU since its inception. The current FF–01 discusses the acceptability of using Hanford Site ambient air monitoring data for demonstrating compliance with radiological dose limits. Also, the FF–01 prescriptively describes in fair detail the Hanford Site method of estimating fugitive emissions and the corresponding radiological dose to the MEI. Section 5.0 of the FF-01, "Method for Monitoring and Reporting of Diffuse and Fugitive Emissions," directs that the "average aggregate emissions from diffuse sources will then be used to estimate the dose at the Hanford Site perimeter with the CAP88–PC code." Compliance to this direction was achieved for 2013, as well as in earlier years.

With respect to dose effects from fugitive emissions, WDOH regulations are consistent with the MOU, as evidenced by WAC 246–247–010(2), which states that the Subpart H dose standard applies to "point sources, nonpoint sources, and fugitive emissions." However, WAC 246–247–030(12) acknowledges that fugitive emissions "are not feasible to directly measure and quantify." This admission underscores the technical difficulties and inherent complexities in estimating fugitive emissions and their dose effects. Despite such challenges, the Hanford Site method affords a defensible and conservative estimate of fugitive radionuclide emissions and resulting doses, which are reported annually, both individually and in combination with the maximum dose from point–source emissions, radon doses, and, as warranted, the doses from nonroutine airborne releases. Summing the doses from all of these radiological sources of emissions assures a comprehensive compliance determination against the Subpart H and WAC 246–247 dose standards.

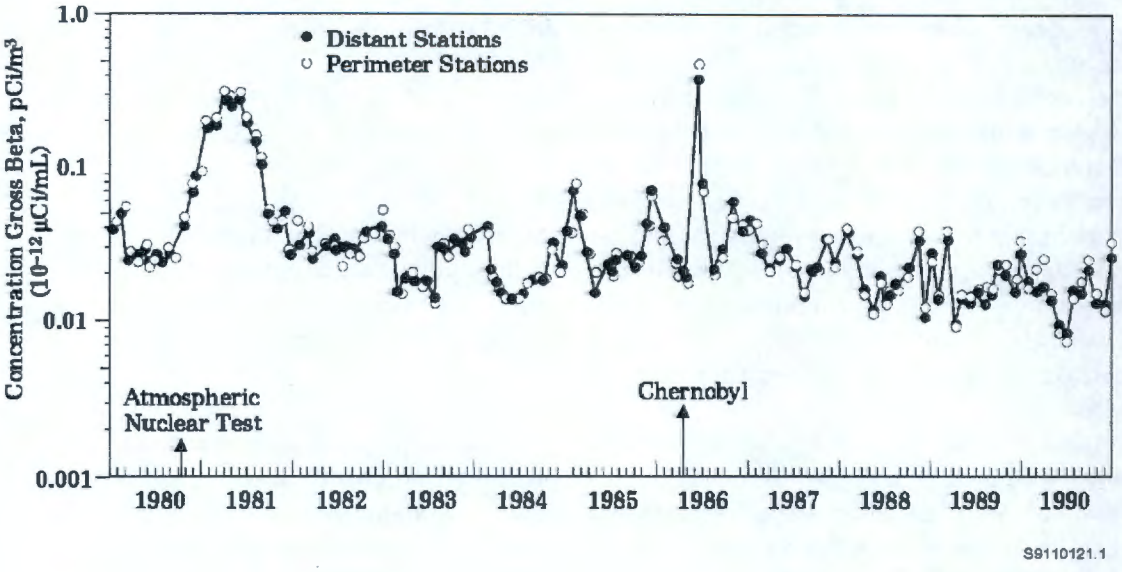
Currently, all nuclear material production facilities at the Hanford Site have been shut down, are undergoing cleanup and demolition, or are in surveillance and maintenance status. Only waste minimization, stabilization processes, research activities, environmental remediation, and D&D continue. In the past, when the Hanford Site was operating at or near full capacity, point–source emissions were easily detected. Now, however, radioactive materials released from point sources have in large measure diminished to effectively background levels found in the ambient environment remote

from the Hanford Site. As a consequence, the contribution from fugitive emissions has become a greater percentage of total emissions from the Hanford Site, even though fugitive emissions have thus far remained relatively small and constant.

Passively ventilated point sources, breather vents and other openings on tanks, vaults, vented containers, and other structures are potential conduits of fugitive radioactive emissions. Airborne radionuclides inside vented structures can be released through passive air exchanges, typically caused by changes in atmospheric pressure and temperature. It is difficult, however, to accurately assess radionuclide releases that might occur under such conditions, particularly when a vent opening is irregularly shaped or when multiple openings are in close proximity. This difficulty in accurately and readily quantifying passively ventilated emissions is the main reason why these sources are not routinely sampled using conventional point–source sampling methods. However, low emissions can be verified using other approved means such as smears, non–destructive analysis, occupational continuous air monitors, and direct radiation measurement using hand–held instruments. As an alternative to routine record sampling, estimates of radionuclides discharged as fugitive emissions from such sources are made based on data collected from a stable network of ambient air samplers around the downwind perimeter of the Hanford Site. Fugitive radionuclide release estimates are then calculated using these data. Section 4.2 contains the dose and release estimates and resulting doses for Hanford Site fugitive emissions in 2013.

For this report, doses have been calculated for emissions from both actively ventilated point sources and from fugitive sources. Dose results for each type of release are presented separately, in addition to the totals for all sources of radioactive emissions. Historical gross beta data displayed in Figure 4-1 are illustrative of the impacts distant nuclear events in the world had on regional concentrations of airborne radioactivity, measured by the former Hanford Site Surface Environmental Surveillance Project. (For perspective, ambient air concentrations measured at sample locations along the Hanford Site perimeter differ little from concentrations measured at locations distant from the Hanford Site.)

Figure 4–1. Historical Impact of Gross Beta Radioactivity in Hanford Site Ambient Air Samples, 1979 through 1990 (PNL–7346, *Hanford Site Environmental Report for Calendar Year 1990*).



4.1 FUGITIVE EMISSIONS MONITORING

MSA manages both the NFM and FFM Programs, along with analysis of radionuclide samples collected in the environment at locations on and off the Hanford Site. Further program and project information is presented in the remainder of this section.

4.1.1 Near–Field Monitoring

NFM is defined as monitoring of the environment done near facilities and work sites that have potentially dispersible radioactivity. The monitoring locations include nuclear facilities, active remediation work sites, and waste storage or disposal facilities such as container storage, burial grounds, underground tanks (i.e., Tank Farms), ponds, cribs, trenches, and ditches.

Routine monitoring activities include the sampling and monitoring of ambient air, surface contamination, external radiation doses, soil, vegetation, and animals. Samples are collected from known or expected effluent transport pathways, which are generally downwind of potential or actual airborne releases and downgradient of liquid discharges. Ambient air sampling is the primary method used in monitoring fugitive emissions, with other media samples possibly useful as secondary indicators.

In 2013, airborne radioactivity was sampled by a network of 71 near-field ambient air samplers operated as continuously as possible near facilities and work sites, as shown in the following list:

Number of Samplers	Location
4	100–D Area
3	100–H Area
7	100–K Area
3	100–N Area
44	200 Areas
3	ERDF
2	300 Area
4	618–10
1	600 Area

Figure 4–2 identifies the locations of the ambient air samplers used for NFM, as well as FFM. The station at the Wye Barricade is collocated with samplers operated by MSA and WDOH. Four other stations have WDOH samplers collocated with them: one each at 100–KE, at ERDF, at the 216–ZPIC Trench (aka 216–Z–19, 11, 1D) in the 200 West Area, at the 618-10 Burial Ground Project, and at C Tank Farms in the 200 East Area. Additional samplers are also used to support specific environmental remediation tasks. Ambient air samplers are primarily located at or near (within about 1,600 ft [500 m]) sites and facilities having the potential for or history of radionuclide releases to the environment.

Particulate air samples are analyzed for gross alpha activity, gross beta activity, gamma–emitting isotopes, ^{90}Sr, uranium isotopes (^{234}U, ^{235}U, and ^{238}U), and plutonium isotopes (^{238}Pu and $^{239}/^{240}Pu$). The primary gamma–emitting isotopes reported over the years include ^{60}Co, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{154}Eu, and ^{155}Eu. Samples collected at selected locations are also analyzed for ^{241}Am and/or ^{241}Pu. More detailed descriptions of these monitoring activities can be found in DOE/RL–2013–47, *Hanford Site Environmental Report for Calendar Year 2013*.

4.1.2 Far–Field Monitoring

FFM encompasses sampling and analyzing for radiological contaminants at locations in four surveillance zones in the environment on and off the Hanford Site. The first surveillance zone extends from the NFM locations to the Hanford Site perimeter. The second zone consists of a series of perimeter sampling stations near or just inside the Hanford Site boundary and along State Highway 240. The third zone consists of nearby community sampling locations within a 30–mi (48–km) radius of the Hanford Site. The fourth zone (i.e., background locations) currently consists of a single distant community location upwind of the Hanford Site and considered unaffected by its operations.

Routine surveillance activities include the sampling and monitoring of air, surface water, groundwater, food and farm products, fish and wildlife, soil and vegetation, and external radiation. Like the near–field monitoring program, ambient air sampling is the primary method used in monitoring fugitive emissions.

The air surveillance network consists of 40 sampling stations, of which 21 are onsite, 11 at the Hanford Site perimeter, seven in nearby communities, and one in a distant community considered a background location. This program routinely monitors for radioactive vapors, gases, and aerosols, which at selected locations includes sampling for ^{3}H in the ambient air. The surveillance network located around the 300 and 400 Areas functions as a near–field network.

Airborne particulate radionuclides at all sampling stations are sampled and analyzed. Most particulate air samples are routinely analyzed for gross alpha activity, gross beta activity, gamma–emitting isotopes, ^{90}Sr, uranium isotopes (^{234}U, ^{235}U, and ^{238}U), and plutonium isotopes (^{238}Pu and $^{239/240}Pu$). Gamma–emitting isotope concentrations reported in 2013 include ^{60}Co, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{155}Eu, and ^{241}Am. A more detailed description of this program can be found in DOE/RL–91–50, *Environmental Monitoring Plan*.

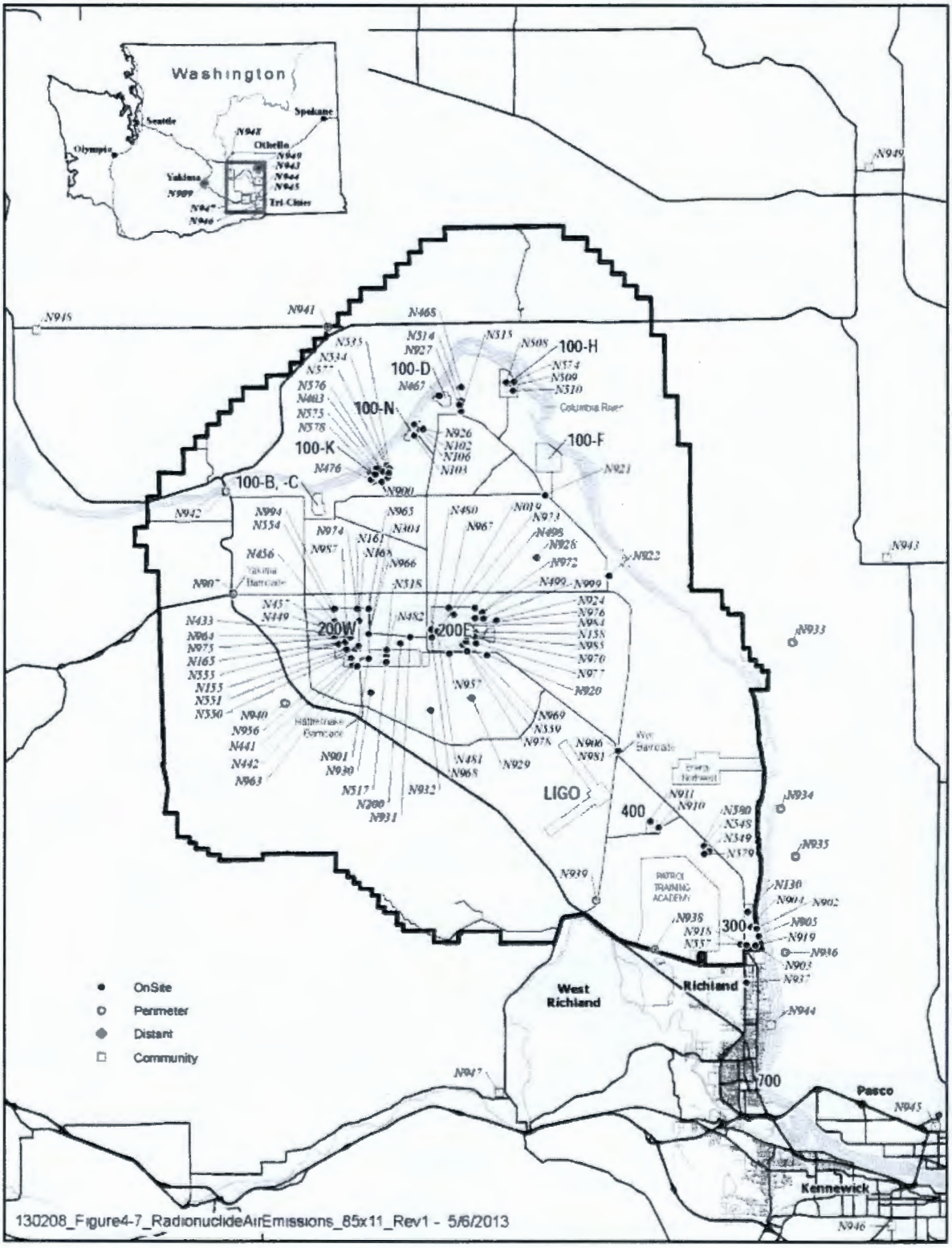
4.2 ESTIMATED DOSES FROM FUGITIVE EMISSIONS

Potential releases from fugitive sources and the resulting dose to an offsite member of the public were estimated using ambient air monitoring data from FFM air sampling locations along the Hanford Site perimeter. Data from 16 selected perimeter and nearby community locations were considered in the assessment of fugitive emissions in 2013 (refer to Figure 4–2, sampling locations N907, N933-N947).

4.2.1 Dose Assessment Method

The method currently used to estimate emissions from fugitive sources at the Hanford Site, and the subsequent dose to a maximally exposed member of the public, is based on measured ambient air concentrations at the site perimeter. Contributions from monitored stack emissions and background radioactivity are subtracted from ambient air concentrations measured for each radionuclide. If the difference is positive, the result is attributed to fugitive sources. From the adjusted ambient air concentrations, CAP88–PC is used to back–calculate fugitive releases in curies per year, conservatively

Figure 4–2. Ambient Air Monitoring Locations.



assumed to emanate from a single, centralized location in the 200 West Area, an assumption that yields the largest release estimate.

This is an indirect method for estimating fugitive emissions, but is subject to less uncertainty in estimating dose to a member of the public because it uses actual monitoring data from the site perimeter where members of the public could be located. This method is also far more cost effective than estimating fugitive emissions from the resuspension of particulate radionuclides from over 1,000 potential fugitive emission sources at the Hanford Site. Current information on the extent and characteristics of onsite soil contamination is insufficient to use radionuclide resuspension estimates in conjunction with transport and dose modeling for many potential sources of fugitive emissions. The ambient air sampling results consisted of measured air concentrations for radionuclides that could be released from Hanford Site operations and fugitive sources. Hanford Site radionuclides requiring assay of ambient air samples include ^{3}H, ^{60}Co, ^{90}Sr, ^{137}Cs, ^{154}Eu, ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, $^{239/240}Pu$, and ^{241}Am (DOE/RL–91–50).

An additional set of gamma–emitters found during laboratory analyses of the ambient air samples are also available in air sample reports; these include ^{40}K, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{152}Eu, and ^{155}Eu. In 2013, the ever–present ^{40}K (primordial in origin) isotope was measurable at detectable levels. The remaining gamma–emitters were reported at below minimum detectable levels.

A document was published in 2007 that not only details the method and procedures used to estimate Hanford Site radiological doses to the MEI from both radioactive point-source and fugitive-source emissions but also offers a brief history of relevant federal and state regulations and agency agreements (refer to DOE/RL–2007–53). This document evolved out of several DOE discussions with EPA and WDOH on the topic of the Hanford Site MEI. WDOH personnel participated in the review phase of the document and accepted the manner in which their resulting comments had been incorporated.

Using the CAP88–PC atmospheric dispersion modeling code, radionuclide air concentrations resulting from monitored stack emissions at Hanford Site facilities and other nearby non–DOE sources were calculated for perimeter and nearby community sampling locations. These modeled airborne radionuclide concentrations attributable to the stack emissions were subtracted from the ambient monitoring results. Average regional background concentrations for each radionuclide were calculated from the air sample results obtained at the distant community sampling station in Yakima, Washington, outside the 80–km (50–mile) radius and historically upwind from Hanford Site sources. The average background concentration at that station was also subtracted from the ambient monitoring results at the Hanford Site perimeter stations. The net air concentrations at the site perimeter, adjusted to account for monitored emission sources and background concentrations, are assumed to be the contribution of emissions from fugitive sources.

Hypothetical releases of radionuclides from fugitive sources are estimated using the net perimeter air concentrations attributable to fugitive emissions and by performing a back–calculation using CAP88–PC. The 200 West Area near the center of the Hanford Site is assumed to be the source of all fugitive emissions. This assumption results in a conservatively high estimate of releases and doses from all fugitive sources. The average of the estimated emissions for each perimeter monitoring station is then used with CAP88–PC to estimate the dose at the Hanford Site perimeter. Table 4–1 displays results from the perimeter monitoring location having the highest estimated dose from fugitive emissions, as well as the dose at the location of the member of the public who received the highest dose from monitored

Table 4–1. Estimated Hanford Site Fugitive Emissions and Resulting Effective Dose Equivalents for 2013.[a]

Radionuclide[b]	Estimated fugitive emissions from 200 Areas (Ci)[c]	Location	
		Estimated dose to MEI at PSF (mrem)[d, e]	Estimated dose at Prosser Barricade (mrem)[f]
^{3}H	1.9 E+03	4.9 E–02	7.3 E–02
^{60}Co	-1.5 E–01	0	0
^{90}Sr	-1.2 E–01	0	0
^{106}Ru	-6.9 E–01	0	0
^{125}Sb	3.9 E–01	5.0 E–04[g]	8.4 E–04[g]
^{134}Cs	2.4 E–02	5.8 E–04[g]	9.8 E–04[g]
$^{137}Cs/^{137m}Ba$	6.1 E–02	2.8 E–03	4.0 E–03
^{152}Eu	1.7 E–01	6.4 E–04[g]	1.1 E–03[g]
^{154}Eu	-7.4 E–01	0	0
^{155}Eu	2.0 E–01	6.9 E–05[g]	1.2 E–04[g]
Total U	1.2 E–02	1.1 E–03	1.9 E–03
^{238}Pu	1.6 E–04	1.8 E–04	3.0 E–04
$^{239/240}Pu$	-1.4 E–03	0	0
^{241}Am	-1.7 E+00	0	0
	Total ▶	5.5 E–02	8.4 E–02

[a]Hanford Site stack emissions, background radioactivity, and emissions from Perma-Fix Northwest, Inc., AREVA Federal Services LLC, and the ENCGS have been subtracted from these fugitive emissions estimates, which may contain releases from other non-DOE nuclear facilities. Negative values for releases of a radionuclide indicate that air concentrations at the site perimeter are lower than the combined air concentrations expected from natural background and monitored stack releases.

[b]Not all radionuclides listed were evaluated at every sampling station.

[c]1 Ci = 3.7 E+10 Bq. Emissions from fugitive sources are assumed to originate in the Hanford Site 200 West Area and have a release height of 1 m. The 300 Area also has potential sources for the resuspension of uranium from soil, along with naturally occurring uranium isotopes found throughout the area. Uranium releases were modeled as if the total inventory were from the 200 Areas, because it was not possible to determine the source of uranium isotopes detected at offsite sample stations.

[d]1 mrem = 1.0 E–02 mSv; these doses are based on air monitoring results for sample stations at the site perimeter. Radionuclides with negative releases consequently have a zero dose.

[e]This same dose applies to the Sagemoor location.

[f]The highest estimated dose from fugitive emissions was at the Prosser Barricade, a location with no routine occupancy by a member of the public, which disqualifies it for consideration as a possible MEI location.

[g]The indicated ^{125}Sb, ^{134}Cs, ^{152}Eu, and ^{155}Eu doses, conservatively reported, results from the procedure adopted for calculating and reporting fugitive dose. The dose estimate from these nuclides results from consideration of measurements at background, perimeter, and community monitoring stations. The procedure uses air sample results whether they are above or below detection levels. All air sample measurements in 2013 of ^{125}Sb, ^{134}Cs, ^{152}Eu, and ^{155}Eu were below minimum detection levels for all samples used in the calculation. The particular combination of lower background station data and higher perimeter and community air sample data resulted in a mathematically calculated dose estimate for these nuclides in 2013.

point–source emissions. A combined dose to a member of the public comprising the highest dose from monitored point–source emissions and the dose at that location from estimated fugitive–source emissions is reported and evaluated for compliance with the 10 mrem/yr standards in Subpart H of 40 CFR Part 61 and in WAC–246–247.

4.2.2 Results of Dose Assessment

During 2013, the measured annual average ambient air concentrations of ^{3}H, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{152}Eu, ^{155}Eu, ^{238}Pu, and total uranium (^{234}U, ^{235}U, and ^{238}U; modeled as ^{234}U) at the perimeter and nearby community sampling locations were assessed to be greater than the combined contributions of these analytes from stack releases and the annual average air concentration measured at the background station. Thus, calculating the net fugitive air concentrations for these isotopes resulted in positive values. Calculating the net fugitive air concentrations for ^{60}Co, ^{154}Eu, and $^{239/240}Pu$ resulted in negative values. All of the net air concentrations, both positive and negative, for each radionuclide were used in back–calculating fugitive releases from the 200 West Area.

The calculated fugitive–source release estimates shown in Table 4–1 represent the average of the individual release estimates calculated from each of the perimeter and nearby community locations for each radionuclide. Note that not all radionuclides were evaluated at every sampling station; the estimated release of a radionuclide is based on analytical data associated with those stations from which samples were analyzed for that particular radionuclide.

