U.S. DEPARTMENT OF ENERGY

PNNL-20436-3

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Department of Energy – Office of Science

Pacific Northwest National Laboratory Site Radionuclide Air Emissions Report for Calendar Year 2012

SF Snyder
JM Barnett
LE Bisping

June 2013

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

Facilities with potential emissions of radioactive materials at the U.S. Department of Energy (DOE) Office of Science (-SC) Pacific Northwest National Laboratory (PNNL) Site (hereafter, PNNL Site) are research laboratories at the Physical Sciences Facility, Environmental Molecular Sciences Laboratory, Life Sciences Laboratory-II (LSLII), and Research Technology Laboratory (RTL). This is the first PNNL Site report to include LSLII and RTL facilities, as incorporated into the Radioactive Air Emissions License-05.

This report documents radionuclide air emissions that result in the highest effective dose equivalent (EDE) to an offsite 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 (NESHAP), 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."

Federal regulations in 40 CFR 61, Subpart H require the measurement and reporting of radionuclides emitted from DOE facilities and the resulting offsite dose from those emissions. Those regulations impose a standard of 10 mrem/yr EDE, which is not to be exceeded. Washington State adopted the 40 CFR 61 standard of 10 mrem/yr EDE into its regulations that require the calculation and reporting of the EDE to the MEI from both point source emissions and from any fugitive source emissions of radionuclides. WAC 246-247 further requires the reporting of radionuclide emissions, including radon, from all PNNL Site sources.

The Clean Air Act Amendments of 1989 revised the NESHAP regulations (i.e., 40 CFR 61, Subpart H) to govern emissions of radionuclides from DOE facilities. Those regulations are intended for the measurement of point source emissions but are inclusive of fugitive emissions with regard to complying with the dose standard.

The dose to the PNNL Site MEI due to routine major and minor point source emissions in 2012 from PNNL Site sources is 9E-06 mrem (9E-08 mSv) EDE. The dose from fugitive emissions (i.e., unmonitored sources) is 1E-7 mrem (1E-9 mSv) EDE. The dose from radon emissions is 2E-6 mrem (2E-08 mSv) EDE. No nonroutine emissions occurred in 2012. The total radiological dose for 2012 to the MEI from all PNNL Site radionuclide emissions, including fugitive emissions and radon, is 1E-5 mrem (1E-7 mSv) EDE, or 100,000 times smaller than the federal and state standard of 10 mrem/yr, to which the PNNL Site is in compliance.

For further information concerning this report, you may contact Theresa L. Aldridge, U.S. Department of Energy, Pacific Northwest Site Office, by telephone at (509) 372 4508 or by e-mail Theresa.Aldridge@pnso.science.doe.gov.

CERTIFICATION of PNNL-20436-3

DOE-SC PNNL Site
Radionuclide Air Emissions Report
Calendar Year 2012

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. [verbatim from 40 CFR 61, Subpart H, 61.94(b)(9)]