When the resulting release estimate in Table 4–1 is less than zero for an individual radionuclide, the average of the air concentrations at the perimeter stations was smaller than the combined concentrations expected as a result of stack emissions and regional background. In such cases, it is unlikely that fugitive sources contributed significantly to the offsite measured air concentrations for those radionuclides.

The calculated hypothetical fugitive release results in an estimated mean dose to both the MEI and an individual at Sagemoor Road to be 0.0055 mrem (0.000055 mSv) EDE, shown in Table 4–1. The fugitive releases for the sampled radionuclides were also used to calculate the dose to a hypothetical receptor at a number of sampling stations. An individual at the Prosser Barricade sampling station, which is within the Hanford Site boundary, had the highest estimated dose of 0.082 mrem (0.00082 mSv) EDE. However, the station at West End of Fir Road (see N934 on Figure 4–2) was the station with the highest offsite dose estimate from Hanford Site fugitive emissions, 0.078 mrem (0.00078 mSv) EDE. Dose estimates were between the MEI and Prosser Barricade values at five sampling stations (Ringold Met Tower, West End of Fir Road, Dogwood Road, Horn Rapids Substation, and Basin City [on Figure 4-2, monitoring locations N933, N934, N938, N939, and N943, respectively]) and at the Ringold potential MEI location (see Figure 3-1). Dose estimates at all other sampling stations and potential MEI locations were lower than those estimated at the PSF MEI location.

For purposes of demonstrating compliance with the MEI dose standard, the dose at PSF from fugitive sources was chosen instead of the Prosser Barricade dose for adding to the point–source dose at the MEI location. The reason is three–fold. One, regardless of the size difference between doses from point–source emissions and from fugitive–source emissions, the method used to calculate the dose from point–source emissions is given primacy because it is based on agency–approved sampling of emissions from agency-permitted stacks, whereas the method used to calculate the fugitive emission dose is hypothetical, conservative, and includes sample results at or below detectable levels. Of the locations

evaluated, the combined dose from stacks and fugitive sources was highest at PSF. Two, the fugitive–dose method centers on a single point of origin for all fugitive emissions, which adds to the conservative quality of the method, whereas the point–source method is presumed to be more reflective of actual emissions because it uses mostly measured emission values from five different geographical operating zones across the Hanford Site. And three, the location of the highest fugitive–source dose is within the Hanford Site boundary, where a member of the public would not be allowed full–time unrestricted access, and will invariably under the current fugitive dose method be attributed a higher dose than other potential MEI locations that are not in the direct downwind path of the hypothetical point of emanation in the 200 West Area for all Hanford Site fugitive emissions.

Where the release estimate for a particular radionuclide was less than zero, the dose estimate for that nuclide was set to zero before combining the contributions of all radionuclides to obtain the total dose at each location. The MEI dose derived was 0.13 mrem (0.0013 mSv) EDE from point–source emissions, 0.055 mrem (0.00055 mSv) EDE from fugitive emissions, and 0.063 mrem (0.00063 mSv) EDE from radon (i.e., ^{220}Rn and ^{222}Rn) emissions. For 2013, the total estimated dose to the offsite MEI at PSF was 0.25 mrem (0.0025 mSv) EDE, which is significantly below the federal and state 10 mrem/yr standard. To compare the 2013 and 2012 MEI doses, the total estimated MEI dose for 2012 was 0.099 mrem (0.00099 mSv) EDE, comprising 0.025 mrem (0.00025 mSv) EDE from point–source emissions, 0.0086 mrem (0.000086 mSv) EDE from fugitive emissions, and 0.065 mrem (0.00065 mSv) EDE from radon emissions.

In addition to the site–wide fugitive emissions estimates, fugitive tritium emissions from a single source during 2013 were estimated to determine their contribution to the public radiological dose. Tritium emissions from the 200 Area Tank Farms were estimated as less than 6 Ci/yr (2 E+11 Bq/yr), but assumed to be 6 Ci/yr for dose estimation. Emissions were assumed to be in the form of tritiated water vapor. For 2013, the resulting dose to the Hanford Site MEI from estimated 200 Area fugitive tritium emissions from the 200 Area Tank Farms was 0.00016 mrem (1.6 E–6 mSv) EDE. The dose from this source of fugitive emissions was much lower than the dose from monitored point–source emissions and did not substantially increase the total dose to an offsite receptor.

4.2.3 Discussion of Bias in Dose Assessment

It should be noted that the release estimates for fugitive sources in Table 4–1 were obtained using CAP88–PC, which incorporates a continuous–release Gaussian–plume dispersion model. Releases from fugitive sources would be expected to occur primarily under conditions that are very different from the annual average assumptions used by CAP88–PC. This is particularly true for emissions that are a function of wind speed, such as resuspension of contaminated soil and evaporation from ponds. Because release rates from such sources are greatest under conditions that favor atmospheric dispersion, use of an annual average continuous release model to back–calculate the release quantities might introduce a significant bias into these estimates. The dose estimates for sources of this type might also be affected by seasonal variation in the resuspension rates caused by the prevalence of strong winds during certain seasons of the year. If those seasonal episodes occur primarily during times when crop production is minimal, some of the exposure pathways incorporated into the CAP88–PC code (direct deposition on human and animal food crops, for example) would not be applicable. The release and dose estimates reported for fugitive sources in this evaluation should therefore be viewed as approximations whose accuracy is limited by a number of factors inherent in the sampling and modeling process.

4.3 FUGITIVE EMISSION SOURCES

The Hanford Site consists of 586 mi^2 (1,518 km^2) of semiarid shrub–steppe land, of which approximately 6 percent (about 32 mi^2 [83 km^2], or 20,000 acres [8,090 ha]) has been disturbed and/or actively used. This 6 percent of land is distributed into large operational and support areas: the 100, 200 Areas (which includes the 200 East and 200 West Areas), 300, 400, and 600 Areas.

Almost all point and fugitive sources of radionuclide emissions are located in the five operational Areas (i.e., 100, 200 East, 200 West, 300, and 400 Areas). For dose modeling purposes, sources outside those operational areas are combined with sources within the nearest operational area. Most point–source emissions are measured directly, but at a few facilities they are conservatively calculated from process knowledge. Emissions from fugitive sources are estimated using sample results from a network of environmental surveillance monitoring systems located along the Hanford Site perimeter and at several receptor locations. In some instances, emissions from specific fugitive emission sources are based on known inventories and/or release records.

The Hanford Site was acquired by the federal government in 1943 and dedicated to producing plutonium for national defense and managing the resulting production wastes. Restoring the Hanford Site environment is the new mission that has largely supplanted the previous operational objectives for national defense. The environmental restoration effort will entail activities such as decontaminating and decommissioning over 100 facilities and cleaning up and restoring about 1,500 waste sites. Until the restoration and cleanup work is completed, radioactive emissions may be released from hundreds of fugitive sources, in addition to monitored point sources.

Besides both measuring and modeling point–source emissions to determine public doses, environmental surveillance is conducted. Environmental and food–chain pathways are monitored near facilities emitting radionuclides from either point sources or fugitive sources.

The environmental pathways for all air emissions from the Hanford Site are monitored using a stratified sampling approach. Samples are collected and radiation measured according to four surveillance zones. These zones extend from main onsite operational areas to offsite regions (DOE/RL–2013–18).

The first surveillance zone begins near the operating facilities and ends at the Hanford Site perimeter. Fugitive emissions generally will be most concentrated and easier to detect in this area before diluting further as they drift offsite.

The second surveillance zone is a series of sampling stations that surround the Hanford Site near its perimeter. Because a person could live as close to the Hanford Site as some of these stations, their data represent the maximum exposures for a member of the public. Therefore, ambient air sampling data from the perimeter locations most closely reflect the actual impacts of radionuclide air emissions from point sources and fugitive sources at the Hanford Site.

The third surveillance zone encompasses nearby and distant communities within a 50–mi (80–km) radius of the center of the Hanford Site but beyond its boundaries. Surveillance is conducted in communities to provide measurements at those locations where the most people are potentially exposed. This surveillance ensures radionuclide levels are well below standards established to protect the public health.

Finally, the fourth surveillance zone comprises distant locations at which background concentrations are measured. These concentrations are compared with onsite, perimeter, and community locations to indicate the effects of Hanford Site activities. Background locations are essentially unaffected by Hanford Site emissions but contain similar levels of radioactivity originating naturally and from nuclear–testing fallout.

The goal of environmental surveillance at the Hanford Site is to verify compliance with DOE, EPA, and WDOH radiological dose standards for public protection. This goal is accomplished by measuring radionuclides and consequent exposure in the onsite and offsite environment. The environmental surveillance criteria are derived from (1) the collected environmental surveillance data on radionuclides and doses, (2) applicable regulations other than DOE Orders, (3) DOE Order 458.1, *Radiation Protection of the Public and the Environment*, and (4) DOE/EH–0173T. The surveillance project was established on these criteria and the pathway analyses that provide information on radionuclides and media contributing to human dose. Experience from Hanford Site environmental surveillance activities and studies conducted over the past 45 years have built an invaluable technical repository of information for planning and data interpretation.

4.3.1 Description of Fugitive Emission Sources

The presently identified actual or potential categorical sources of fugitive radionuclide emissions to the environment at the Hanford Site are described in this section. Among the sources that could release radioactive fugitive emissions are several types of waste handling and disposal facilities such as cribs, ponds, ditches, trenches, retention basins, valve pits, French drains, reverse wells, tanks, vented containers, and burial grounds. Over 1,000 of these types of sources have been identified, of which more than 95 percent are inactive (DOE/RL–88–30, *Hanford Site Waste Management Units Report*). Facilities that are operating on standby or are inactive can also be sources of radioactive fugitive emissions. These following activities can also cause fugitive radioactive emissions: deactivation, decontamination, decommissioning, and demolition of facilities; characterization of waste sites and areas; and cleanup of inactive waste sites. Each waste site or facility usually has one or more features or characteristics that could contribute to the fugitive release of emissions. The features may be passive vents, risers, equipment and personnel access doors, and exhausters, whereas characteristics may include an undetected leak, unburied waste, or an absence of intrusion barriers. Rates of fugitive emissions could be influenced by a variety of environmental conditions, such as (1) changing atmospheric pressures, (2) wind speed, (3) erosion, (4) evaporation, (5) percolation, and (6) biotic intrusion. Range fires present another cause of fugitive emissions, by way of smoke from burned material that contained radioactive particles and the resultant loss of vegetative cover, which had served to retard the resuspension of surface soil contaminants.

The general types of sites and facilities and their potential primary sources of fugitive emissions are briefly described in the following sections. Additional relatively current information and status detail on the remediation of fugitive emission sources can be found in DOE/RL-2013-47, the *Hanford Site Environmental Report for Calendar Year 2013*.

4.3.1.1 Crib

Low–level liquid waste was discharged to cribs, which are subsurface systems similar to sanitary drain fields that allow the liquid component of the waste to percolate into the soil. The natural properties of the soil were used to remove radioactive material from the effluent water through filtration, ion–exchange, and precipitation reactions.

Many cribs are vented to the atmosphere through vents and pipe risers. Some cribs, however, have had vents and pipe risers either blanked or removed. Those engineered structures promoted the downward flow of liquids disposed of in cribs but also provide pathways to the surface and atmosphere. Secondary causes of fugitive emissions include erosion and uptake and intrusion by biota, followed by wind–caused particle resuspension.

4.3.1.2 Ditch

A ditch is an open, unlined excavation formerly used for disposing of liquid effluents or transporting liquid effluents to ponds for disposal. Most ditches have been filled with soil. Fugitive emissions from ditches occur primarily from wind–caused particle resuspension, vegetative uptake, biota intrusion, and erosion.

4.3.1.3 Trench

Early disposal practices included disposing of liquid effluents into unlined trenches and over time filling the structures with soil. Those trenches were mostly replaced by cribs such as the BC–cribs, now retired. Fugitive emissions from trenches are primarily caused by erosion, uptake and intrusion by biota, followed by wind–caused particle resuspension.

4.3.1.4 Retention Basin

Similar to trenches, retention basins generally were lined with concrete and used to hold liquid before routing it to ditches or ponds. Fugitive emissions from retention basins are caused primarily by wind–caused particle resuspension.

4.3.1.5 Diversion Box

A diversion box is usually an underground concrete structure formed around a junction of transfer lines carrying liquid effluent. When diversion boxes are accessed for operations or maintenance, radioactively contaminated material might be released in the form of fugitive emissions.

4.3.1.6 Valve Pit

A valve pit is similar in structure to a diversion box, but contains piping valves. When valve pits are accessed for maintenance or operations, radioactively contaminated material might be released in the form of fugitive emissions.

4.3.1.7 French Drain and Reverse Well

A French drain is a rock–filled encasement inserted in the ground. A reverse well is an ordinary well formerly used for mixing liquid waste with groundwater. These subsurface systems were used to dispose of potentially contaminated liquid waste by promoting percolation into the soil. The natural filtration properties of the soil removed radioactive material from effluent water. Fugitive emissions from French drains and reverse wells might occur through erosion or uptake and intrusion by biota, followed by wind–caused particle resuspension.

4.3.1.8 Tank

A tank generally is a large reinforced metal structure that receives liquid effluent for storage. Examples are DSTs and SSTs. Pathways for fugitive emissions from tanks include passively ventilated point sources and inactive exhausters open to the atmosphere. Transport mechanisms for these emissions include deposition and subsequent particle resuspension.

4.3.1.9 Burial Ground

Burial grounds are trenches in which contaminated solid waste is buried. Waste packaging procedures and burial practices used depend on the type of waste. Fugitive emissions occur at burial grounds through direct release to the atmosphere before the waste is buried, but could occur after burial by way of erosion, vegetative uptake, biota intrusion, and wind–caused particle resuspension.

4.3.1.10 Deactivation, Decontamination, Decommissioning, and Demolition Activities

Deactivation, decontamination, decommissioning, and demolition activities are conducted to minimize the potential release or spread of contamination from facilities and equipment. Deactivation activities are intended to remove facility systems and/or areas from operational service to make them ready for the facility transition phase in which facilities are either converted to another use or placed in a permanent shutdown condition. Activities could include removal of spent nuclear fuel; draining and/or de–energizing of systems; removal of accessible stored radioactive and hazardous material; and other actions that place the facility systems and/or areas in a safe and stable condition. Deactivation reduces the risk to the public and the environment until the ultimate disposition of each facility is decided and implemented, and allows the surveillance–and–maintenance program to be conducted more cost effectively.

Decontamination primarily consists of physically removing contaminants, but can also include fixing contaminants in place, to the extent they are not smearable, to prevent their mobility during demolition. Methods might include washing with water, scraping, sandblasting, or fixing the contamination in place by painting, applying asphalt, etc. Demolition involves destroying and removing the structure and might include excavating its foundation. In some cases, contaminated material might be exposed to the atmosphere, but proper planning and controls should minimize these exposures. Monitors around demolition sites are used to measure or indicate the effectiveness of controls.

4.3.1.11 Waste Site Characterization and Cleanup Activities

Characterization is performed to determine the extent of contamination. Cleanup activities are conducted to minimize the potential release or spread of contamination from inactive waste sites. Contaminated soils and structures are excavated and transported to ERDF and/or other disposal sites. Contaminated materials are exposed to the atmosphere during excavation and disposal activities. Proper planning and controls such as water sprays and fixatives are used to minimize the potential for airborne emissions. The waste sites are backfilled after excavation and the disposed material is covered with soil.

4.3.1.12 Radioactively Contaminated Outdoor Surface Areas

Radiological surveys are routinely conducted at these types of radioactively contaminated outdoor surface areas: burial grounds, cribs, trenches, retention basins, and known unplanned release sites. The surveys are performed at least annually, but more frequently when needed. The areal magnitude of

outdoor surface contamination varies, despite continuing efforts to clean, stabilize, or remediate them. Newly identified contamination can be the result of preexisting contamination having migrated, by way of wind-caused resuspension or by biological intrusion, to previously uncontaminated areas or because radiological screening criteria have become more stringent. Fugitive emissions originating from contaminated soil are primarily caused by erosion, plant uptake, biota intrusion, and wind–caused particle resuspension.

4.3.1.13 Structures with Radioactive Contamination

Structures having indoor contamination and not actively ventilated through a point source could be sources for fugitive emissions. Many structures control fugitive emissions with ventilation systems and contamination control practices. Ventilation systems generally help maintain a negative indoor air pressure and can significantly reduce airborne contaminants from leaving the building by use of pollution abatement systems. Many structures with ventilation systems discharge air to the atmosphere via an emission control device, typically a HEPA filter. Facilities with a potential to emit radioactive contaminants and that have actively ventilated, filtered, and routinely sampled point sources are not considered a source of fugitive emissions. This type of facility has the potential, though lesser in extent, than facilities not equipped with active ventilation systems but with a comparable source term. The Hanford Site has many old structures with radioactive contamination and no building ventilation. Contaminants can sometimes migrate outdoors via human entry and exit. Also, contaminants can migrate outdoors via passive ventilation or animal intrusion because these structures often have cracks and gaps that serve as pathways to the outdoors. Once the contaminants are transported outdoors, they can become airborne by wind–caused resuspension.

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5.0 SUPPLEMENTAL INFORMATION

This section has supplemental information related to Hanford Site radionuclide air emissions in 2013 and consists of the following:

- Collective (population) dose estimate
- Compliance status with respect to Subparts Q and T of 40 CFR 61
- Periodic confirmatory measurements related to NOCs
- Ambient air sampling measurements
- Quality assurance (QA) program status of compliance with 40 CFR 61, Appendix B, Method 114.

5.1 COLLECTIVE DOSE ESTIMATE

Collective doses to the population surrounding the Hanford Site in calendar year 2013 were not available for publication in this report. That information is published annually and will be reported in DOE/RL-2013-47, the *Hanford Site Environmental Report for Calendar Year 2013*.

5.2 COMPLIANCE STATUS WITH 40 CFR 61, SUBPARTS Q AND T

In 40 CFR 61, Subpart Q, "National Emission Standards for Radon Emissions From Department of Energy Facilities," paragraph 61.190 states that the provisions of Subpart Q apply to the design and operation of all storage and disposal facilities for radium–bearing material that emits ^{222}Rn to the air. Paragraph 61.191(b) states that a source means any building, structure, pile, impoundment, or area used for interim storage or disposal that is or contains waste material containing radium in sufficient concentration to emit ^{222}Rn in excess of a standard of 20 $pCi/m^2/s$. The known quantities of ^{226}Ra (the immediate precursor to ^{222}Rn) stored at the Hanford Site were evaluated and found to decay to ^{222}Rn at a rate below the standard.

Activities at the Hanford Site were evaluated for compliance with 40 CFR 61, Subpart T, "National Emissions Standards for Radon Emissions From the Disposal of Uranium Mill Tailings." In paragraph 61.220, "Designation of Facilities," owners and operators of such facilities are subject to the provisions in Subpart T: those whose sites were used for the disposal of tailings and that managed residual radioactive material or uranium byproduct materials during and following the processing of uranium ores and that are listed in or designated by the Secretary of Energy under Title I of the Uranium Mill Tailings Control Act of 1978 or regulated under Title II of that act. Since no uranium milling and uranium–ore processing activities are conducted at the Hanford Site, Subpart T does not apply.

5.3 PERIODIC CONFIRMATORY MEASUREMENTS

This section contains measurement data related to point-source emission abatement media. The dat

a are indicative of low emissions from those sources, a condition for which confirmatory measurements are periodically made as required by NOCs and other regulatory agreements.

5.3.1 Miscellaneous Periodic Confirmatory Emission Measurements

Table 5–1 presents data indicative of low emissions. The data derive from the nondestructive analysis of HEPA filters associated with the listed sources.

Table 5–1. Nondestructive Analysis Results for 2013.

Location	Filtration	Analysis date	Radionuclide	µCi
Site-wide guzzler	HEPA	11/18/13	^{60}Co ^{137}Cs	ND ND
296-S-23, 219-S	HEPA	04/16/13	^{137}Cs	1.582 E–01
240-S-302 Radial Breather Filter	HEPA	05/01–02/14	^{137}Cs	3.470 E–04

1 Ci = 1 curie = 3.7 E+10 Bq; ND = not detected; NA = not applicable.

Table 5–2 has data indicative of low emissions from a work area where an air sparger is located inside the 105-KW Basin. The data derive from the destructive analysis of a passively ventilated HEPA filter in a vent connected to that work area.

Table 5–2. 105-KW Basin Destructive Analysis Results for 2013.

Emission Unit (Location; EDP code)	Filter medium	Radionuclides or type of radioactivity measured	Activity, pCi
105-KW Air Sparging Vent (105-KW Basin; Y249)	HEPA	long-lived Hanford-typical radionuclides[a] and gross alpha and gross beta	none detected

HEPA = high-efficiency particulate air

[a] ^{90}Sr, ^{137}Cs, ^{238}Pu, $^{239/240}Pu$, ^{241}Pu, and ^{241}Am.

5.4 AMBIENT AIR SAMPLING MEASUREMENTS

The NF and FF monitoring programs comprise a comprehensive network of monitoring locations near facilities and projects at the Hanford Site, as well as at perimeter and offsite locations. The programs monitor soil, vegetation, and ambient air that may contain radionuclides dispersed there by onsite activities. NFM also uses thermoluminescent dosimeters to measure ambient dose rates. Emissions from many NOC activities are not measured directly at the source, as are emissions from forcibly ventilated stacks. Frequently, NOC activities are temporary and not conducted within the confines of structures having ventilation systems equipped with sampling or monitoring equipment. Hence, assessing emissions from these activities is not nearly as straightforward as is measuring stack emissions.

WDOH requires that emissions from NOC activities be measured periodically to confirm whether or not they are low. A variety of measurement data are used in this confirmation process, including those from the NFM program, dose–rate surveys, surface smears, continuous air monitor sampling, and both nondestructive and destructive analysis, especially of HEPA filters. Further confirmation methods are allowed, provided they are first approved by WDOH.

Summarized in Table 5–3 and 5–4 are the analytical data measured from NFM ambient air samples collected during 2013, organized by general emission unit, which for regulatory purposes is construed as

equivalent to an operational area such as the 100, 200, 300, 400, or 600 Area. Radionuclides with concentrations that fell below analytical detection limits in both the first and second half of the semi–annual composite samples were not listed in the tables.

- Several River Corridor Contract (RCC) projects have requirements for annually reporting ambient air monitoring data obtained from samples collected at air monitoring stations managed by MSA. The stations (and their electronic data processing [EDP] codes) in proximity to these projects are as follows:
- "Yakima Barricade" (N907) is used for the 100–D, 100–H, and 118–K–1 Field Remediation Projects
- "E100K – 118-K-1 Project" (N917) is used for the 118–K–1 Field Remediation Project
- "300 Trench" (N904), "300 NE" (N902), "300 Area South Gate"/"300 Area Composite" (N903), "300 South West" (N918), and "300 Water Intake" (N905) are used for the 300-FF-2 Field Remediation Project and the 300 Area Demolition Project. (These MSA-managed ambient air monitors in the 300 Area also sample emissions from the 300 Area general emission unit.)

Tables 5-5 and 5-6 have data from perimeter ambient air monitoring stations, which are part of the FFM program. The data in Table 5-5 are required by the FF-01 and were used in calculating the radiological fugitive-emission dose to the Hanford Site MEI.

The following definitions apply to abbreviations and units of measure found in Tables 5–3 through 5–5:

- EDP = Electronic Data Processing [code] (these alpha–numeric codes, such as "N464," serve as sampler location identifiers)
- "1st half" and "2nd half" refer to 6-month periods of the calendar year; i.e., January 1 through June 30 and July 1 through December 31, respectively
- 1 Ci = 1 curie = 3.7 E+10 becquerels (Bq)
- pCi = picocurie = E–12 Ci
- m^3 = cubic meter pCi/m^3 = picocuries per cubic meter (pCi = E–12 curies)
- NA = not applicable (because up to 26 samples were analyzed each half year and up to 13 a quarter, but this table shows only a single isotopic result obtained for that period)
- ND = not detected (i.e., result less than zero, less than its overall analytical error, or no peak detected).

Table 5–3. Hanford Site Near–Field Monitoring Air Sampling Results for 2013.
(13 sub–tables on 10 sheets)

100 Areas

100-D Field Remediation Project

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N467	gross α	NA	NA	9.1 E–04	2.1 E–03
	gross β	NA	NA	1.5 E–02	3.4 E–02
	^{90}Sr	3.1 E–04	ND	3.1 E–04	3.1 E–04
	^{234}U	1.2 E–05	ND	1.2 E–05	1.2 E–05
	^{238}U	7.0 E–06	ND	7.0 E–06	7.0 E–06
N468	gross α	NA	NA	9.9 E–04	2.7 E–03
	gross β	NA	NA	1.7 E–02	4.2 E–02
	^{90}Sr	1.2 E–04	ND	1.2 E–04	1.2 E–04
	^{234}U	4.6 E–06	ND	4.6 E–06	4.6 E–06
	^{238}U	7.9 E–06	ND	7.9 E–06	7.9 E–06
N514	gross α	NA	NA	8.8 E–04	1.5 E–03
	gross β	NA	NA	1.5 E–02	4.1 E–02
	^{234}U	4.3 E–06	ND	4.3 E–06	4.3 E–06
	^{238}U	8.6 E–06	ND	8.6 E–06	8.6 E–06
	$^{239/240}$Pu	9.5 E–06	ND	9.5 E–06	9.5 E–06
N515	gross α	NA	NA	9.1 E–04	2.2 E–03
	gross β	NA	NA	1.6 E–02	3.9 E–02
	^{234}U	7.6 E–06	ND	7.6 E–06	7.6 E–06
	^{238}U	1.2 E–05	ND	1.2 E–05	1.2 E–05
	$^{239/240}$Pu	4.0 E–06	ND	4.0 E–06	4.0 E–06

100-H Field Remediation Project

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N509	gross α	NA	NA	8.0 E-04	1.8 E-03
	gross β	NA	NA	1.5 E-02	4.0 E-02
	^{90}Sr	1.8 E-04	ND	1.8 E-04	1.8 E-04
	^{234}U	1.2 E-05	ND	1.2 E-05	1.2 E-05
	^{238}U	5.8 E-06	ND	5.8 E-06	5.8 E-06
N510	gross α	NA	NA	3.4 E–04	3.4 E–04
	gross β	NA	NA	4.1 E–03	4.1 E–03
N574	gross α	NA	NA	8.8 E–04	1.4 E–03
	gross β	NA	NA	1.4 E–02	3.0 E–02
	^{90}Sr	5.2 E–04	ND	5.2 E–04	5.2 E–04

Sludge Treatment Project

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N476	gross α	NA	NA	1.0 E–03	2.6 E–03
	gross β	NA	NA	1.8 E–02	4.5 E–02
	^{234}U	7.9 E–06	8.7 E–06	8.3 E–06	8.7 E–06
	^{238}U	ND	1.0 E–05	1.0 E–05	1.0 E–05
N575	gross α	NA	NA	1.1 E–03	2.9 E–03
	gross β	NA	NA	2.2 E–02	6.0 E–02
	^{234}U	7.8 E–06	1.2 E–05	9.8 E–06	1.2 E–05
N576	gross α	NA	NA	1.1 E–03	2.4 E–03
	gross β	NA	NA	2.0 E–02	5.1 E–02
	^{234}U	9.5 E–06	6.4 E–06	8.0 E–06	9.5 E–06
	^{238}U	ND	8.5 E–06	8.5 E–06	8.5 E–06
N577	gross α	NA	NA	1.5 E–03	3.4 E–03
	gross β	NA	NA	2.9 E–02	6.4 E–02
N578	gross α	NA	NA	1.1 E–03	3.0 E–03
	gross β	NA	NA	2.2 E–02	6.8 E–02
	^{90}Sr	ND	1.4 E–04	1.4 E–04	1.4 E–04
	^{235}U	4.0 E–06	ND	4.0 E–06	4.0 E–06
	^{238}U	7.3 E–06	7.5 E–06	7.4 E–06	7.5 E–06
N900 (100-K Area)	gross α	NA	NA	8.9 E–04	2.9 E–03
	gross β	NA	NA	2.3 E–02	8.4 E–02
	^{3}H	ND	ND	1.8 E+01	7.5 E+01

100-N D4 Project

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N102	gross α	NA	NA	1.3 E–03	5.5 E–03
	gross β	NA	NA	2.0 E–02	6.9 E–02
	^{234}U	1.4 E–05	1.2 E–05	1.3 E–05	1.4 E–05
	^{235}U	7.2 E–06	ND	7.2 E–06	7.2 E–06
	^{238}U	8.1 E–06	9.7 E–06	8.9 E–06	9.7 E–06
N103	gross α	NA	NA	1.1 E–03	2.7 E–03
	gross β	NA	NA	1.6 E–02	5.3 E–02
	^{234}U	6.7 E–06	1.9 E–05	1.3 E–05	1.9 E–05
	^{238}U	1.0 E–05	9.1 E–06	9.8 E–06	1.0 E–05
N106	gross α	NA	NA	1.2 E–03	3.7 E–03
	gross β	NA	NA	1.9 E–02	5.8 E–02
	^{234}U	7.8 E–06	1.2 E–05	9.7 E–06	1.2 E–05
	^{238}U	5.7 E–06	1.2 E–05	8.6 E–06	1.2 E–05

200 Area

200 East Area

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N019	gross α	NA	NA	1.4 E–03	3.5 E–03
	gross β	NA	NA	1.9 E–02	7.6 E–02
	^{90}Sr	1.5 E–04	1.9 E–04	1.7 E–04	1.9 E–04
N158	gross α	NA	NA	1.1 E–03	2.7 E–03
	gross β	NA	NA	1.9 E–02	5.9 E–02
	^{90}Sr	ND	1.2 E–04	1.2 E–04	1.2 E–04
	^{234}U	ND	1.1 E–05	1.1 E–05	1.1 E–05
	^{238}U	ND	7.6 E–06	7.6 E–06	7.6 E–06
N498	gross α	NA	NA	1.0 E–03	3.1 E–03
	gross β	NA	NA	2.0 E–02	6.8 E–02
	^{235}U	4.0 E–06	ND	4.0 E–06	4.0 E–06
	^{238}U	8.8 E–06	ND	8.8 E–06	8.8 E–06
	$^{239/240}$Pu	ND	6.0 E–06	6.0 E–06	6.0 E–06
N499	gross α	NA	NA	1.1 E–03	3.1 E–03
	gross β	NA	NA	2.1 E–02	6.9 E–02
	^{90}Sr	1.2 E–04	2.4 E–04	1.8 E–04	2.4 E–04
	^{137}Cs	4.4 E–04	ND	4.4 E–04	4.4 E–04
	^{234}U	ND	1.6 E–05	1.6 E–05	1.6 E–05
N532	gross α	NA	NA	9.7 E–04	2.5 E–03
	gross β	NA	NA	2.0 E–02	5.2 E–02
	^{90}Sr	ND	1.6 E–04	1.6 E–04	1.6 E–04
	^{234}U	ND	1.1 E–05	1.1 E–05	1.1 E–05
	^{238}U	ND	5.6 E–06	5.6 E–06	5.6 E–06
N559	gross α	NA	NA	1.3 E–03	6.6 E–03
	gross β	NA	NA	2.2 E–02	8.6 E–02
	^{234}U	ND	9.7 E–06	9.7 E–06	9.7 E–06
	^{235}U	ND	4.8 E–06	4.8 E–06	4.8 E–06
	^{238}U	ND	1.4 E–05	1.4 E–05	1.4 E–05
N957	gross α	NA	NA	1.2 E–03	3.3 E–03
	gross β	NA	NA	1.8 E–02	4.6 E–02
	^{90}Sr	1.2 E–04	ND	1.2 E–04	1.2 E–04
	^{234}U	ND	1.6 E–05	1.6 E–05	1.6 E–05
	^{238}U	ND	6.6 E–06	6.6 E–06	6.6 E–06
N967	gross α	NA	NA	1.4 E–03	4.0 E–03
	gross β	NA	NA	2.1 E–02	6.9 E–02
	^{234}U	1.0 E–05	9.7 E–06	1.0 E–05	1.0 E–05
	^{238}U	6.1 E–06	4.5 E–06	5.3 E–06	6.1 E–06
	$^{239/240}$Pu	4.5 E–06	ND	4.5 E–06	4.5 E–06
N968	gross α	NA	NA	1.2 E–03	3.7 E–03
	gross β	NA	NA	1.8 E–02	5.7 E–02
	^{234}U	1.0 E–05	6.5 E–06	8.5 E–06	1.0 E–05
	^{238}U	ND	8.6 E–06	8.6 E–06	8.6 E–06

200 East Area					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N969	gross α	NA	NA	1.2 E–03	3.4 E–03
	gross β	NA	NA	1.9 E–02	5.7 E–02
	^{234}U	ND	1.3 E–05	1.3 E–05	1.3 E–05
	^{238}U	7.8 E–06	ND	7.8 E–06	7.8 E–06
	$^{239/240}Pu$	ND	1.1 E–05	1.1 E–05	1.1 E–05
N970	gross α	NA	NA	1.4 E–03	3.7 E–03
	gross β	NA	NA	2.1 E–02	7.0 E–02
	^{90}Sr	ND	9.1 E–05	9.1 E–05	9.1 E–05
	^{234}U	9.5 E–06	1.3 E–05	1.1 E–05	1.3 E–05
	^{238}U	1.2 E–05	6.7 E–06	9.5 E–06	1.2 E–05
N972	gross α	NA	NA	1.3 E–03	4.1 E–03
	gross β	NA	NA	2.2 E–02	8.2 E–02
	^{90}Sr	ND	1.3 E–04	1.3 E–04	1.3 E–04
	^{137}Cs	1.8 E–03	ND	1.8 E–03	1.8 E–03
	^{234}U	9.4 E–06	1.2 E–05	1.1 E–05	1.2 E–05
	^{238}U	7.9 E–06	ND	7.9 E–06	7.9 E–06
N973	gross α	NA	NA	1.3 E–03	4.4 E–03
	gross β	NA	NA	2.1 E–02	7.1 E–02
	^{234}U	1.4 E–05	9.9 E–06	1.2 E–05	1.4 E–05
	$^{239/240}Pu$	5.4 E–06	ND	5.4 E–06	5.4 E–06
N976	gross α	NA	NA	9.6 E–04	3.2 E–03
	gross β	NA	NA	1.8 E–02	6.3 E–02
	^{90}Sr	ND	1.3 E–04	1.3 E–04	1.3 E–04
	^{137}Cs	2.8 E–03	ND	2.8 E–03	2.8 E–03
	^{234}U	1.1 E–05	2.2 E–05	1.7 E–05	2.2 E–05
	^{238}U	6.3 E–06	1.2 E–05	9.0 E–06	1.2 E–05
N977	gross α	NA	NA	1.2 E–03	3.4 E–03
	gross β	NA	NA	2.0 E–02	6.1 E–02
	^{90}Sr	ND	8.0 E–05	8.0 E–05	8.0 E–05
	^{234}U	9.5 E–06	1.5 E–05	1.2 E–05	1.5 E–05
	^{238}U	5.4 E–06	9.0 E–06	7.2 E–06	9.0 E–06
	$^{239/240}Pu$	ND	8.1 E–06	8.1 E–06	8.1 E–06
N978	gross α	NA	NA	1.3 E–03	3.6 E–03
	gross β	NA	NA	2.0 E–02	5.7 E–02
	^{234}U	1.2 E–05	6.2 E–06	9.1 E–06	1.2 E–05
	^{238}U	7.2 E–06	ND	7.2 E–06	7.2 E–06
	$^{239/240}Pu$	3.7 E–06	ND	3.7 E–06	3.7 E–06
N984	gross α	NA	NA	1.3 E–03	4.3 E–03
	gross β	NA	NA	3.0 E–02	1.2 E–01
	^{90}Sr	1.5 E–04	1.5 E–04	1.5 E–04	1.5 E–04
	^{137}Cs	1.9 E–02	1.2 E–03	1.0 E–02	1.9 E–02
	^{234}U	9.8 E–06	1.1 E–05	1.0 E–05	1.1 E–05
	^{238}U	ND	5.7 E–06	5.7 E–06	5.7 E–06

200 East Area

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N985	gross α	NA	NA	1.2 E–03	3.7 E–03
	gross β	NA	NA	2.0 E–02	6.8 E–02
	^{234}U	ND	1.1 E–05	1.1 E–05	1.1 E–05
	^{238}U	7.0 E–06	ND	7.0 E–06	7.0 E–06
N999	gross α	NA	NA	1.2 E–03	3.8 E–03
	gross β	NA	NA	2.2 E–02	7.5 E–02
	^{90}Sr	ND	6.9 E–04	6.9 E–04	6.9 E–04
	^{137}Cs	1.6 E–03	1.2 E–03	1.4 E–03	1.6 E–03
	^{234}U	7.4 E–06	ND	7.4 E–06	7.4 E–06
	^{238}U	3.7 E–06	4.7 E–06	4.2 E–06	4.7 E–06

Canister Storage Building (200 East Area)

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N480	gross α	NA	NA	1.0 E–03	2.7 E–03
	gross β	NA	NA	2.1 E–02	7.5 E–02
	^{90}Sr	1.0 E–04	9.4 E–05	1.0 E–04	1.0 E–04
	^{234}U	6.7 E–06	8.6 E–06	7.7 E–06	8.6 E–06
	^{238}U	6.0 E–06	6.2 E–06	6.1 E–06	6.2 E–06
	$^{239/240}$Pu	ND	7.9 E–06	7.9 E–06	7.9 E–06
N481	gross α	NA	NA	1.0 E–03	2.8 E–03
	gross β	NA	NA	2.1 E–02	7.7 E–02
	^{234}U	ND	7.5 E–06	7.5 E–06	7.5 E–06
	^{235}U	3.9 E–06	ND	3.9 E–06	3.9 E–06
	^{238}U	4.3 E–06	9.0 E–06	6.6 E–06	9.0 E–06

200 West Area

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N155	gross α	NA	NA	1.0 E–03	2.8 E–03
	gross β	NA	NA	1.8 E–02	6.3 E–02
	^{90}Sr	ND	1.1 E–04	1.1 E–04	1.1 E–04
	^{234}U	ND	1.1 E–05	1.1 E–05	1.1 E–05
	^{238}U	ND	9.6 E–06	9.6 E–06	9.6 E–06
N161	gross α	NA	NA	1.3 E–03	3.3 E–03
	gross β	NA	NA	1.9 E–02	5.5 E–02
	^{90}Sr	ND	9.1 E–05	9.1 E–05	9.1 E–05
	^{234}U	1.1 E–05	ND	1.1 E–05	1.1 E–05
	^{238}U	ND	7.7 E–06	7.7 E–06	7.7 E–06

200 West Area					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N165	gross α	NA	NA	1.2 E–03	2.4 E–03
	gross β	NA	NA	1.6 E–02	4.6 E–02
	^{90}Sr	2.4 E–04	ND	2.4 E–04	2.4 E–04
	^{234}U	1.0 E–05	ND	1.0 E–05	1.0 E–05
	^{238}U	5.6 E–06	6.8 E–06	6.2 E–06	6.8 E–06
	$^{239/240}Pu$	1.6 E–04	6.9 E–05	1.2 E–04	1.6 E–04
	^{241}Am	2.1 E–05	2.5 E–05	2.3 E–05	2.5 E–05
N168	gross α	NA	NA	1.1 E–03	2.5 E–03
	gross β	NA	NA	2.0 E–02	6.8 E–02
	^{90}Sr	1.8 E–04	1.0 E–04	1.4 E–04	1.8 E–04
	^{234}U	9.2 E–06	ND	9.2 E–06	9.2 E–06
	^{235}U	ND	4.1 E–06	4.1 E–06	4.1 E–06
	^{238}U	ND	9.7 E–06	9.7 E–06	9.7 E–06
N200	gross α	NA	NA	1.1 E–03	2.9 E–03
	gross β	NA	NA	1.8 E–02	6.9 E–02
	^{90}Sr	ND	8.1 E–05	8.1 E–05	8.1 E–05
	^{234}U	9.3 E–06	7.4 E–06	8.3 E–06	9.3 E–06
	^{238}U	4.6 E–06	5.4 E–06	5.0 E–06	5.4 E–06
N304	gross α	NA	NA	1.1 E–03	3.2 E–03
	gross β	NA	NA	1.9 E–02	7.1 E–02
	^{90}Sr	ND	7.2 E–05	7.2 E–05	7.2 E–05
	^{234}U	1.2 E–05	1.5 E–05	1.4 E–05	1.5 E–05
	^{238}U	ND	5.6 E–06	5.6 E–06	5.6 E–06
N433	gross α	NA	NA	1.2 E–03	3.1 E–03
	gross β	NA	NA	1.9 E–02	6.0 E–02
	^{90}Sr	ND	8.2 E–05	8.2 E–05	8.2 E–05
	^{234}U	ND	1.2 E–05	1.2 E–05	1.2 E–05
	^{235}U	ND	4.1 E–06	4.1 E–06	4.1 E–06
	^{238}U	7.7 E–06	6.8 E–06	7.2 E–06	7.7 E–06
N441	gross α	NA	NA	1.0 E–03	2.7 E–03
	gross β	NA	NA	1.9 E–02	6.9 E–02
	^{234}U	7.9 E–06	9.9 E–06	8.9 E–06	9.9 E–06
	^{238}U	4.0 E–06	7.7 E–06	5.8 E–06	7.7 E–06
	$^{239/240}Pu$	8.7 E–06	ND	8.7 E–06	8.7 E–06
N442	gross α	NA	NA	1.2 E–03	2.9 E–03
	gross β	NA	NA	2.0 E–02	7.2 E–02
	^{234}U	6.4 E–06	9.1 E–06	7.7 E–06	9.1 E–06
	^{235}U	4.4 E–06	3.8 E–06	4.1 E–06	4.4 E–06
	^{238}U	4.0 E–06	7.7 E–06	5.9 E–06	7.7 E–06
N449	gross α	NA	NA	1.2 E–03	2.4 E–03
	gross β	NA	NA	1.8 E–02	5.5 E–02
	^{90}Sr	ND	9.0 E–05	9.0 E–05	9.0 E–05
	^{234}U	ND	1.1 E–05	1.1 E–05	1.1 E–05
	^{238}U	ND	7.0 E–06	7.0 E–06	7.0 E–06

200 West Area					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N456	gross α	NA	NA	1.1 E–03	2.9 E–03
	gross β	NA	NA	2.0 E–02	7.3 E–02
	^{234}U	ND	9.8 E–06	9.8 E–06	9.8 E–06
	^{235}U	4.8 E–06	ND	4.8 E–06	4.8 E–06
	^{238}U	ND	7.2 E–06	7.2 E–06	7.2 E–06
	$^{239/240}Pu$	1.7 E–05	ND	1.7 E–05	1.7 E–05
N457	gross α	NA	NA	1.1 E–03	3.0 E–03
	gross β	NA	NA	2.0 E–02	7.3 E–02
	^{234}U	4.3 E–06	ND	4.3 E–06	4.3 E–06
	^{238}U	ND	1.2 E–05	1.2 E–05	1.2 E–05
N554	gross α	NA	NA	1.2 E–03	3.4 E–03
	gross β	NA	NA	2.2 E–02	7.6 E–02
	^{90}Sr	7.7 E–05	9.1 E–05	8.4 E–05	9.1 E–05
	^{234}U	1.5 E–05	1.2 E–05	1.4 E–05	1.5 E–05
	^{238}U	ND	7.4 E–06	7.4 E–06	7.4 E–06
	$^{239/240}Pu$	3.4 E–06	1.3 E–05	8.4 E–06	1.3 E–05
N555	gross α	NA	NA	1.3 E–03	3.1 E–03
	gross β	NA	NA	2.1 E–02	5.4 E–02
	^{90}Sr	8.8 E–05	ND	8.8 E–05	8.8 E–05
	^{238}U	ND	6.2 E–06	6.2 E–06	6.2 E–06
N956	gross α	NA	NA	1.1 E–03	2.2 E–03
	gross β	NA	NA	1.5 E–02	3.8 E–02
	^{90}Sr	1.2 E–04	ND	1.2 E–04	1.2 E–04
	^{234}U	1.0 E–05	ND	1.0 E–05	1.0 E–05
	$^{239/240}Pu$	1.4 E–05	ND	1.4 E–05	1.4 E–05
N963	gross α	NA	NA	1.2 E–03	3.5 E–03
	gross β	NA	NA	2.0 E–02	7.6 E–02
	^{234}U	ND	7.1 E–06	7.1 E–06	7.1 E–06
	^{238}U	ND	7.8 E–06	7.8 E–06	7.8 E–06
	$^{239/240}Pu$	6.1 E–05	ND	6.1 E–05	6.1 E–05
N964	gross α	NA	NA	1.2 E–03	3.8 E–03
	gross β	NA	NA	1.9 E–02	6.5 E–02
	^{90}Sr	ND	1.1 E–04	1.1 E–04	1.1 E–04
	^{137}Cs	ND	5.0 E–04	5.0 E–04	5.0 E–04
	^{234}U	ND	1.0 E–05	1.0 E–05	1.0 E–05
	^{235}U	ND	6.1 E–06	6.1 E–06	6.1 E–06
	^{238}U	ND	6.3 E–06	6.3 E–06	6.3 E–06
N965	gross α	NA	NA	1.3 E–03	3.7 E–03
	gross β	NA	NA	1.9 E–02	6.0 E–02
	^{234}U	ND	1.2 E–05	1.2 E–05	1.2 E–05
N966	gross α	NA	NA	1.2 E–03	3.6 E–03
	gross β	NA	NA	2.0 E–02	6.6 E–02
	^{234}U	ND	1.6 E–05	1.6 E–05	1.6 E–05
	^{238}U	ND	8.9 E–06	8.9 E–06	8.9 E–06

200 West Area					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N974	gross α	NA	NA	1.4 E–03	4.7 E–03
	gross β	NA	NA	2.0 E–02	6.8 E–02
	^{90}Sr	ND	1.2 E–04	1.2 E–04	1.2 E–04
	^{234}U	1.1 E–05	1.0 E–05	1.0 E–05	1.1 E–05
	^{238}U	ND	6.8 E–06	6.8 E–06	6.8 E–06
N975	gross α	NA	NA	1.3 E–03	3.8 E–03
	gross β	NA	NA	2.0 E–02	6.7 E–02
	^{90}Sr	1.1 E–04	ND	1.1 E–04	1.1 E–04
	^{234}U	1.0 E–05	ND	1.0 E–05	1.0 E–05
	^{238}U	ND	8.1 E–06	8.1 E–06	8.1 E–06
	$^{239/240}$Pu	1.6 E–05	ND	1.6 E–05	1.6 E–05
N987	gross α	NA	NA	1.3 E–03	4.1 E–03
	gross β	NA	NA	2.1 E–02	7.4 E–02
	^{234}U	8.5 E–06	ND	8.5 E–06	8.5 E–06
	^{238}U	ND	5.0 E–06	5.0 E–06	5.0 E–06
N994	gross α	NA	NA	1.1 E–03	2.9 E–03
	gross β	NA	NA	1.8 E–02	5.7 E–02
	^{234}U	7.5 E–06	ND	7.5 E–06	7.5 E–06
	^{238}U	ND	1.2 E–05	1.2 E–05	1.2 E–05

Environmental Restoration Disposal Facility					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N482	gross α	NA	NA	8.2 E–04	1.9 E–03
	gross β	NA	NA	1.4 E–02	4.3 E–02
	^{234}U	1.1 E–05	1.7 E–05	1.4 E–05	1.7 E–05
	^{235}U	ND	4.4 E–06	4.4 E–06	4.4 E–06
	^{238}U	9.1 E–06	1.0 E–05	9.8 E–06	1.0 E–05
	$^{239/240}$Pu	ND	8.8 E–06	8.8 E–06	8.8 E–06
N517	gross α	NA	NA	9.0 E–04	2.0 E–03
	gross β	NA	NA	1.7 E–02	4.5 E–02
	^{234}U	ND	1.7 E–05	1.7 E–05	1.7 E–05
	^{238}U	1.1 E–05	1.8 E–05	1.5 E–05	1.8 E–05
	$^{239/240}$Pu	ND	4.6 E–06	4.6 E–06	4.6 E–06
N518	gross α	NA	NA	8.8 E–04	1.9 E–03
	gross β	NA	NA	1.6 E–02	4.3 E–02
	^{90}Sr	ND	8.2 E–05	8.2 E–05	8.2 E–05
	^{234}U	1.6 E–05	1.3 E–05	1.4 E–05	1.6 E–05
	^{238}U	ND	1.8 E–05	1.8 E–05	1.8 E–05
	$^{239/240}$Pu	ND	1.2 E–05	1.2 E–05	1.2 E–05

Environmental Restoration Disposal Facility

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N168	gross α	NA	NA	1.1 E–03	2.5 E–03
	gross β	NA	NA	2.0 E–02	6.8 E–02
	^{90}Sr	1.8 E–04	1.0 E–04	1.4 E–04	1.8 E–04
	^{234}U	9.2 E–06	ND	9.2 E–06	9.2 E–06
	^{235}U	ND	4.1 E–06	4.1 E–06	4.1 E–06
	^{238}U	ND	9.7 E–06	9.7 E–06	9.7 E–06
N963	gross α	NA	NA	1.2 E–03	3.5 E–03
	gross β	NA	NA	2.0 E–02	7.6 E–02
	^{234}U	ND	7.1 E–06	7.1 E–06	7.1 E–06
	^{238}U	ND	7.8 E–06	7.8 E–06	7.8 E–06
	$^{239/240}$Pu	6.1 E–05	ND	6.1 E–05	6.1 E–05

300 Area

300-FF-2 Field Remediation and 300 Area D4 Projects

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N130	gross α	NA	NA	1.2 E–03	2.9 E–03
	gross β	NA	NA	2.0 E–02	8.2 E–02
	^{90}Sr	1.0 E–04	ND	1.0 E–04	1.0 E–04
	^{234}U	ND	1.6 E–05	1.6 E–05	1.6 E–05
	^{238}U	7.0 E–06	1.9 E–05	1.3 E–05	1.9 E–05
N557	gross α	NA	NA	1.1 E–03	2.7 E–03
	gross β	NA	NA	2.1 E–02	6.4 E–02
	^{90}Sr	2.1 E–04	ND	2.1 E–04	2.1 E–04
	^{234}U	ND	2.2 E–05	2.0 E–05	2.2 E–05
	^{238}U	ND	1.4 E–05	1.4 E–05	1.4 E–05

400 Area

FFTF Air Samplers

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N911 (400 N)	gross α	NA	NA	8.6 E–04	4.2 E–03
	gross β	NA	NA	2.5 E–02	1.3 E–01
N912 (400 S)	gross α	NA	NA	9.3 E–04	3.5 E–03
	gross β	NA	NA	2.4 E–02	8.2 E–02
	^{3}H	ND	ND	1.3E+01	4.1E+01
	^{40}K	ND	5.5 E–03	5.5 E–03	5.5 E–03

600 Area

618-10 Burial Ground					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N548	gross α	NA	NA	1.3 E–03	3.7 E–03
	gross β	NA	NA	2.2 E–02	7.7 E–02
	^{90}Sr	1.4 E–04	ND	1.4 E–04	1.4 E–04
	^{234}U	ND	1.1 E–05	1.1 E–05	1.1 E–05
	^{238}U	4.3 E–05	1.7 E–05	3.0 E–05	4.3 E–05
	$^{239/240}$Pu	5.9 E–05	4.7 E–05	5.3 E–05	5.9 E–05
	^{241}Am	2.5 E–05	1.3 E–05	1.9 E–05	2.5 E–05
N549	gross α	NA	NA	1.0 E–03	2.9 E–03
	gross β	NA	NA	2.1 E–02	7.9 E–02
	^{234}U	ND	7.0 E–06	7.0 E–06	7.0 E–06
	^{238}U	ND	1.1 E–05	1.1 E–05	1.1 E–05
	$^{239/240}$Pu	8.9 E–06	5.2 E–06	7.0 E–06	8.9 E–06
	^{241}Am	ND	2.4 E–05	2.4 E–05	2.4 E–05
N579	gross α	NA	NA	1.4 E–03	9.1 E–03
	gross β	NA	NA	2.2 E–02	1.1 E–01
	^{234}U	ND	3.0 E–05	3.0 E–05	3.0 E–05
	^{238}U	ND	1.1 E–05	1.1 E–05	1.1 E–05
	$^{239/240}$Pu	ND	4.6 E–06	4.6 E–06	4.6 E–06
	^{241}Am	ND	5.3 E–06	5.3 E–06	5.3 E–06
N580	gross α	NA	NA	1.4 E–03	9.9 E–03
	gross β	NA	NA	2.1 E–02	6.6 E–02
	^{90}Sr	9.4 E–05	ND	9.4 E–05	9.4 E–05
	^{234}U	ND	6.7 E–06	6.7 E–06	6.7 E–06
	^{238}U	2.5 E–05	8.7 E–06	1.7 E–05	2.5 E–05
	$^{239/240}$Pu	ND	1.7 E–04	1.7 E–04	1.7 E–04
	^{241}Am	ND	4.1 E–05	4.1 E–05	4.1 E–05

Wye Barricade					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N981	gross α	NA	NA	1.3 E–03	3.4 E–03
	gross β	NA	NA	2.2 E–02	7.5 E–02
	^{234}U	6.6 E–06	8.1 E–06	7.4 E–06	8.1 E–06
	^{238}U	ND	9.8 E–06	9.8 E–06	9.8 E–06

Table 5–4. Hanford Site Ambient Air Sampling Results for 2013: Special.

Supplemental Air Data for RCC Projects			
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3	
		Average	Maximum
N902 (300 NE)	gross α	9.4 E–04	3.8 E–03
	gross β	2.4 E–02	8.8 E–02
	^{3}H	2.0 E+01	5.5 E+01
	^{234}U	4.1 E–05	4.2 E–05
	^{238}U	3.2 E–05	3.5 E–05
	^{241}Am	1.5 E–05	1.5 E–05
N903 (300 Area South Gate)	gross α	9.2 E–04	3.2 E–03
	gross β	2.4 E–02	8.6 E–02
	^{3}H	1.4 E+01	5.7 E+01
	^{234}U	4.5 E–05	5.2 E–05
	^{238}U	3.8 E–05	4.4 E–05
N904 (300 Trench)	gross α	8.2 E–04	3.0 E–03
	gross β	2.4 E–02	8.1 E–02
	^{3}H	1.3 E+01	6.7 E+01
	^{40}K	5.5 E–03	5.5 E–03
	^{234}U	4.1 E–05	4.5 E–05
	^{238}U	4.4 E–05	4.7 E–05
	^{241}Am	1.6 E–05	1.6 E–05
N905 (300 Water Intake)	gross α	9.6 E–04	3.1 E–03
	gross β	2.5 E–02	8.6 E–02
	^{3}H	1.4 E+01	5.2 E+01
	^{234}U	4.7 E–05	5.6 E–05
	^{238}U	3.7 E–05	3.8 E–05
N907 (Yakima Barricade)	gross α	9.2 E–04	3.9 E–03
	gross β	2.3 E–02	8.3 E–02
N918 (300 South West)	gross α	8.4 E–04	3.0 E–03
	gross β	2.4 E–02	7.7 E–02
	^{3}H	1.5 E+01	2.2 E+01
	^{234}U	5.1 E–05	6.2 E–05
	^{238}U	4.4 E–05	4.7 E–05
	^{241}Am	7.8 E–06	7.8 E–06
N921 (100-F Meteorological Tower)	gross α	1.0 E–03	3.9 E–03
	gross β	2.6 E–02	9.2 E–02

Table 5–5. FF-01-Required Far-Field Monitoring Ambient Air Results Used in Fugitive Dose Calculations for 2013. (2 sheets)

FF-01-Required Far-Field Monitoring Ambient Air Results					
EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N933 (Ringold Met. Tower)	gross α	NA	NA	9.6 E–04	3.0 E–03
	gross β	NA	NA	2.3 E–02	8.3 E–02
	^{3}H	ND	ND	7.8 E+00	1.1 E+01
N934 (West End of Fir Road)	gross α	NA	NA	9.0 E–04	3.7 E–03
	gross β	NA	NA	2.4 E–02	7.6 E–02
	^{3}H	ND	ND	1.2 E+01	3.6 E+01
	^{234}U	2.0 E–05	2.9 E–05	2.5 E–05	2.9 E–05
	^{238}U	1.6 E–05	5.2 E–05	3.4 E–05	5.2 E–05
N935 (Dogwood Met. Tower)	gross α	NA	NA	9.5 E–04	3.1 E–03
	gross β	NA	NA	2.3 E–02	8.4 E–02
	^{3}H	ND	ND	8.2 E+00	2.4 E+01
	^{234}U	3.6 E–05	7.2 E–05	5.4 E–05	7.2 E–05
	^{238}U	4.0 E–05	8.8 E–05	6.4 E–05	8.8 E–05
N936 (Byers Landing)	gross α	NA	NA	9.2 E–04	3.2 E–03
	gross β	NA	NA	2.4 E–02	9.2 E–02
	^{3}H	ND	ND	2.0 E+01	9.2 E+01
	^{234}U	3.8 E–05	3.5 E–05	3.6 E–05	3.8 E–05
	^{238}U	2.9 E–05	6.3 E–05	4.6 E–05	6.3 E–05
N937 (Battelle Complex)	gross α	NA	NA	9.0 E–04	4.6 E–03
	gross β	NA	NA	2.4 E–02	9.5 E–02
	^{3}H	ND	ND	2.0 E+01	3.3 E+01
	^{234}U	4.1 E–05	4.7 E–05	4.4 E–05	4.7 E–05
	^{238}U	4.1 E–05	6.9 E–05	5.5 E–05	6.9 E–05
N938 (Horn Rapids Substation)	gross α	NA	NA	8.9 E–04	3.8 E–03
	gross β	NA	NA	2.4 E–02	8.6 E–02
N939 (Prosser Barricade)	gross α	NA	NA	8.1 E–04	3.0 E–03
	gross β	NA	NA	2.4 E–02	8.0 E–02
	^{3}H	ND	ND	1.5E+01	5.8 E+01
N941 (Wahluke Slope)	gross α	NA	NA	9.3 E–04	3.2 E–03
	gross β	NA	NA	2.3 E–02	7.5 E–02
	^{3}H	ND	ND	2.0 E+01	9.4 E+01
	^{40}K	8.3 E–03	ND	8.3 E–03	8.3 E–03
N943 (Basin City School)	gross α	NA	NA	9.0 E–04	3.6 E–03
	gross β	NA	NA	2.4 E–02	9.5 E–02
	^{3}H	ND	ND	4.5 E+00	5.7 E+00
	^{40}K	5.7 E–03	ND	5.7 E–03	5.7 E–03
	^{234}U	5.3 E–05	4.7 E–05	5.0 E–05	5.3 E–05
	^{238}U	3.3 E–05	4.1 E–05	3.7 E–05	4.1 E–05

FF-01-Required Far-Field Monitoring Ambient Air Results

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N944 (Leslie Groves Richland)	gross α	NA	NA	9.2 E–04	3.6 E–03
	gross β	NA	NA	2.5 E–02	9.6 E–02
	^{3}H	ND	ND	1.2 E+01	3.5 E+01
	^{234}U	4.0 E–05	3.9 E–05	4.0 E–05	4.0 E–05
	^{238}U	3.4 E–05	3.8 E–05	3.6 E–05	3.8 E–05
N945 (Pasco)	gross β	NA	NA	2.6 E–02	9.9 E–02
	^{234}U	4.3 E–05	4.9 E–05	4.6 E–05	4.9 E–05
	^{238}U	4.5 E–05	4.4 E–05	4.4 E–05	4.5 E–05
N946 (Kennewick-Ely Street)	gross α	NA	NA	7.8 E–04	3.7 E–03
	gross β	NA	NA	2.2 E–02	6.8 E–02
	^{234}U	5.5 E–05	4.1 E–05	4.8 E–05	5.5 E–05
	^{238}U	6.5 E–05	2.5 E–05	4.5 E–05	6.5 E–05

Table 5–6. Far-Field Onsite and Other Perimeter, Community, and Distant Monitoring Ambient Air Results for 2013. (3 sheets)

Other Far-Field Monitoring Ambient Air Results

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
		Onsite			
N900 (100 Areas)	gross α	NA	NA	8.9 E–04	2.9 E–03
	grossβ	NA	NA	2.3 E–02	8.4 E–02
	^{3}H	ND	ND	1.8 E+01	7.5 E+01
N901 (200-W Southeast)	gross α	NA	NA	9.6 E–04	3.2 E–03
	gross β	NA	NA	2.4 E–02	9.1 E–02
	^{234}U	4.8 E–05	4.2 E–05	4.5 E–05	4.8 E–05
	^{238}U	6.3 E–05	3.3 E–05	4.8 E–05	6.3 E–05
N906 (WYE Barricade)	gross α	NA	NA	8.8 E–04	4.0 E–03
	gross β	NA	NA	2.4 E–02	8.3 E–02
	^{234}U	2.1 E–05	4.1 E–05	3.1 E–05	4.1 E–05
	^{238}U	2.5 E–05	2.3 E–05	2.4 E–05	2.5 E–05
N911 (400-N)	gross α	NA	NA	8.6 E–04	4.2 E–03
	gross β	NA	NA	2.5 E–02	1.3 E–01
N912 (400-S)	gross α	NA	NA	9.3 E–04	3.5 E–03
	gross β	NA	NA	2.4 E–02	8.2 E–02
	^{3}H	ND	ND	1.3 E+01	4.1 E+01
	^{40}K	ND	5.5 E–03	5.5 E–03	5.5 E–03
N920 (200-E Area)	gross α	NA	NA	9.9 E–04	4.7 E–03
	gross β	NA	NA	2.4 E–02	8.4 E–02
	^{3}H	ND	ND	2.1 E+01	8.1 E+01
	^{234}U	3.4 E–05	3.1 E–05	3.2 E–05	3.4 E–05
	^{238}U	3.4 E–05	2.9 E–05	3.2 E–05	3.4 E–05

Other Far-Field Monitoring Ambient Air Results

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
N922 (Hanford Townsite)	gross α	NA	NA	1.1 E–03	3.6 E–03
	gross β	NA	NA	2.5 E–02	8.2 E–02
N924 (B Pond)	gross α	NA	NA	1.0 E–03	3.8 E–03
	gross β	NA	NA	2.5 E–02	9.4 E–02
	^{234}U	4.9 E–05	3.8 E–05	4.3 E–05	4.9 E–05
	^{235}U	1.0 E–05	ND	1.0 E–05	1.0 E–05
	^{238}U	3.5 E–05	2.4 E–05	3.0 E–05	3.5 E–05
	^{238}Pu	7.4 E–06	ND	7.4 E–06	7.4 E–06
	$^{239/240}$Pu	1.6 E–04	ND	1.6 E–04	1.6 E–04
N926 (100-N 1325-N Crib)	gross α	NA	NA	1.1 E–03	6.4 E–03
	gross β	NA	NA	2.5 E–02	1.1 E–01
	^{3}H	ND	ND	5.9 E+00	1.2 E+01
N927 (100-D Area)	gross α	NA	NA	1.0 E–03	3.5 E–03
	gross β	NA	NA	2.4 E–02	7.7 E–02
N928 (Gable Mountain)	gross α	NA	NA	8.0 E–04	3.5 E–03
	gross β	NA	NA	2.3 E–02	7.7 E–02
	^{234}U	2.5 E–05	2.8 E–05	2.6 E–05	2.8 E–05
	^{238}U	3.9 E–05	2.6 E–05	3.3 E–05	3.9 E–05
N929 (South of 200-E)	gross α	NA	NA	1.0 E–03	3.8 E–03
	gross β	NA	NA	2.8 E–02	9.1 E–02
	^{234}U	2.7 E–05	2.5 E–05	2.6 E–05	2.7 E–05
	^{238}U	4.5 E–05	1.9 E–05	3.2 E–05	4.5 E–05
N930 (Army Loop Camp)	gross α	NA	NA	8.6 E–04	3.2 E–03
	gross β	NA	NA	2.3 E–02	8.3 E–02
	^{234}U	3.7 E–05	3.5 E–05	3.6 E–05	3.7 E–05
	^{238}U	3.8 E–05	3.3 E–05	3.5 E–05	3.8 E–05
N931 (200 Tel. Exchange)	gross α	NA	NA	1.0 E–03	3.8 E–03
	gross β	NA	NA	2.3 E–02	9.0 E–02
	^{3}H	ND	ND	3.5 E+01	1.1 E+02
	^{40}K	ND	9.4 E–03	9.4 E–03	9.4 E–03
	^{234}U	4.2 E–05	4.8 E–05	4.5 E–05	4.8 E–05
	^{238}U	3.3 E–05	3.7 E–05	3.5 E–05	3.7 E–05
N932 (Southwest of B/C Cribs)	gross α	NA	NA	1.0 E–03	3.9 E–03
	gross β	NA	NA	2.5 E–02	8.8 E–02
	^{234}U	4.4 E–05	3.8 E–05	4.1 E–05	4.4 E–05
	^{238}U	3.2 E–05	4.2 E–05	3.7 E–05	4.2 E–05
Perimeter					
N940 (Rattlesnake Springs)	gross α	NA	NA	8.7 E–04	3.4 E–03
	gross β	NA	NA	2.4 E–02	8.4 E–02
	^{40}K	ND	5.1 E–03	5.1 E–03	5.1 E–03
N942 (South of Vernita Bridge)	gross α	NA	NA	7.8 E–04	2.3 E–03
	gross β	NA	NA	1.9 E–02	6.7 E–02

Other Far-Field Monitoring Ambient Air Results

EDP code	Radionuclide or type of radioactivity	Concentration, pCi/m^3			
		1st half	2nd half	Average	Maximum
		Community			
N947 (Benton City)	gross β	NA	NA	2.2 E–02	7.7 E–02
N948 (Mattawa)	gross β	NA	NA	2.2 E–02	7.9 E–02
	^{40}K	ND	4.2 E–03	4.2 E–03	4.2 E–03
N949 (Othello)	gross β	NA	NA	2.3 E–02	8.3 E–02
	^{40}K	ND	4.3 E–03	4.3 E–03	4.3 E–03
	^{234}U	3.6 E–05	4.2 E–05	3.9 E–05	4.2 E–05
	^{238}U	4.7 E–05	3.9 E–05	4.3 E–05	4.7 E–05
		Distant			
N909 (Yakima)	gross α	NA	NA	8.9 E–04	3.6 E–03
	gross β	NA	NA	2.1 E–02	9.5 E–02
	^{3}H	ND	ND	9.5 E+00	1.7 E+01
	^{40}K	4.9 E–03	ND	4.9 E–03	4.9 E–03
	^{234}U	3.1 E–05	3.9 E–05	3.5 E–05	3.9 E–05
	^{238}U	3.5 E–05	3.3 E–05	3.4 E–05	3.5 E–05

5.5 QUALITY ASSURANCE

Air emission data reported in this document are partly the product of having applied QA principles identified in the QA plans cited below, which serve to assure compliance with the QA criteria of 40 CFR 61, Appendix B, Method 114. Applying these principles positively influences the collecting, handling, tracking, analyzing, verifying, validating, and reporting of radionuclide air emission samples.

EM–QA–01, *Effluent Management Quality Assurance Plan*

ENV–1–1.15, 2006, *Quality Assurance Project Plan for Radiological Air Emissions Monitoring*, Section 6.1

ETD–001, 2005, *Quality Assurance Project Plan for the Hanford Site Surface Environmental Surveillance and the Drinking Water Monitoring Project*

HNF–EP–0835, *Statement of Work for Services Provided by the Waste Sampling and Characterization Facility for the Effluent and Environmental Monitoring Program during Calendar Year 2013* [see Appendix B, "Method 114 Point-by-Point Comparison with Analytical Methods Used at the Waste Sampling and Characterization Facility"]

HNF–SD–CP–QAPP–017, *Waste Sampling and Characterization Facility Quality Assurance Program Plan*

MSC–23333, *Environmental Quality Assurance Program Plan*

TFC–PLN–71, *Quality Assurance Program Plan for Tank Farm Contractor Radioactive Air Emissions.*

The effluent monitoring quality assurance elements described in the above plans are compatible with one or more of the following documents:

- 10 CFR 830
- 40 CFR 61, Appendix B, "Method 114 – Test Methods for Measuring Radionuclide Emissions from Stationary Sources"
- ASME NQA–1
- DOE Order 414.1D
- DOE Order 458.1, *Radiation Protection of the Public and the Environment*
- DOE/EH–0173T
- EPA QA/R–5

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6.0 REFERENCES

10 CFR 830, "Nuclear Safety Management," Title 10, *Code of Federal Regulations*, Part 830, as amended.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities," Title 40, *Code of Federal Regulations*, Part 61, as amended.

40 CFR 70, "State Operating Permit Programs," Title 40, *Code of Federal Regulations*, Part 70, as amended.

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DOE/RL–2006–29, *Calculating Potential–to–Emit Radiological Releases and Doses*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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HNF–EP–0835, *Statement of Work for Services Provided by the Waste Sampling and Characterization Facility for the Effluent and Environmental Monitoring Program during Calendar Year 2013*, Mission Support Alliance, LLC, Richland, Washington.

HNF–SD–CP–QAPP–017, *Waste Sampling and Characterization Facility Quality Assurance Program Plan*, Mission Support Alliance, LLC, Richland, Washington.

MSC–23333, *Environmental Quality Assurance Program Plan*, Rev. 2, Mission Support Alliance, LLC, Richland, Washington.

PNNL–6415, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, Pacific Northwest National Laboratory, Richland, Washington.

PNL–8148, *Hanford Site Environmental Report for Calendar Year 1991*, Pacific Northwest Laboratory, Richland, Washington.

TFC–PLN–71, *Quality Assurance Program Plan for Tank Farm Contractor Radioactive Air Emissions*, Washington River Protection Solutions, LLC, Richland, Washington.

WAC 246–247, "Radiation Protection – Air Emissions," Washington Administrative Code, Olympia, Washington.

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APPENDIX A

DOSE MODELING AND METEOROLOGICAL DATA

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Figure A–1. Meteorological Stations in 2013.

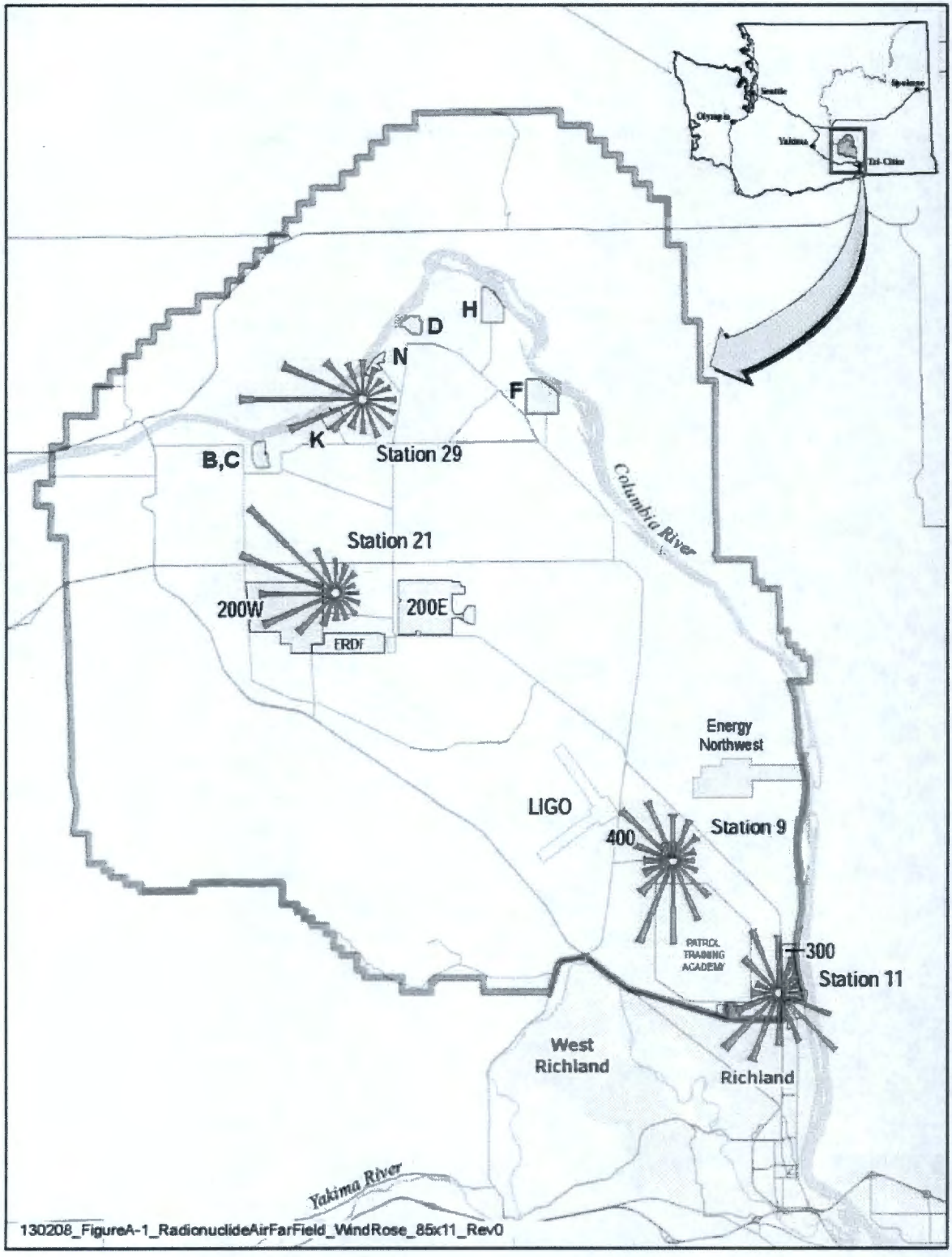


Figure A–2. 100–K Area Wind Rose and Histogram.

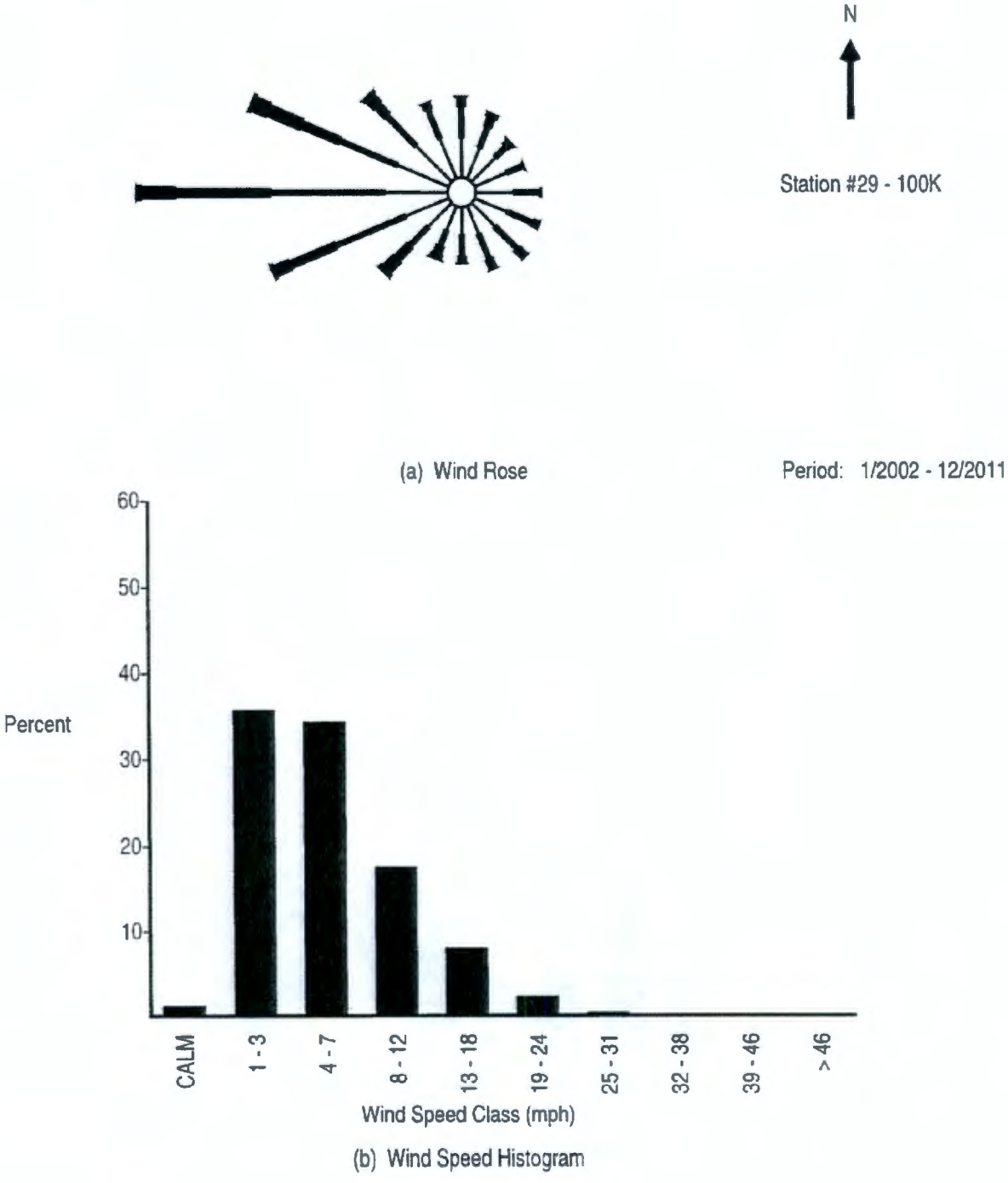
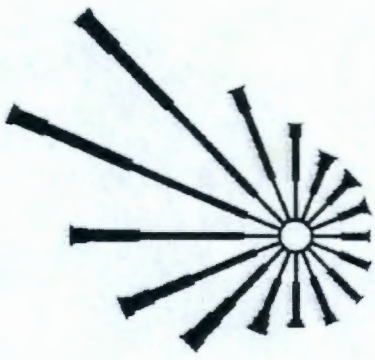


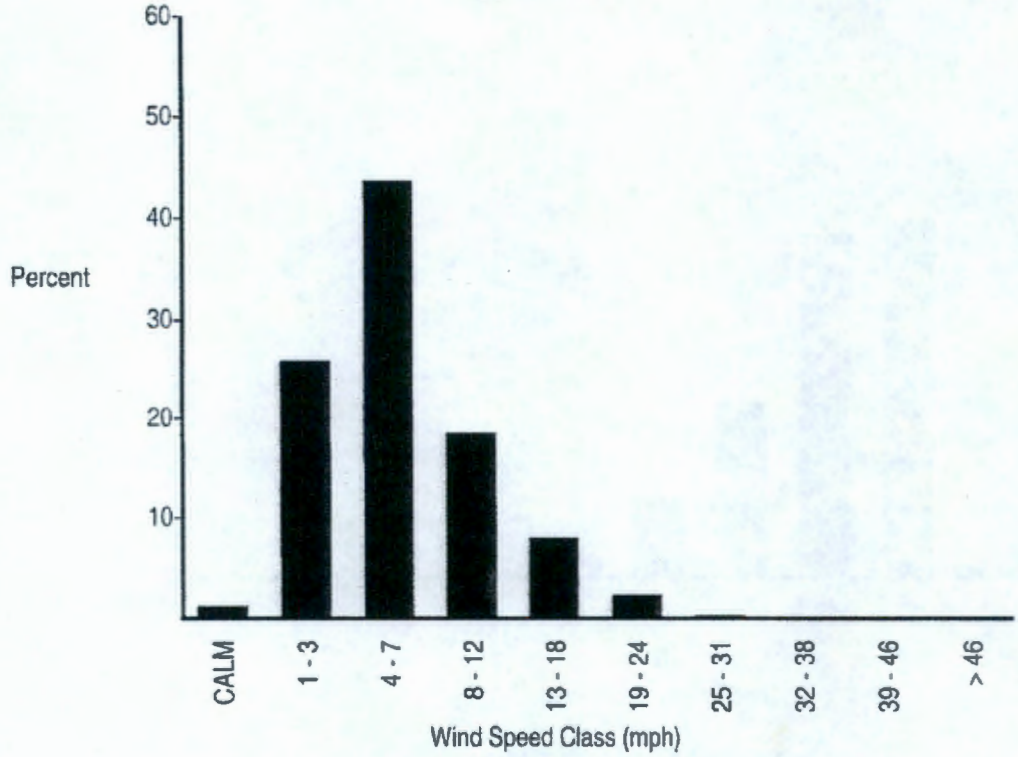
Figure A–3. 200 Area Wind Rose and Histogram.



Station #21 - HMS

(a) Wind Rose

Period: 1/2013 - 12/2013



(b) Wind Speed Histogram

Figure A–4. 300 Area Wind Rose and Histogram.

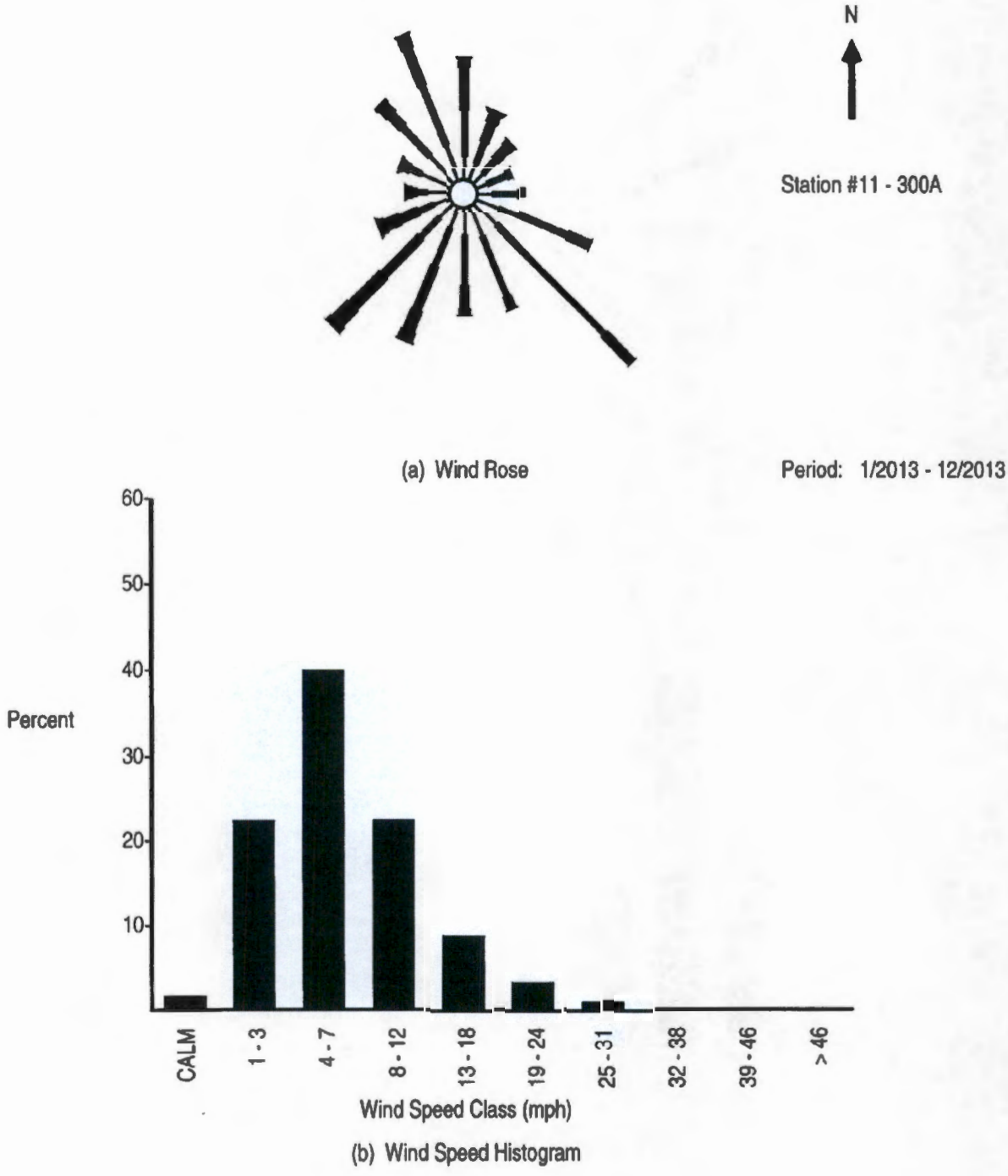


Figure A–5. 400 Area Wind Rose and Histogram.

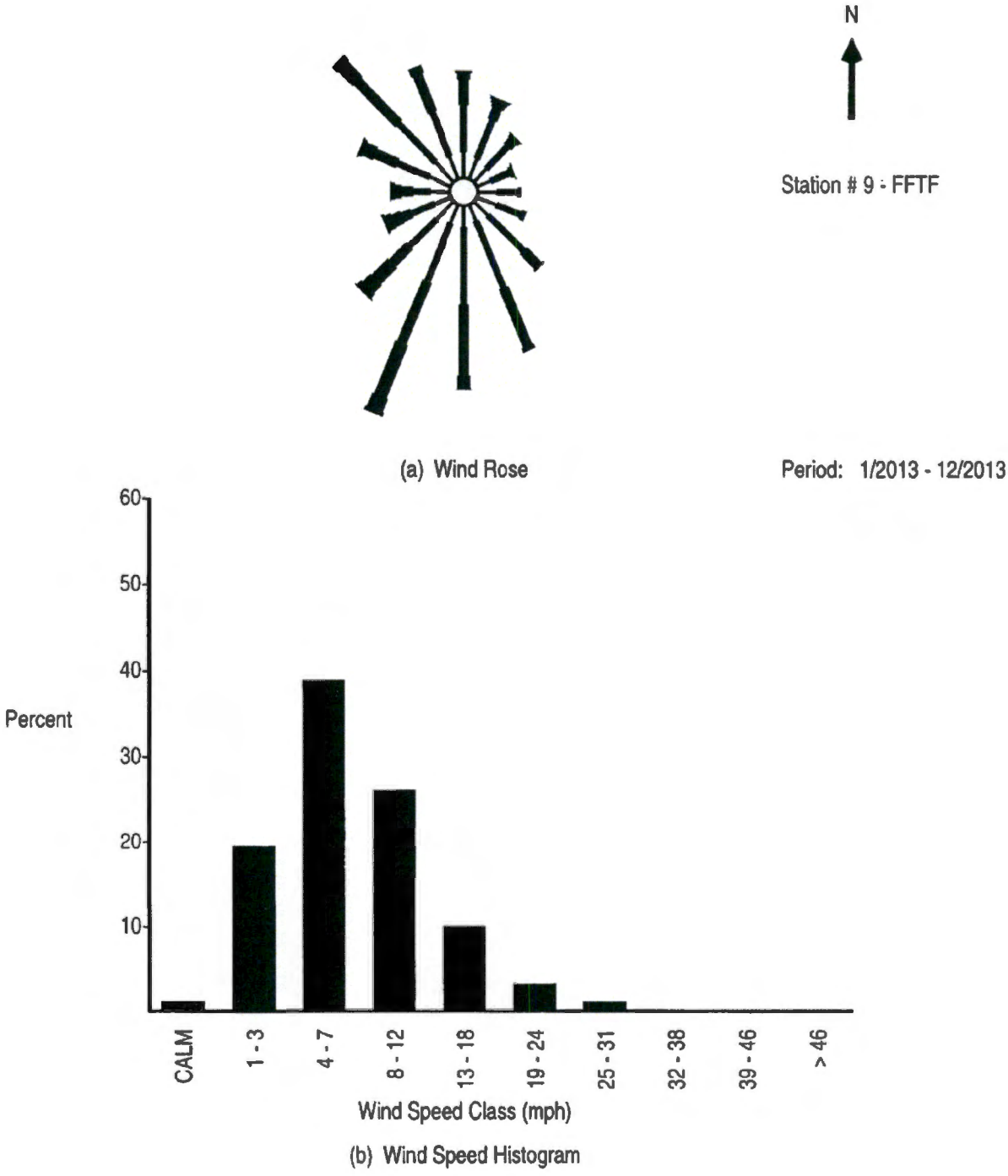


Table A–1. Annual Average Joint Frequency during 2002-2011 (as percent of time) of Wind Speed, Stability Class, and Direction for the 100–K Area (Station 29) at the 10–Meter Level. (3 sheets)

Wind Speed (m/sec)	Stability Class	Wind direction toward:																
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	Total
0.89	A	0.20	0.13	0.10	0.10	0.09	0.08	0.09	0.07	0.06	0.04	0.07	0.10	0.15	0.21	0.21	0.20	1.90
	B	0.12	0.09	0.07	0.06	0.07	0.06	0.05	0.05	0.03	0.03	0.04	0.07	0.10	0.14	0.17	0.13	1.28
	C	0.17	0.12	0.10	0.09	0.09	0.09	0.06	0.05	0.03	0.03	0.05	0.07	0.13	0.17	0.19	0.19	1.63
	D	0.70	0.56	0.49	0.50	0.52	0.55	0.47	0.40	0.35	0.29	0.32	0.45	0.65	0.71	0.77	0.70	8.43
	E	0.50	0.45	0.54	0.59	0.64	0.53	0.52	0.51	0.49	0.46	0.54	0.69	0.87	0.72	0.66	0.56	9.27
	F	0.48	0.45	0.52	0.53	0.62	0.56	0.51	0.47	0.49	0.49	0.70	0.92	1.25	0.96	0.72	0.54	10.21
	G	0.16	0.16	0.18	0.17	0.20	0.19	0.20	0.19	0.17	0.18	0.28	0.48	0.65	0.44	0.27	0.21	4.13
	Total	**2.33**	**1.96**	**2.00**	**2.04**	**2.23**	**2.06**	**1.90**	**1.74**	**1.62**	**1.52**	**2.00**	**2.78**	**3.80**	**3.35**	**2.99**	**2.53**	**36.85**
2.65	A	0.52	0.34	0.16	0.12	0.19	0.21	0.21	0.12	0.08	0.08	0.13	0.27	0.47	0.47	0.57	0.51	4.45
	B	0.26	0.17	0.08	0.06	0.08	0.09	0.10	0.06	0.06	0.04	0.07	0.15	0.22	0.23	0.26	0.26	2.19
	C	0.18	0.17	0.07	0.06	0.13	0.13	0.11	0.08	0.06	0.03	0.06	0.14	0.22	0.20	0.19	0.16	1.99
	D	0.49	0.36	0.26	0.30	0.38	0.47	0.55	0.41	0.27	0.16	0.24	0.60	1.11	0.83	0.64	0.50	7.57
	E	0.22	0.16	0.17	0.27	0.44	0.39	0.51	0.51	0.44	0.39	0.52	1.40	2.48	1.19	0.49	0.25	9.83
	F	0.09	0.07	0.10	0.17	0.25	0.25	0.28	0.32	0.27	0.20	0.39	1.31	1.70	0.61	0.23	0.12	6.36
	G	0.01	0.01	0.02	0.05	0.08	0.07	0.08	0.09	0.08	0.05	0.12	0.61	0.58	0.15	0.04	0.01	2.05
	Total	**1.77**	**1.28**	**0.86**	**1.03**	**1.55**	**1.61**	**1.84**	**1.59**	**1.26**	**0.95**	**1.53**	**4.48**	**6.78**	**3.68**	**2.42**	**1.81**	**34.44**
4.7	A	0.15	0.22	0.10	0.03	0.05	0.09	0.08	0.04	0.02	0.06	0.13	0.29	0.49	0.44	0.24	0.09	2.52
	B	0.04	0.08	0.02	0.01	0.02	0.04	0.04	0.02	0.02	0.03	0.06	0.11	0.18	0.14	0.08	0.03	0.92
	C	0.05	0.05	0.02	0.02	0.02	0.06	0.05	0.03	0.02	0.03	0.05	0.10	0.16	0.10	0.06	0.03	0.85
	D	0.15	0.12	0.07	0.04	0.09	0.16	0.21	0.16	0.10	0.16	0.31	0.56	1.06	0.57	0.21	0.14	4.11
	E	0.08	0.08	0.05	0.04	0.04	0.10	0.26	0.24	0.17	0.21	0.44	1.25	2.98	1.06	0.19	0.07	7.26
	F	0.03	0.02	0.01	0.01	0.01	0.03	0.09	0.13	0.05	0.02	0.07	0.50	0.68	0.14	0.04	0.02	1.85
	G	0	0	0	0	0	0	0.01	0.03	0.01	0	0.01	0.08	0.09	0	0	0	0.23
	Total	**0.50**	**0.57**	**0.27**	**0.15**	**0.23**	**0.48**	**0.74**	**0.65**	**0.39**	**0.51**	**1.07**	**2.89**	**5.64**	**2.45**	**0.82**	**0.38**	**17.74**

Table A–1. Annual Average Joint Frequency during 2002-2011 (as percent of time) of Wind Speed, Stability Class, and Direction for the 100–K Area (Station 29) at the 10–Meter Level. (3 sheets)

Wind Speed (m/sec)	Stability Class	Wind direction toward:																
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	Total
7.15	A	0.04	0.10	0.04	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.16	0.19	0.31	0.46	0.25	0.03	1.67
	B	0.01	0.03	0.02	0.01	0	0.01	0.01	0	0	0.01	0.05	0.06	0.07	0.10	0.06	0	0.44
	C	0.01	0.02	0.01	0	0	0.01	0.01	0.01	0	0.01	0.05	0.07	0.08	0.12	0.06	0.01	0.47
	D	0.06	0.08	0.04	0.01	0.01	0.01	0.02	0.04	0.03	0.12	0.31	0.28	0.51	0.67	0.19	0.02	2.40
	E	0.03	0.05	0.03	0.01	0	0.01	0.04	0.04	0.07	0.14	0.30	0.34	0.95	0.74	0.08	0.01	2.84
	F	0.01	0.01	0	0	0	0	0	0	0	0	0.01	0.02	0.08	0.03	0.01	0	0.17
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0.16**	**0.29**	**0.14**	**0.04**	**0.02**	**0.06**	**0.09**	**0.10**	**0.11**	**0.30**	**0.88**	**0.96**	**2.00**	**2.12**	**0.65**	**0.07**	**7.99**
9.8	A	0.01	0.01	0	0	0	0	0	0	0	0	0.05	0.05	0.08	0.30	0.12	0	0.62
	B	0	0	0	0	0	0	0	0	0	0	0.03	0.02	0.02	0.07	0.02	0	0.16
	C	0	0	0	0	0	0	0	0	0	0	0.03	0.02	0.02	0.06	0.02	0	0.15
	D	0.01	0.01	0.02	0	0	0	0	0	0	0.05	0.12	0.08	0.12	0.28	0.05	0.01	0.75
	E	0	0.03	0.05	0	0	0	0	0.01	0.01	0.05	0.08	0.05	0.12	0.23	0.02	0	0.65
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0.02**	**0.05**	**0.07**	**0**	**0**	**0**	**0**	**0.01**	**0.01**	**0.10**	**0.31**	**0.22**	**0.36**	**0.94**	**0.23**	**0.01**	**2.33**
12.7	A	0	0	0	0	0	0	0	0	0	0.01	0	0	0.01	0.09	0.02	0	0.13
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0	0	0.02
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0.01
	D	0	0	0	0	0	0	0	0	0	0.01	0.02	0.03	0.01	0.08	0.01	0	0.16
	E	0	0.01	0.01	0	0	0	0	0	0	0.01	0.01	0.02	0.01	0.04	0.01	0	0.12
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0.01**	**0.01**	**0**	**0**	**0**	**0**	**0**	**0**	**0.03**	**0.03**	**0.05**	**0.03**	**0.24**	**0.04**	**0**	**0.44**

Table A–1. Annual Average Joint Frequency during 2002-2011 (as percent of time) of Wind Speed, Stability Class, and Direction for the 100–K Area (Station 29) at the 10–Meter Level. (3 sheets)

Wind Speed (m/sec)	Stability Class	Wind direction toward:																
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	Total
15.6	A	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0.01
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0.01
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.01**	**0.01**	**0**	**0**	**0.02**
19	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total	A	0.92	0.80	0.40	0.26	0.34	0.40	0.39	0.24	0.17	0.21	0.54	0.90	1.52	1.97	1.41	0.83	11.30
	B	0.43	0.37	0.19	0.14	0.17	0.20	0.20	0.13	0.11	0.11	0.25	0.41	0.59	0.70	0.59	0.42	5.01
	C	0.41	0.36	0.20	0.17	0.24	0.29	0.23	0.17	0.11	0.10	0.24	0.40	0.61	0.66	0.52	0.39	5.10
	D	1.41	1.13	0.88	0.85	1.00	1.19	1.25	1.01	0.75	0.79	1.32	2.00	3.46	3.15	1.87	1.37	23.43
	E	0.83	0.78	0.85	0.91	1.12	1.03	1.33	1.31	1.18	1.26	1.89	3.75	7.41	3.98	1.45	0.89	29.97
	F	0.61	0.55	0.63	0.71	0.88	0.84	0.88	0.92	0.81	0.71	1.17	2.75	3.71	1.74	1.00	0.68	18.59
	G	0.17	0.17	0.20	0.22	0.28	0.26	0.29	0.31	0.26	0.23	0.41	1.17	1.32	0.59	0.31	0.22	6.41
	Total	**4.78**	**4.16**	**3.35**	**3.26**	**4.03**	**4.21**	**4.57**	**4.09**	**3.39**	**3.41**	**5.82**	**11.38**	**18.62**	**12.79**	**7.15**	**4.80**	**99.81**

Note: The data recoverability of Station 29 at 100-K was less than 20% for CY 2013 due to failure of the support structure. Station 29 average annual meteorological data for the years 2002 through 2011 were substituted for CY 2013 modeling.

Table A–2. Annual Average Joint Frequency during 2013 (as percent of time) of Wind Speed, Stability Class, and Direction for the 200 Area Meteorology Station (Station 21) at the 10–Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	Total
0.89	A	0.30	0.31	0.32	0.33	0.22	0.29	0.28	0.23	0.22	0.20	0.14	0.16	0.20	0.21	0.21	0.37	3.99
	B	0.05	0.10	0.07	0.14	0.10	0.03	0.09	0.04	0.06	0.04	0.04	0.04	0.05	0.11	0.11	0.08	1.15
	C	0.09	0.09	0.06	0.10	0.10	0.05	0.05	0.03	0.03	0.05	0.02	0.03	0.07	0.06	0.10	0.16	1.09
	D	0.52	0.37	0.64	0.45	0.47	0.41	0.41	0.22	0.27	0.17	0.20	0.13	0.23	0.40	0.50	0.56	5.95
	E	0.41	0.23	0.20	0.28	0.36	0.39	0.39	0.39	0.43	0.43	0.44	0.40	0.50	0.39	0.42	0.36	6.02
	F	0.42	0.26	0.14	0.19	0.19	0.35	0.28	0.28	0.34	0.54	0.35	0.43	0.61	0.46	0.51	0.51	5.86
	G	0.19	0.16	0.14	0.10	0.12	0.14	0.15	0.28	0.21	0.15	0.20	0.21	0.19	0.28	0.24	0.26	3.02
	Total	**1.98**	**1.52**	**1.57**	**1.59**	**1.56**	**1.66**	**1.65**	**1.47**	**1.56**	**1.58**	**1.39**	**1.40**	**1.85**	**1.91**	**2.09**	**2.30**	**27.08**
2.65	A	0.66	0.62	0.67	0.48	0.42	0.61	0.73	0.55	0.46	0.44	0.33	0.23	0.24	0.38	0.71	0.87	8.40
	B	0.29	0.13	0.16	0.12	0.16	0.12	0.12	0.07	0.05	0.08	0.06	0.08	0.07	0.12	0.34	0.34	2.31
	C	0.20	0.13	0.06	0.16	0.11	0.12	0.17	0.01	0.05	0.06	0.03	0.08	0.06	0.12	0.34	0.26	1.96
	D	0.37	0.27	0.15	0.20	0.29	0.29	0.32	0.20	0.11	0.07	0.13	0.17	0.18	0.65	1.03	0.76	5.19
	E	0.27	0.09	0.12	0.12	0.25	0.19	0.29	0.42	0.37	0.29	0.37	0.61	1.12	1.33	1.13	0.53	7.50
	F	0.21	0.09	0.09	0.13	0.10	0.17	0.36	0.53	0.45	0.47	0.92	1.59	2.48	2.49	1.76	0.51	12.35
	G	0.05	0.01	0.03	0.05	0.03	0.04	0.12	0.27	0.34	0.39	0.56	0.74	1.11	1.26	0.77	0.26	6.03
	Total	**2.05**	**1.34**	**1.28**	**1.26**	**1.36**	**1.54**	**2.11**	**2.05**	**1.83**	**1.80**	**2.40**	**3.50**	**5.26**	**6.35**	**6.08**	**3.53**	**43.74**
4.7	A	0.31	0.19	0.13	0.10	0.05	0.03	0.02	0.03	0.04	0.07	0.26	0.30	0.12	0.30	0.78	0.42	3.15
	B	0.04	0.04	0	0.01	0.01	0.01	0.01	0.01	0	0.02	0.06	0.08	0.02	0.06	0.27	0.12	0.76
	C	0.03	0.02	0	0.01	0	0.01	0	0.02	0.02	0.02	0.02	0.06	0.05	0.10	0.18	0.05	0.59
	D	0.13	0.09	0.04	0.02	0.01	0	0	0.04	0.03	0.05	0.12	0.21	0.18	0.67	0.68	0.18	2.45
	E	0.10	0.07	0.03	0.03	0.01	0	0.01	0.14	0.05	0.09	0.56	0.89	1.36	2.06	1.19	0.21	6.80
	F	0.04	0.01	0	0	0	0.02	0.01	0.13	0.07	0.11	0.13	0.45	0.78	1.02	0.63	0.09	3.49
	G	0	0	0	0.02	0.01	0	0	0.02	0	0.04	0.05	0.25	0.16	0.39	0.22	0.03	1.19
	Total	**0.65**	**0.42**	**0.20**	**0.19**	**0.09**	**0.07**	**0.05**	**0.39**	**0.21**	**0.40**	**1.20**	**2.24**	**2.67**	**4.60**	**3.95**	**1.10**	**18.43**

Table A–2. Annual Average Joint Frequency during 2013 (as percent of time) of Wind Speed, Stability Class, and Direction for the 200 Area Meteorology Station (Station 21) at the 10–Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	Total
7.15	A	0.05	0.11	0.10	0.08	0.01	0	0	0	0.01	0.04	0.16	0.16	0.13	0.19	0.49	0.04	1.57
	B	0.02	0.01	0	0	0	0	0	0	0	0.01	0.02	0.01	0.02	0.06	0.04	0	0.19
	C	0	0	0	0.01	0	0	0	0	0	0.01	0.11	0.08	0.03	0.04	0.10	0	0.38
	D	0.01	0.07	0.07	0.02	0	0	0	0	0.02	0.12	0.34	0.31	0.13	0.32	0.45	0.02	1.88
	E	0.01	0.02	0.01	0	0	0	0	0.04	0.13	0.19	0.62	0.48	0.31	0.99	0.87	0.01	3.68
	F	0	0	0	0	0	0	0	0.02	0.01	0.02	0.02	0.06	0.08	0.03	0.03	0	0.27
	G	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0.01
	Total	**0.09**	**0.21**	**0.18**	**0.11**	**0.01**	**0**	**0**	**0.06**	**0.17**	**0.40**	**1.27**	**1.10**	**0.70**	**1.63**	**1.98**	**0.07**	**7.98**
9.8	A	0	0	0.03	0.03	0	0	0	0	0	0.01	0.14	0.11	0.10	0.06	0.17	0.03	0.68
	B	0	0	0	0	0	0	0	0	0	0	0.10	0.06	0	0	0.01	0	0.17
	C	0.01	0	0	0	0	0	0	0	0	0	0.07	0.06	0.01	0.02	0.03	0	0.20
	D	0	0.03	0.02	0.01	0	0	0	0	0	0.09	0.16	0.11	0.03	0.05	0.10	0	0.60
	E	0	0.04	0.02	0	0	0	0	0	0.03	0.13	0.14	0.06	0.01	0.18	0.08	0	0.69
	F	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0.01
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0.01**	**0.07**	**0.07**	**0.04**	**0**	**0**	**0**	**0**	**0.03**	**0.24**	**0.61**	**0.40**	**0.15**	**0.31**	**0.39**	**0.03**	**2.35**
12.7	A	0	0	0.01	0	0	0	0	0	0	0	0.03	0.05	0.01	0.01	0	0	0.11
	B	0	0	0	0	0	0	0	0	0	0	0.02	0.02	0	0	0	0	0.04
	C	0	0	0.01	0	0	0	0	0	0	0	0.03	0.01	0	0	0	0	0.05
	D	0	0.02	0.07	0	0	0	0	0	0	0	0.01	0.04	0	0	0	0	0.14
	E	0	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0.02**	**0.10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.09**	**0.12**	**0.01**	**0.01**	**0**	**0**	**0.35**

Table A–2. Annual Average Joint Frequency during 2013 (as percent of time) of Wind Speed, Stability Class, and Direction for the 200 Area Meteorology Station (Station 21) at the 10–Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	Total
15.6	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0.02
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.02**
19	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total	A	1.32	1.23	1.26	1.02	0.70	0.93	1.03	0.81	0.73	0.76	1.06	1.01	0.80	1.15	2.36	1.73	17.90
	B	0.40	0.28	0.23	0.27	0.27	0.16	0.22	0.12	0.11	0.15	0.30	0.29	0.16	0.35	0.77	0.54	4.62
	C	0.33	0.24	0.13	0.28	0.21	0.18	0.22	0.06	0.10	0.14	0.28	0.32	0.22	0.34	0.75	0.47	4.27
	D	1.03	0.85	0.99	0.70	0.77	0.70	0.73	0.46	0.43	0.50	0.96	0.99	0.75	2.09	2.76	1.52	16.23
	E	0.79	0.45	0.39	0.43	0.62	0.58	0.69	0.99	1.01	1.13	2.13	2.44	3.30	4.95	3.69	1.11	24.70
	F	0.67	0.36	0.23	0.32	0.29	0.54	0.65	0.96	0.87	1.15	1.42	2.53	3.95	4.00	2.93	1.11	21.98
	G	0.24	0.17	0.17	0.17	0.16	0.18	0.27	0.57	0.55	0.59	0.81	1.20	1.46	1.93	1.23	0.55	10.25
	Total	**4.78**	**3.58**	**3.40**	**3.19**	**3.02**	**3.27**	**3.81**	**3.97**	**3.80**	**4.42**	**6.96**	**8.78**	**10.64**	**14.81**	**14.49**	**7.03**	**99.95**

Table A–3. Annual Average Joint Frequency during 2013 (as percent of time) of Wind Speed, Stability Class, and Direction for the 200 East Area (Station 6) at the 10–Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	Total
0.89	A	0.41	0.36	0.38	0.41	0.47	0.46	0.31	0.19	0.08	0.08	0.07	0.07	0.10	0.08	0.25	0.38	4.10
	B	0.11	0.12	0.14	0.10	0.16	0.12	0.08	0.09	0.04	0.01	0.02	0.04	0.03	0.07	0.11	0.07	1.31
	C	0.10	0.16	0.12	0.11	0.07	0.11	0.08	0.02	0.04	0.01	0.03	0.03	0.04	0.09	0.10	0.10	1.21
	D	0.56	0.54	0.53	0.38	0.59	0.51	0.50	0.27	0.16	0.10	0.09	0.13	0.20	0.37	0.54	0.50	5.97
	E	0.20	0.23	0.18	0.29	0.41	0.35	0.41	0.39	0.36	0.32	0.33	0.32	0.40	0.63	0.49	0.40	5.71
	F	0.20	0.22	0.24	0.28	0.30	0.37	0.58	0.46	0.54	0.42	0.53	0.50	0.58	0.52	0.53	0.27	6.54
	G	0.09	0.14	0.11	0.11	0.09	0.36	0.40	0.37	0.28	0.30	0.24	0.25	0.30	0.42	0.24	0.08	3.78
	Total	**1.67**	**1.77**	**1.70**	**1.68**	**2.09**	**2.28**	**2.36**	**1.79**	**1.50**	**1.24**	**1.31**	**1.34**	**1.65**	**2.18**	**2.26**	**1.80**	**28.62**
2.65	A	0.79	0.67	0.39	0.41	0.53	0.77	1.08	0.47	0.25	0.17	0.24	0.27	0.26	0.24	0.44	0.69	7.67
	B	0.29	0.20	0.13	0.17	0.13	0.23	0.15	0.09	0.05	0.03	0.01	0.04	0.07	0.13	0.18	0.28	2.18
	C	0.11	0.11	0.07	0.08	0.19	0.15	0.17	0.06	0.02	0.03	0.01	0.05	0.07	0.11	0.26	0.16	1.65
	D	0.36	0.20	0.11	0.10	0.28	0.31	0.54	0.28	0.14	0.09	0.08	0.08	0.13	0.44	0.88	0.66	4.68
	E	0.13	0.06	0.06	0.12	0.20	0.26	0.48	0.55	0.38	0.20	0.26	0.48	0.92	1.16	0.87	0.31	6.44
	F	0.09	0.03	0.07	0.01	0.05	0.23	0.52	0.85	0.55	0.34	0.40	0.76	1.46	2.22	1.04	0.28	8.90
	G	0.02	0	0	0.02	0.02	0.06	0.21	0.49	0.23	0.22	0.20	0.36	0.84	1.20	0.38	0.07	4.32
	Total	**1.79**	**1.27**	**0.83**	**0.91**	**1.40**	**2.01**	**3.15**	**2.79**	**1.62**	**1.08**	**1.20**	**2.04**	**3.75**	**5.50**	**4.05**	**2.45**	**35.84**
4.7	A	0.41	0.28	0.20	0.05	0.17	0.17	0.21	0.26	0.11	0.07	0.13	0.29	0.29	0.23	0.53	0.27	3.67
	B	0.07	0.05	0	0.01	0.04	0.06	0.07	0.04	0	0.03	0.03	0.05	0.05	0.07	0.06	0.11	0.74
	C	0.06	0.01	0	0	0.01	0.07	0.05	0.03	0.01	0.03	0.03	0.06	0.09	0.10	0.12	0.06	0.73
	D	0.13	0.13	0	0	0.02	0.07	0.19	0.10	0.09	0.04	0.12	0.16	0.16	0.59	0.55	0.26	2.61
	E	0.11	0.07	0.02	0.03	0	0.02	0.10	0.21	0.21	0.12	0.25	0.42	1.04	2.62	0.95	0.21	6.38
	F	0.05	0.05	0	0	0.02	0.03	0.15	0.27	0.18	0.02	0.09	0.39	1.22	2.88	0.53	0.04	5.92
	G	0	0	0	0.02	0.01	0	0.03	0.07	0.07	0	0.03	0.13	0.57	1.06	0.13	0	2.12
	Total	**0.83**	**0.59**	**0.22**	**0.11**	**0.27**	**0.42**	**0.80**	**0.98**	**0.67**	**0.31**	**0.68**	**1.50**	**3.42**	**7.55**	**2.87**	**0.95**	**22.17**

Table A–3. Annual Average Joint Frequency during 2013 (as percent of time) of Wind Speed, Stability Class, and Direction for the 200 East Area (Station 6) at the 10–Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	Total
7.15	A	0.07	0.09	0.07	0.02	0	0.01	0.03	0.01	0	0.01	0.06	0.21	0.12	0.21	0.47	0.04	1.42
	B	0.03	0.01	0	0	0	0	0	0.01	0	0.01	0.03	0.01	0.02	0.03	0.05	0.01	0.21
	C	0	0	0	0.01	0	0	0.03	0.01	0	0	0.05	0.03	0.02	0.05	0.13	0	0.33
	D	0.03	0.09	0.02	0.01	0	0	0	0.02	0.02	0.12	0.16	0.26	0.22	0.38	0.45	0.03	1.81
	E	0.09	0.04	0.04	0	0	0	0.03	0.04	0.11	0.11	0.25	0.60	0.65	2.02	0.72	0.02	4.72
	F	0.01	0	0	0	0	0	0	0.01	0.01	0.04	0.01	0.03	0.16	0.31	0.02	0.01	0.61
	G	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0.01
	Total	**0.23**	**0.23**	**0.13**	**0.04**	**0**	**0.01**	**0.09**	**0.10**	**0.14**	**0.29**	**0.56**	**1.14**	**1.20**	**3.00**	**1.84**	**0.11**	**9.11**
9.8	A	0	0	0.06	0.01	0	0	0	0	0	0	0.06	0.08	0.19	0.12	0.21	0.02	0.75
	B	0	0	0	0	0	0	0	0	0	0	0.03	0.08	0.03	0	0.01	0	0.15
	C	0.01	0	0	0	0	0	0	0	0	0	0.05	0.04	0.06	0.01	0.05	0	0.22
	D	0	0.08	0.02	0	0	0	0	0.01	0	0.04	0.14	0.19	0.10	0.15	0.16	0.02	0.91
	E	0	0.07	0.01	0	0	0	0	0.02	0.03	0.11	0.22	0.21	0.09	0.37	0.21	0	1.34
	F	0	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0.02
	G	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0.01
	Total	**0.01**	**0.15**	**0.09**	**0.01**	**0**	**0**	**0**	**0.03**	**0.03**	**0.18**	**0.50**	**0.60**	**0.47**	**0.65**	**0.64**	**0.04**	**3.40**
12.7	A	0	0	0	0	0	0	0	0	0	0	0.04	0.10	0.03	0.03	0.07	0	0.27
	B	0	0	0	0	0	0	0	0	0	0	0.01	0.05	0	0.01	0	0	0.07
	C	0	0.01	0	0	0	0	0	0	0	0	0.02	0.04	0.01	0.01	0.02	0	0.11
	D	0	0.10	0.01	0	0	0	0	0	0	0.01	0.04	0.06	0.03	0.02	0.03	0	0.30
	E	0	0	0	0	0	0	0	0	0	0.03	0.04	0.02	0	0.01	0.02	0	0.12
	F	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0.01
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0.11**	**0.01**	**0**	**0**	**0**	**0**	**0**	**0**	**0.05**	**0.15**	**0.27**	**0.07**	**0.08**	**0.14**	**0**	**0.88**

Table A–3. Annual Average Joint Frequency during 2013 (as percent of time) of Wind Speed, Stability Class, and Direction for the 200 East Area (Station 6) at the 10–Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	Total
15.6	A	0	0	0	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0.02
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0	0.02
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.03**	**0.01**	**0**	**0**	**0**	**0.04**
19	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total	A	1.68	1.40	1.10	0.90	1.17	1.41	1.63	0.93	0.44	0.33	0.60	1.04	0.99	0.91	1.97	1.40	17.90
	B	0.50	0.38	0.27	0.28	0.33	0.41	0.30	0.23	0.09	0.08	0.13	0.27	0.20	0.31	0.41	0.47	4.66
	C	0.28	0.29	0.19	0.20	0.27	0.33	0.33	0.12	0.07	0.07	0.19	0.25	0.29	0.37	0.68	0.32	4.25
	D	1.08	1.14	0.69	0.49	0.89	0.89	1.23	0.68	0.41	0.40	0.63	0.89	0.85	1.95	2.61	1.47	16.30
	E	0.53	0.47	0.31	0.44	0.61	0.63	1.02	1.21	1.09	0.89	1.35	2.05	3.10	6.81	3.26	0.94	24.71
	F	0.35	0.30	0.31	0.29	0.37	0.63	1.25	1.59	1.28	0.85	1.03	1.68	3.42	5.93	2.12	0.60	22.00
	G	0.11	0.14	0.11	0.15	0.12	0.42	0.64	0.93	0.58	0.53	0.47	0.74	1.72	2.68	0.75	0.15	10.24
	Total	**4.53**	**4.12**	**2.98**	**2.75**	**3.76**	**4.72**	**6.40**	**5.69**	**3.96**	**3.15**	**4.40**	**6.92**	**10.57**	**18.96**	**11.80**	**5.35**	**100.06**

Table A–4. Annual Average Joint Frequency during 2013 (as percent of time) of Wind Speed, Stability Class, and Direction for the 300 Area (Station 11) at the 10–Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																Total
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	
0.89	A	0.08	0.15	0.11	0.09	0.11	0.15	0.10	0.16	0.07	0.07	0.04	0.05	0.05	0.07	0.06	0.05	1.41
	B	0.01	0.06	0.03	0.01	0.01	0.05	0.01	0	0.03	0.03	0.04	0.02	0	0	0	0.01	0.31
	C	0.01	0.02	0.03	0.07	0.06	0.12	0.09	0.07	0.02	0.02	0.02	0	0	0.01	0	0.02	0.56
	D	0.31	0.27	0.19	0.18	0.18	0.41	0.46	0.36	0.30	0.20	0.15	0.22	0.21	0.30	0.41	0.45	4.60
	E	0.22	0.14	0.16	0.15	0.16	0.38	0.57	0.54	0.62	0.45	0.38	0.41	0.36	0.58	0.59	0.49	6.20
	F	0.46	0.23	0.26	0.15	0.20	0.29	0.50	0.57	0.53	0.46	0.46	0.36	0.54	0.73	0.81	0.69	7.24
	G	0.18	0.11	0.06	0.08	0.18	0.14	0.24	0.37	0.20	0.25	0.26	0.18	0.28	0.35	0.38	0.46	3.72
	Total	**1.27**	**0.98**	**0.84**	**0.73**	**0.90**	**1.54**	**1.97**	**2.07**	**1.77**	**1.48**	**1.35**	**1.24**	**1.44**	**2.04**	**2.25**	**2.17**	**24.04**
2.65	A	0.40	0.39	0.40	0.49	0.78	0.95	1.19	0.51	0.50	0.59	0.42	0.16	0.14	0.08	0.07	0.15	7.22
	B	0.08	0.06	0.17	0.34	0.29	0.36	0.32	0.10	0.05	0.18	0.05	0.05	0.01	0	0.02	0.07	2.15
	C	0.08	0.10	0.19	0.20	0.13	0.21	0.34	0.15	0.11	0.11	0.14	0.02	0.01	0.01	0.01	0.03	1.84
	D	0.46	0.27	0.14	0.12	0.15	0.45	1.12	0.43	0.32	0.36	0.28	0.17	0.08	0.11	0.31	0.74	5.51
	E	0.58	0.23	0.02	0.04	0.11	0.87	1.89	0.88	0.82	0.64	0.37	0.39	0.23	0.29	0.73	1.02	9.11
	F	0.72	0.24	0.04	0.04	0.06	1.18	2.69	1.09	0.79	0.38	0.26	0.15	0.09	0.19	0.81	1.16	9.89
	G	0.32	0.04	0	0	0	0.31	1.50	0.64	0.34	0.13	0.08	0.04	0.03	0.07	0.33	0.55	4.38
	Total	**2.64**	**1.33**	**0.96**	**1.23**	**1.52**	**4.33**	**9.05**	**3.80**	**2.93**	**2.39**	**1.60**	**0.98**	**0.59**	**0.75**	**2.28**	**3.72**	**40.10**
4.7	A	0.26	0.34	0.61	0.17	0.23	0.65	0.74	0.27	0.27	0.81	0.94	0.23	0.06	0.05	0.08	0.15	5.86
	B	0.07	0.16	0.19	0.12	0.15	0.17	0.14	0.02	0.06	0.16	0.17	0.05	0	0	0.01	0.04	1.51
	C	0.06	0.08	0.10	0.03	0.04	0.03	0.08	0.09	0.04	0.11	0.14	0.03	0.01	0	0.02	0.06	0.92
	D	0.33	0.16	0.02	0	0.01	0.05	0.24	0.11	0.27	0.33	0.42	0.25	0.08	0.13	0.25	0.63	3.28
	E	0.68	0.15	0.03	0	0.01	0.14	0.26	0.20	0.44	0.71	0.80	0.35	0.10	0.13	0.45	0.75	5.20
	F	0.65	0.14	0.01	0.01	0.02	0.29	0.45	0.07	0.26	0.56	0.47	0.27	0.06	0.07	0.13	0.42	3.88
	G	0.44	0.11	0	0	0	0.16	0.41	0.04	0.06	0.18	0.18	0.02	0	0	0.04	0.21	1.85
	Total	**2.49**	**1.14**	**0.96**	**0.33**	**0.46**	**1.49**	**2.32**	**0.80**	**1.40**	**2.86**	**3.12**	**1.20**	**0.31**	**0.38**	**0.98**	**2.26**	**22.50**

Table A–4. Annual Average Joint Frequency during 2013 (as percent of time) of Wind Speed, Stability Class, and Direction for the 300 Area (Station 11) at the 10–Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																Total
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	
7.15	A	0.19	0.34	0.27	0.01	0	0	0.03	0.02	0.05	0.25	0.51	0.34	0.14	0.06	0.08	0.08	2.37
	B	0.03	0.05	0	0	0	0.01	0	0	0.03	0.07	0.12	0.03	0	0	0	0.02	0.36
	C	0.01	0.02	0.01	0	0	0	0.01	0	0.04	0.12	0.22	0.05	0.02	0.05	0.01	0.04	0.60
	D	0.10	0.07	0.03	0	0	0	0.01	0.01	0.07	0.24	0.49	0.20	0.10	0.02	0.22	0.21	1.77
	E	0.12	0.05	0	0	0	0.01	0.03	0.07	0.16	0.49	0.84	0.20	0.07	0.03	0.32	0.35	2.74
	F	0.03	0	0	0.01	0	0	0	0.03	0.03	0.12	0.29	0.05	0	0	0.04	0.11	0.71
	G	0.02	0.01	0.05	0.03	0	0	0	0	0	0.02	0.12	0.03	0	0	0	0.01	0.29
	Total	**0.50**	**0.54**	**0.36**	**0.05**	**0**	**0.02**	**0.08**	**0.13**	**0.38**	**1.31**	**2.59**	**0.90**	**0.33**	**0.16**	**0.67**	**0.82**	**8.84**
9.8	A	0.01	0	0.03	0	0	0	0	0	0.01	0.08	0.20	0.12	0.08	0.11	0.12	0.02	0.78
	B	0.01	0	0	0	0	0	0	0	0	0.01	0.07	0.07	0.02	0	0.01	0	0.19
	C	0	0	0	0	0	0	0	0	0	0.03	0.11	0.02	0.01	0.01	0.02	0	0.20
	D	0.06	0.03	0.02	0	0	0	0	0	0.02	0.14	0.31	0.08	0.06	0.01	0.11	0.06	0.90
	E	0.05	0.05	0.01	0	0	0	0	0.01	0.03	0.27	0.51	0.05	0.01	0	0.04	0.03	1.06
	F	0	0	0	0	0	0	0	0	0.01	0.01	0.08	0	0	0	0	0	0.10
	G	0	0	0	0	0	0	0	0	0	0.01	0.02	0	0	0	0	0	0.03
	Total	**0.13**	**0.08**	**0.06**	**0**	**0**	**0**	**0**	**0.01**	**0.07**	**0.55**	**1.30**	**0.34**	**0.18**	**0.13**	**0.30**	**0.11**	**3.26**
12.7	A	0.01	0.03	0	0	0	0	0	0	0	0	0.12	0.07	0.01	0.01	0	0	0.25
	B	0	0	0	0	0	0	0	0	0	0.01	0.05	0.01	0.01	0	0	0	0.08
	C	0.01	0.01	0	0	0	0	0	0	0	0.01	0.03	0.03	0.01	0	0	0	0.10
	D	0.01	0.07	0	0	0	0	0	0	0	0.03	0.05	0.01	0.01	0	0	0	0.18
	E	0.02	0.03	0	0	0	0	0	0	0	0.10	0.21	0.03	0	0	0	0	0.39
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0.05**	**0.14**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.15**	**0.46**	**0.15**	**0.04**	**0.01**	**0**	**0**	**1.00**

Table A–4. Annual Average Joint Frequency during 2013 (as percent of time) of Wind Speed, Stability Class, and Direction for the 300 Area (Station 11) at the 10–Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																Total
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	
15.6	A	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0	0	0.03
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0.05	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0	0	0.07
	E	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0.01
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	***0***	***0.05***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0.01***	***0.05***	***0***	***0***	***0***	***0***	***0.11***
19	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0.01
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.01**	**0**	**0**	**0**	**0**	**0**	**0.01**
Total	A	0.95	1.25	1.42	0.76	1.12	1.75	2.06	0.96	0.90	1.80	2.23	1.00	0.48	0.38	0.41	0.45	17.92
	B	0.20	0.33	0.39	0.47	0.45	0.59	0.47	0.12	0.17	0.46	0.50	0.23	0.04	0[a]	0.04	0.14	4.60
	C	0.17	0.23	0.33	0.30	0.23	0.36	0.52	0.31	0.21	0.40	0.66	0.15	0.06	0.08	0.06	0.15	4.22
	D	1.27	0.92	0.40	0.30	0.34	0.91	1.83	0.91	0.98	1.30	1.72	0.94	0.54	0.57	1.30	2.09	16.32
	E	1.67	0.65	0.22	0.19	0.28	1.40	2.75	1.70	2.07	2.66	3.11	1.44	0.77	1.03	2.13	2.64	24.71
	F	1.86	0.61	0.31	0.21	0.28	1.76	3.64	1.76	1.62	1.53	1.56	0.83	0.69	0.99	1.79	2.38	21.82
	G	0.96	0.27	0.11	0.11	0.18	0.61	2.15	1.05	0.60	0.59	0.66	0.27	0.31	0.42	0.75	1.23	10.27
	Total	**7.08**	**4.26**	**3.18**	**2.34**	**2.88**	**7.38**	**13.42**	**6.81**	**6.55**	**8.74**	**10.44**	**4.86**	**2.89**	**3.47**	**6.48**	**9.08**	**99.86**

[a]A highly unusual circumstance of no B Stability Classes in the ESE direction resulted from CY 2013 meteorological data at Station 11. This caused an error in CAP88-PC operation. The smallest increment (0.01 and 0.0001) was added to the CAP88-formated meteorological file to allow code operation and to minimally impact CAP88-PC output.

Table A–5. Annual Average Joint Frequency during 2013 (as percent of time) of Wind Speed, Stability Class, and Direction for the 400 Area (Station 9) at the 10–Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	Total
0.89	A	0.15	0.18	0.15	0.09	0.15	0.14	0.16	0.14	0.13	0.14	0.15	0.05	0.04	0.13	0.06	0.14	2.00
	B	0.03	0.02	0.05	0.05	0.05	0.05	0.03	0.05	0.02	0	0.05	0.06	0.04	0.04	0.02	0.04	0.60
	C	0.11	0.04	0.06	0.04	0.06	0.10	0.04	0.03	0.02	0.06	0.05	0.04	0.03	0.02	0.02	0.08	0.80
	D	0.38	0.38	0.30	0.31	0.38	0.44	0.34	0.28	0.19	0.19	0.27	0.15	0.11	0.26	0.37	0.33	4.68
	E	0.30	0.16	0.13	0.15	0.26	0.28	0.30	0.34	0.44	0.36	0.31	0.24	0.39	0.38	0.49	0.27	4.80
	F	0.39	0.28	0.29	0.18	0.19	0.20	0.28	0.21	0.37	0.29	0.40	0.37	0.43	0.39	0.52	0.41	5.20
	G	0.13	0.20	0.10	0.08	0.08	0.12	0.08	0.06	0.21	0.21	0.31	0.19	0.16	0.23	0.17	0.14	2.47
	Total	**1.49**	**1.26**	**1.08**	**0.90**	**1.17**	**1.33**	**1.23**	**1.11**	**1.38**	**1.25**	**1.54**	**1.10**	**1.20**	**1.45**	**1.65**	**1.41**	**20.55**
2.65	A	0.53	0.50	0.41	0.49	0.57	0.45	0.76	0.79	0.98	0.74	0.33	0.21	0.11	0.15	0.15	0.29	7.46
	B	0.15	0.16	0.15	0.20	0.11	0.24	0.30	0.12	0.22	0.14	0.05	0.04	0.03	0.01	0.06	0.09	2.07
	C	0.16	0.07	0.16	0.07	0.13	0.11	0.20	0.16	0.13	0.17	0.07	0.05	0.03	0	0	0.10	1.61
	D	0.41	0.25	0.18	0.17	0.17	0.23	0.52	0.71	0.43	0.26	0.17	0.14	0.10	0.32	0.52	0.64	5.22
	E	0.34	0.33	0.33	0.11	0.11	0.22	0.55	0.95	1.01	0.92	0.54	0.56	0.30	0.72	0.99	0.45	8.43
	F	0.72	0.70	0.32	0.10	0.14	0.20	0.48	0.99	1.19	0.97	0.64	0.33	0.29	0.58	0.96	0.77	9.38
	G	0.39	0.38	0.22	0.06	0.01	0.07	0.12	0.53	0.58	0.50	0.46	0.14	0.16	0.28	0.42	0.41	4.73
	Total	**2.70**	**2.39**	**1.77**	**1.20**	**1.24**	**1.52**	**2.93**	**4.25**	**4.54**	**3.70**	**2.26**	**1.47**	**1.02**	**2.06**	**3.10**	**2.75**	**38.90**
4.7	A	0.44	0.24	0.17	0.05	0.13	0.16	0.18	0.27	0.90	1.05	0.28	0.18	0.11	0.18	0.17	0.34	4.85
	B	0.18	0.09	0.06	0.03	0.04	0.07	0.07	0.08	0.19	0.12	0.06	0.04	0.01	0.03	0.03	0.15	1.25
	C	0.07	0.04	0.06	0.05	0.02	0.04	0.04	0.03	0.16	0.15	0.04	0.04	0.03	0.04	0.03	0.14	0.98
	D	0.23	0.05	0.05	0.03	0.02	0.02	0.08	0.39	0.55	0.39	0.17	0.09	0.08	0.17	0.63	0.42	3.37
	E	0.18	0.06	0.02	0.02	0.01	0.01	0.27	0.90	0.85	0.97	0.49	0.19	0.37	0.76	1.27	0.40	6.77
	F	0.22	0.10	0.06	0	0	0	0.37	1.38	1.08	0.93	0.20	0.06	0.10	0.21	0.90	0.52	6.13
	G	0.15	0.14	0.04	0	0	0	0.25	0.64	0.32	0.28	0.17	0.02	0.01	0.02	0.38	0.30	2.72
	Total	**1.47**	**0.72**	**0.46**	**0.18**	**0.22**	**0.30**	**1.26**	**3.69**	**4.05**	**3.89**	**1.41**	**0.62**	**0.71**	**1.41**	**3.41**	**2.27**	**26.07**

Table A–5. Annual Average Joint Frequency during 2013 (as percent of time) of Wind Speed, Stability Class, and Direction for the 400 Area (Station 9) at the 10–Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	Total
7.15	A	0.24	0.14	0.10	0.01	0	0	0.03	0.02	0.19	0.77	0.20	0.30	0.10	0.11	0.12	0.19	2.52
	B	0.02	0.02	0	0	0	0	0.03	0.02	0.03	0.19	0.08	0.02	0	0	0.02	0.02	0.45
	C	0.01	0	0.01	0	0	0	0.01	0.01	0.04	0.19	0.11	0.01	0.01	0.01	0.02	0	0.43
	D	0.07	0.05	0.02	0	0	0	0.01	0.03	0.09	0.50	0.35	0.09	0.13	0.14	0.32	0.12	1.92
	E	0.05	0	0.03	0	0	0.01	0.04	0.06	0.27	1.08	0.53	0.10	0.09	0.37	0.65	0.11	3.39
	F	0	0	0	0	0	0	0.01	0.07	0.13	0.46	0.08	0.05	0.05	0.05	0.07	0.02	0.99
	G	0	0	0.03	0.03	0	0	0	0.03	0.09	0.11	0	0	0	0	0.01	0	0.30
	Total	**0.39**	**0.21**	**0.19**	**0.04**	**0**	**0.01**	**0.13**	**0.24**	**0.84**	**3.30**	**1.35**	**0.57**	**0.38**	**0.68**	**1.21**	**0.46**	**10**
9.8	A	0.01	0.01	0.06	0.05	0	0	0	0	0.01	0.10	0.09	0.11	0.10	0.06	0.12	0	0.72
	B	0	0	0	0	0	0	0	0	0	0.04	0.03	0.03	0.01	0.01	0.01	0	0.13
	C	0.01	0	0	0	0	0	0	0	0	0.05	0.05	0.02	0.05	0.04	0.03	0	0.25
	D	0.04	0.04	0.01	0	0	0	0	0	0.01	0.15	0.19	0.10	0.07	0.05	0.16	0.01	0.83
	E	0.06	0.12	0	0	0	0	0	0	0.01	0.44	0.26	0.11	0.01	0.04	0.10	0	1.15
	F	0	0	0	0	0	0	0	0	0	0.03	0	0	0.02	0	0	0	0.05
	G	0	0	0	0	0	0	0	0	0	0.02	0.01	0	0	0	0	0	0.03
	Total	**0.12**	**0.17**	**0.07**	**0.05**	**0**	**0**	**0**	**0**	**0.03**	**0.83**	**0.63**	**0.37**	**0.26**	**0.20**	**0.42**	**0.01**	**3.16**
12.7	A	0	0.03	0	0	0	0	0	0	0	0	0.14	0.05	0.05	0.06	0	0	0.33
	B	0	0	0	0	0	0	0	0	0	0.02	0.05	0.06	0.01	0	0	0	0.14
	C	0	0.01	0	0	0	0	0	0	0	0.03	0.04	0.01	0	0	0	0	0.09
	D	0	0.11	0	0	0	0	0	0	0	0.07	0.07	0.02	0	0	0	0	0.27
	E	0	0	0	0	0	0	0	0	0	0.12	0.08	0.01	0	0	0	0	0.21
	F	0	0	0	0	0	0	0	0	0	0.01	0	0	0.01	0	0	0	0.02
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0.15**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.25**	**0.38**	**0.15**	**0.07**	**0.06**	**0**	**0**	**1.06**

Table A–5. Annual Average Joint Frequency during 2013 (as percent of time) of Wind Speed, Stability Class, and Direction for the 400 Area (Station 9) at the 10–Meter Level. (3 sheets)

Wind speed (m/sec)	Stability class	Wind direction toward:																
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	Total
15.6	A	0	0	0	0	0	0	0	0	0	0	0.02	0.01	0	0	0	0	0.03
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0.01
	D	0	0.02	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0.03
	E	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0.01
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0.02**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.05**	**0.01**	**0**	**0**	**0**	**0**	**0.08**
19	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0	0	0	0.02
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.01**	**0.01**	**0**	**0**	**0**	**0**	**0**	**0.02**
Total	A	1.37	1.10	0.89	0.69	0.85	0.75	1.13	1.22	2.21	2.80	1.21	0.91	0.51	0.69	0.62	0.96	17.91
	B	0.38	0.29	0.26	0.28	0.20	0.36	0.43	0.27	0.46	0.51	0.32	0.25	0.10	0.09	0.14	0.30	4.64
	C	0.36	0.16	0.29	0.16	0.21	0.25	0.29	0.23	0.35	0.65	0.37	0.17	0.15	0.11	0.10	0.32	4.17
	D	1.13	0.90	0.56	0.51	0.57	0.69	0.95	1.41	1.27	1.57	1.24	0.59	0.49	0.94	2.00	1.52	16.34
	E	0.93	0.67	0.51	0.28	0.38	0.52	1.16	2.25	2.58	3.89	2.22	1.21	1.16	2.27	3.50	1.23	24.76
	F	1.33	1.08	0.67	0.28	0.33	0.40	1.14	2.65	2.77	2.69	1.32	0.81	0.90	1.23	2.45	1.72	21.77
	G	0.67	0.72	0.39	0.17	0.09	0.19	0.45	1.26	1.20	1.12	0.95	0.35	0.33	0.53	0.98	0.85	10.25
	Total	**6.17**	**4.92**	**3.57**	**2.37**	**2.63**	**3.16**	**5.55**	**9.29**	**10.84**	**13.23**	**7.63**	**4.29**	**3.64**	**5.86**	**9.79**	**6.90**	**99.84**

Table A–6. Radionuclide Data on Clearance Type, Particle Size, Scavenging Coefficient, and Deposition Velocity Used for CAP88–PC Dose Calculations at the Hanford Site, 2013.

Radionuclide	Clearance type	Particle size (µm)	Scavenging coefficient (per second)	Deposition velocity (m/s)
^{3}H (vapor)	V	0	0	0
^{3}H (elemental)	G	0	0	0
^{14}C	M	1	1.60 E–06	1.80 E–03
^{22}Na	M	1	1.60 E–06	1.80 E–03
^{60}Co	M	1	1.60 E–06	1.80 E–03
^{85}Kr	G	0	0	0
^{90}Y	M	1	1.60 E–06	1.80 E–03
^{90}Sr	M	1	1.60 E–06	1.80 E–03
^{99}Tc	M	1	1.60 E–06	1.80 E–03
^{106}Ru	M	1	1.60 E–06	1.80 E–03
^{125}Sb	M	1	1.60 E–06	1.80 E–03
^{129}I	F	1	1.60 E–06	3.50 E–02
^{134}Cs	F	1	1.60 E–06	1.80 E–03
^{137}Cs	F	1	1.60 E–06	1.80 E–03
^{152}Eu	M	1	1.60 E–06	1.80 E–03
^{154}Eu	M	1	1.60 E–06	1.80 E–03
^{155}Eu	M	1	1.60 E–06	1.80 E–03
^{153}Gd	M	1	1.60 E–06	1.80 E–03
^{220}Rn	G	0	0	0
^{226}Ra	M	1	1.60 E–06	1.80 E–03
^{227}Ac	M	1	1.60 E–06	1.80 E–03
^{231}Pa	M	1	1.60 E–06	1.80 E–03
^{232}U	M	1	1.60 E–06	1.80 E–03
^{233}U	M	1	1.60 E–06	1.80 E–03
^{234}U	M	1	1.60 E–06	1.80 E–03
^{235}U	M	1	1.60 E–06	1.80 E–03
^{238}U	M	1	1.60 E–06	1.80 E–03
^{237}Np	M	1	1.60 E–06	1.80 E–03
^{238}Pu	M	1	1.60 E–06	1.80 E–03
^{239}Pu	M	1	1.60 E–06	1.80 E–03
^{241}Pu	M	1	1.60 E–06	1.80 E–03
^{241}Am	M	1	1.60 E–06	1.80 E–03
^{243}Am	M	1	1.60 E–06	1.80 E–03
^{243}Cm	M	1	1.60 E–06	1.80 E–03
^{244}Cm	M	1	1.60 E–06	1.80 E–03

Table A–7. Radionuclide Data on Decay Constant and Transfer Coefficient Used for CAP88–PC Dose Calculations at the Hanford Site, 2013.

Radionuclide	Decay constant (per day)			Transfer coefficient	
	Radioactive	Surface	Water	Milk[1]	Meat[2]
^{3}H (vapor)	1.54 E–04	5.48 E–05	0	0	0
^{3}H (elemental)	1.54 E–04	5.48 E–05	0	0	0
^{14}C	3.31 E–07	5.48 E–05	0	0	0
^{22}Na	7.29 E–04	5.48 E–05	0	4.00 E–02	8.00 E–02
^{60}Co	3.60 E–04	5.48 E–05	0	2.00 E–03	3.00 E–02
^{85}Kr	1.77 E–04	5.48 E–05	0	0	0
^{90}Y	2.60 E–01	5.48 E–05	0	6.00 E–05	2.00 E–03
^{90}Sr	6.52 E–05	5.48 E–05	0	2.00 E–03	1.00 E–02
^{99}Tc	8.91 E–09	5.48 E–05	0	1.00 E–03	1.00 E–04
^{106}Ru	1.88 E–03	5.48 E–05	0	2.00 E–05	2.00 E–03
^{125}Sb	6.85 E–04	5.48 E–05	0	1.00 E–04	1.00 E–03
^{129}I	1.21 E–10	5.48 E–05	0	1.00 E–02	4.00 E–02
^{134}Cs	9.20 E–04	5.48 E–05	0	1.00 E–02	5.00 E–02
^{137}Cs	6.32 E–05	5.48 E–05	0	1.00 E–02	5.00 E–02
^{152}Eu	1.42 E–04	5.48 E–05	0	6.00 E–05	2.00 E–03
^{154}Eu	2.21 E–04	5.48 E–05	0	6.00 E–05	2.00 E–03
^{155}Eu	4.00 E–04	5.48 E–05	0	6.00 E–05	2.00 E–03
^{153}Gd	2.86 E–03	5.48 E–05	0	6.00 E–05	2.00 E–03
^{220}Rn	1.08 E+03	5.48 E–05	0	0	0
^{226}Ra	1.19 E–06	5.48 E–05	0	1.00 E–03	2.00 E–03
^{227}Ac	8.71 E–05	5.48 E–05	0	2.00 E–06	2.00 E–05
^{231}Pa	5.79 E–08	5.48 E–05	0	5.00 E–06	5.00 E–06
^{232}U	2.64 E–05	5.48 E–05	0	4.00 E–04	8.00 E–04
^{233}U	1.20 E–08	5.48 E–05	0	4.00 E–04	8.00 E–04
^{234}U	7.76 E–09	5.48 E–05	0	4.00 E–04	8.00 E–04
^{235}U	2.70 E–12	5.48 E–05	0	4.00 E–04	8.00 E–04
^{238}U	4.25 E–13	5.48 E–05	0	4.00 E–04	8.00 E–04
^{237}Np	8.87 E–10	5.48 E–05	0	1.00 E–05	1.00 E–03
^{238}Pu	2.16 E–05	5.48 E–05	0	1.00 E–06	1.00 E–04
^{239}Pu	7.88 E–08	5.48 E–05	0	1.00 E–06	1.00 E–04
^{241}Pu	1.32 E–04	5.48 E–05	0	1.00 E–06	1.00 E–04
^{241}Am	4.39 E–06	5.48 E–05	0	2.00 E–06	5.00 E–05
^{243}Am	2.57 E–07	5.48 E–05	0	2.00 E–06	5.00 E–05
^{243}Cm	6.66 E–05	5.48 E–05	0	2.00 E–06	2.00 E–05
^{244}Cm	6.66 E–05	5.48 E–05	0	2.00 E–06	2.00 E–05

[1]Fraction of animal's daily intake of nuclide that appears in each liter of milk, in days/L.
[2]Fraction of animal's intake of nuclide that appears in each kg of meat, in days/kg.

Table A–8. Radionuclide Data on Concentration Uptake Factor and Gastric Intestinal Uptake Fraction Used for CAP88–PC Dose Calculations at the Hanford Site, 2013.

Radionuclide	Concentration uptake factor		GI uptake fraction	
	Forage[1]	Edible[2]	Inhalation)	Ingestion
^{3}H (vapor)	0	0	1.00 E+00	1.00 E+00
^{3}H (elemental)	0	0	1.00 E+00	1.00 E+00
^{14}C	0	1.00 E+00	1.00 E+00	1.00 E+00
^{22}Na	2.00 E–01	5.00 E–02	1.00 E+00	1.00 E+00
^{60}Co	2.00 E+00	8.00 E–02	1.00 E–01	1.00 E–01
^{85}Kr	0	0	0	0
^{90}Y	1.00 E–01	2.00 E–03	1.00 E–04	1.00 E–04
^{90}Sr	4.00 E+00	3.00 E–01	3.00 E–01	3.00 E–01
^{99}Tc	4.00 E+01	5.00 E+00	5.00 E–01	5.00 E–01
^{106}Ru	2.00 E–01	3.00 E–02	5.00 E–02	5.00 E–02
^{125}Sb	1.00 E–01	1.00 E–02	1.00 E–01	1.00 E–01
^{129}I	1.00 E–01	2.00 E–02	1.00 E+00	1.00 E+00
^{134}Cs	1.00 E+01	2.00 E–01	1.00 E+00	1.00 E+00
^{137}Cs	1.00 E+01	2.00 E–01	1.00 E+00	1.00 E+00
^{152}Eu	1.00 E–01	2.00 E–03	5.00 E–04	5.00 E–04
^{154}Eu	1.00 E–01	2.00 E–03	5.00 E–04	5.00 E–04
^{155}Eu	1.00 E–01	2.00 E–03	5.00 E–04	5.00 E–04
^{153}Gd	1.00 E–01	2.00 E–03	5.00 E–04	5.00 E–04
^{220}Rn	0	0	0	0
^{226}Ra	2.00 E–01	4.00 E–02	2.00 E–01	2.00 E–01
^{227}Ac	1.00 E–01	1.00 E–03	5.00 E–04	5.00 E–04
^{231}Pa	1.00 E–01	1.00 E–02	5.00 E–04	5.00 E–04
^{232}U	1.00 E–01	2.00 E–03	2.00 E–02	2.00 E–02
^{233}U	1.00 E–01	2.00 E–03	2.00 E–02	2.00 E–02
^{234}U	1.00 E–01	2.00 E–03	2.00 E–02	2.00 E–02
^{235}U	1.00 E–01	2.00 E–03	2.00 E–02	2.00 E–02
^{238}U	1.00 E–01	2.00 E–03	2.00 E–02	2.00 E–02
^{237}Np	1.00 E–01	2.00 E–02	5.00 E–04	5.00 E–04
^{238}Pu	1.00 E–01	1.00 E–03	5.00 E–04	5.00 E–04
^{239}Pu	1.00 E–01	1.00 E–03	5.00 E–04	5.00 E–04
^{241}Pu	1.00 E–01	1.00 E–03	5.00 E–04	5.00 E–04
^{241}Am	1.00 E–01	1.00 E–03	5.00 E–04	5.00 E–04
^{243}Am	1.00 E–01	1.00 E–03	5.00 E–04	5.00 E–04
^{243}Cm	1.00 E–01	1.00 E–03	5.00 E–04	5.00 E–04
^{244}Cm	1.00 E–01	1.00 E–03	5.00 E–04	5.00 E–04

[1]Concentration factor for uptake of nuclide from soil for pasture and forage (pCi/kg dry weight per pCi/kg dry soil).
[2]Concentration factor for uptake of nuclide from soil by edible parts of crops (pCi/kg wet weight per pCi/kg dry soil).

Table A–9. Exposure and Consumption Data for the Hanford Site. (2 sheets)

FOOD SOURCE FOR THE MAXIMALLY EXPOSED INDIVIDUAL
(Fraction of food produced at indicated location)

Food	Local	Regional	Imported
Vegetable	1.000	00	00
Meat	1.000	00	00
Milk	1.000	00	00

VALUES FOR RADIONUCLIDE–INDEPENDENT VARIABLES

HUMAN INHALATION RATE (cm^3/hr) = 9.70 E+05

SOIL PARAMETERS
Effective surface density, kg/sq m, dry weight
(assumes 15–cm plow layer) = 2.24 E+02

BUILDUP TIMES
For activity in soil (yr) = 5.00 E+01
For radionuclides deposited on ground/water (d) = 1.83 E+04

DELAY TIMES
Ingestion of pasture grass by animals (hr) = 0 E+00
Ingestion of stored feed by animals (hr) = 2.40 E+03
Ingestion of leafy vegetables by man (hr) = 2.40 E+01
Ingestion of produce by man (hours) = 1.20 E+02
Transport time from animal feed–milk–man (d) = 2.00 E+00
Time from slaughter to consumption (d) = 1.50 E+01

WEATHERING
Removal rate constant for physical loss (per hr) = 3.00 E–03

CROP EXPOSURE DURATION
Pasture grass (hr) = 7.20 E+02
Crops/leafy vegetables (hr) = 2.16 E+03

AGRICULTURAL PRODUCTIVITY
Grass–cow–milk–man pathway (kg/m^2) = 3.00 E–01
Produce/leafy veg for human consumption (kg/m^2) = 2.00 E+00

FALLOUT INTERCEPTION FRACTIONS
Vegetables = 2.50 E–01
Pasture = 2.50 E–01

GRAZING PARAMETERS
Fraction of year animals graze on pasture = 7.50 E–01
Fraction of daily feed that is pasture grass when animal grazes on pasture = 1.00 E+00

Table A–9. Exposure and Consumption Data for the Hanford Site. (2 sheets)

ANIMAL FEED CONSUMPTION FACTORS
Contaminated feed/forage (kg/day, dry weight) = 1.56 E+01

DAIRY PRODUCTIVITY
Milk production of cow (L/day) = 1.10 E+01

MEAT ANIMAL SLAUGHTER PARAMETERS
Muscle mass of animal at slaughter (kg) = 2.00 E+02
Fraction of herd slaughtered (per day) = 3.81 E–03

DECONTAMINATION
Fraction of radioactivity retained after washing
or leafy vegetables and produce = 1.00 E+00

FRACTIONS GROWN IN GARDEN OF INTEREST
Produce ingested = 1.00 E+0
Leafy vegetables ingested = 1.00 E+00

INGESTION RATIOS:
IMMEDIATE SURROUNDING AREA/TOTAL WITHIN AREA
Vegetables = 1.00 E+00
Meat = 1.00 E+00
Milk = 1.00 E+00

MINIMUM INGESTION FRACTIONS FROM OUTSIDE AREA
(Minimum fractions of food types from outside area listed below are actual fixed values.)
Vegetables = 0 E+00
Meat = 0 E+00
Milk = 0 E+00

HUMAN FOOD UTILIZATION FACTORS
Produce ingestion (kg/yr) = 2.20 E+02
Milk ingestion (L/yr) = 2.70 E+02
Meat ingestion (kg/yr) = 9.80 E+01
Leafy vegetable ingestion (kg/yr) = 3.00 E+01

SWIMMING PARAMETERS
Fraction of time spent swimming = 1.00 E–02
Dilution depth for water (cm) = 1.00 E+00

EXTERNAL DOSE
Ground–surface contamination correction factor = 1.00 E+00

Table A–10. Hanford Site Meteorological Data — General Site Information.

HEIGHT OF LID

LIDAI = 1,000 m

RAINFALL RATE

RR = 15.9 cm/yr

AVERAGE AIR TEMPERATURE

A = 12.0 degrees C (53.6 degrees F; 285.2 degrees K)

SURFACE ROUGHNESS LENGTH

0 = 0.010 m

VERTICAL TEMPERATURE GRADIENTS: (TG) (K/m)

STABILITY E	0.073
STABILITY F	0.109
STABILITY G	0.146

APPENDIX B

RADIOACTIVE MATERIALS USED AND/OR POTENTIALLY USED AT THE HANFORD SITE IN 2013

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Table B–1. Radionuclides Used and/or Potentially Used at the Hanford Site in 2013.

Ac-225	Be-7	Cl-36	Eu-156	I-134	N-13	Pb-212	Rb-83	Sm-145	Te-125m	W-185
Ac-227	Be-10	Cm-241	Eu-157	I-134m	Na-22	Pb-214	Rb-84	Sm-147	Te-127	W-187
Ac-228	Bi-207	Cm-242	F-18	I-135	Na-24	Pd-103	Rb-86	Sm-148	Te-127m	W-188
Ag-108	Bi-208	Cm-243	Fe-55	In-106	Na-24m	Pd-107	Rb-87	Sm-151	Te-129	Xe-122
Ag-108m	Bi-210	Cm-244	Fe-59	In-111	Nb-91	Pd-109	Rb-88	Sm-153	Te-129m	Xe-123
Ag-109m	Bi-210m	Cm-245	Fr-221	In-113m	Nb-91m	Pm-143	Rb-89	Sm-157	Te-131	Xe-125
Ag-110	Bi-211	Cm-246	Fr-223	In-114	Nb-92	Pm-144	Rb-90	Sn-113	Te-131m	Xe-127
Ag-110m	Bi-212	Cm-247	Ga-67	In-114m	Nb-93m	Pm-145	Rb-90m	Sn-117m	Te-132	Xe-127m
Ag-111	Bi-213	Cm-248	Ga-68	In-115	Nb-94	Pm-146	Re-186	Sn-119m	Te-133	Xe-129m
Al-26	Bi-214	Cm-250	Ga-70	In-115m	Nb-95	Pm-147	Re-187	Sn-121	Te-133m	Xe-131m
Al-28	Bk-247	Co-56	Ga-72	In-116	Nb-95m	Pm-148	Re-188	Sn-121m	Te-134	Xe-133
Am-240	Bk-249	Co-57	Gd-148	In-116m	Nb-97	Pm-148m	Rh-101	Sn-123	Th-227	Xe-133m
Am-241	Bk-250	Co-58	Gd-149	In-117	Nb-97m	Pm-149	Rh-102	Sn-125	Th-228	Xe-135
Am-241	Br-82	Co-60m	Gd-151	In-117m	Nb-98	Pm-151	Rh-102m	Sn-126	Th-229	Xe-135m
Am-242	Br-82m	Co-60	Gd-152	Ir-192	Nb-100	Po-208	Rh-103m	Sr-85	Th-230	Xe-137
Am-242m	Br-83	Cr-49	Gd-153	K-40	Nb-101	Po-209	Rh-104	Sr-87m	Th-232	Xe-138
Am-243	Br-84	Cr-55	Ge-68	K-42	Nb-103	Po-210	Rh-105	Sr-89	Th-233	Xe-139
Am-245	Br-84m	Cs-131	Ge-71	Kr-81	Nd-144	Po-211	Rh-105m	Sr-90	Th-234	Y-88
Am-246	Br-85	Cs-132	Ge-71m	Kr-81m	Nd-147	Po-212	Rh-106	Sr-91	Ti-44	Y-90
Ar-37	C-11	Cs-134	Ge-75	Kr-83m	Ni-56	Po-213	Rn-219	Sr-92	Ti-45	Y-90m
Ar-39	C-14	Cs-134m	Ge-77	Kr-85	Ni-57	Po-214	Rn-220	Ta-179	Ti-51	Y-91
Ar-41	C-15	Cs-135	Ge-77m	Kr-85m	Ni-59	Po-215	Rn-222	Ta-180	Tl-201	Y-91m
Ar-42	Ca-41	Cs-136	H-3	Kr-87	Ni-63	Po-216	Rn-224	Ta-182	Tl-204	Y-92
As-74	Ca-45	Cs-137	Hf-178m	Kr-88	Ni-65	Po-218	Ru-97	Ta-182m	Tl-206	Y-93
As-76	Ca-47	Cs-137	Hf-179m	Kr-89	Np-235	Pr-143	Ru-103	Ta-183	Tl-207	Yb-164
As-77	Cd-107	Cs-138	Hf-181	Kr-90	Np-236	Pr-144	Ru-105	Tb-157	Tl-208	Yb-169
At-217	Cd-109	Cs-139	Hf-182	La-137	Np-237	Pr-144m	Ru-106	Tb-158	Tl-209	Yb-175
Au-193	Cd-111m	Cs-140	Hg-203	La-138	Np-238	Pu-234	S-35	Tb-160	Tm-168	Yb-177
Au-194	Cd-113	Cs-141	Ho-163	La-140	Np-239	Pu-236	Sb-122	Tb-161	Tm-170	Zn-65
Au-195	Cd-113m	Cu-64	Ho-166	La-142	Np-240	Pu-237	Sb-124	Tc-95	Tm-171	Zn-69
Au-196	Cd-115	Cu-66	Ho-166m	La-144	Np-240m	Pu-238	Sb-125	Tc-95m	U-232	Zn-69m
Au-198	Cd-115m	Cu-67	I-122	Lu-177	O-15	Pu-239	Sb-126	Tc-97	U-233	Zr-88
Au-198m	Cd-117	Dy-159	I-123	Lu-177m	O-19	Pu-240	Sb-126m	Tc-97m	U-234	Zr-89
Au-199	Cd-117m	Dy-165	I-125	Mg-27	Os-191	Pu-241	Sb-127	Tc-98	U-235	Zr-93
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