6/19/13

Roger E. Snyder, Manager
U.S. Department of Energy
Pacific Northwest Site Office

Date

Acronyms and Abbreviations

ASME	American Society of Mechanical Engineers
CAP88-PC	Clean Air Act Assessment Package 1988-Personal Computer
CFR	Code of Federal Regulations
Ci	curie
DOE	U.S. Department of Energy
DOE-ORP	U.S. Department of Energy, Office of River Protection
DOE-RL	U.S. Department of Energy, Richland Operations Office
DOE-SC	U.S. Department of Energy, Office of Science
EDE	effective dose equivalent
EMSL	Environmental Molecular Sciences Laboratory
EPA	U.S. Environmental Protection Agency
HEPA	high-efficiency particulate air (filter)
km	kilometer
LSL	Life Sciences Laboratory
Major	a radioactive point source having a radiological dose potential of greater than 0.1 mrem/yr effective dose equivalent, based on emissions that would result if all pollution-control equipment did not exist but facility operations were otherwise normal
MEI	maximally exposed individual
mi	mile
Minor	a radioactive point source having a radiological dose potential of less than or equal to 0.1 mrem/yr effective dose equivalent, based on emissions that would result if all pollution-control equipment did not exist but facility operations were otherwise normal
mrem	millirem [i.e., 1 x 10-3 rem]
NA	not applicable
ND	not detected
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NOC	Notice of Construction
PCM	periodic confirmatory measurement
PNNL	Pacific Northwest National Laboratory
PNSO	U.S. DOE Pacific Northwest Site Office
PSF	Physical Sciences Facility
QA	quality assurance
RAEL	Radioactive Air Emissions License
RTL	Research Technology Laboratory
rem	roentgen equivalent man
SD	standard deviation
WAC	Washington Administrative Code
WDOH	Washington State Department of Health
yr	year

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1.0 Introduction

This report documents calendar year 2012 radionuclide air emissions from the U.S. Department of Energy (DOE) Office of Science (SC) Pacific Northwest National Laboratory (PNNL) Site (hereafter, PNNL Site), 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 (2002), "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 (2011), "Radiation Protection—Air Emissions." Due to contractual changes effective October 1, 2012, radiological air emissions from Life Sciences Laboratory-II (LSLII) and Research Technology Laboratory (RTL) facilities on the PNNL Campus were added to the Radioactive Air Emissions License-05 (RAEL-05) for the PNNL Site. This report satisfies the annual reporting requirements under the DOE PNNL Site license for calendar year 2012 operations, and the Battelle[1] radioactive materials license, WN-L027-1. This report meets the calendar year 2012 annual reporting requirement for PNNL Campus facility operations as both privately-owned as well as its federally-permitted status that began in October 2012. In addition, the report is compatible with the quality principles of 10 CFR 830 (2001), *Nuclear Safety Management*; DOE Order 414.1D (2011), *Quality Assurance*; American Society of Mechanical Engineers (ASME) NQA-1 (2000), *Quality Assurance Requirements for Nuclear Facility Application, 2000 edition*; and U.S. Environmental Protection Agency (EPA) QA/R-5 (2001), *EPA Requirements for Quality Assurance Project Plans*.

1.1 PNNL Site Description

The PNNL Site (Figure 1.1, yellow boundary) is located in southeastern Washington State. It is less than 1 mile south of the much larger U.S. DOE Hanford Site (Figure 1.2): the PNNL Site occupies 0.54 mi^2 (1.4 km^2) just south of the Hanford Site 300 Area, whereas the Hanford Site occupies about 586 mi^2 (1,518 km^2). The PNNL Site lies about 170 mi (275 km) east-northeast of Portland, Oregon; 170 mi (270 km) southeast of Seattle, Washington; and 125 mi (200 km) southwest of Spokane, Washington.

In addition to the PNNL Site proper, radiological operations at two additional facilities on the PNNL Campus (Figure 1.1, orange boundary) were added to the DOE-SC air permit in October 2012. Prior to October 2012, the area in the PNNL Campus external to the PNNL Site boundary was privately operated by Battelle. Pursuant to the contractual changes, both the PNNL Site and the additional facilities in the PNNL Campus are all operated by PNNL under the oversight of DOE-SC. Only facilities permitted under the PNNL Site RAEL-05 perform radiological operations with potential air emissions.

The area south and east of the PNNL Campus is developed with office, laboratory, and retail space. The Columbia River borders the PNNL Site on the east. Environmental conditions of non-operational Hanford Site areas are also characteristic of the PNNL Site. More in-depth discussions on the characteristics of the Hanford Site are available in the *Hanford Site National Environmental Policy Act (NEPA) Characterization* (Duncan et al. 2007).

[1] Battelle Memorial Institute, Pacific Northwest Division, Richland, WA 99352.

Figure 1.1. DOE-SC PNNL Campus Emissions Units Locations

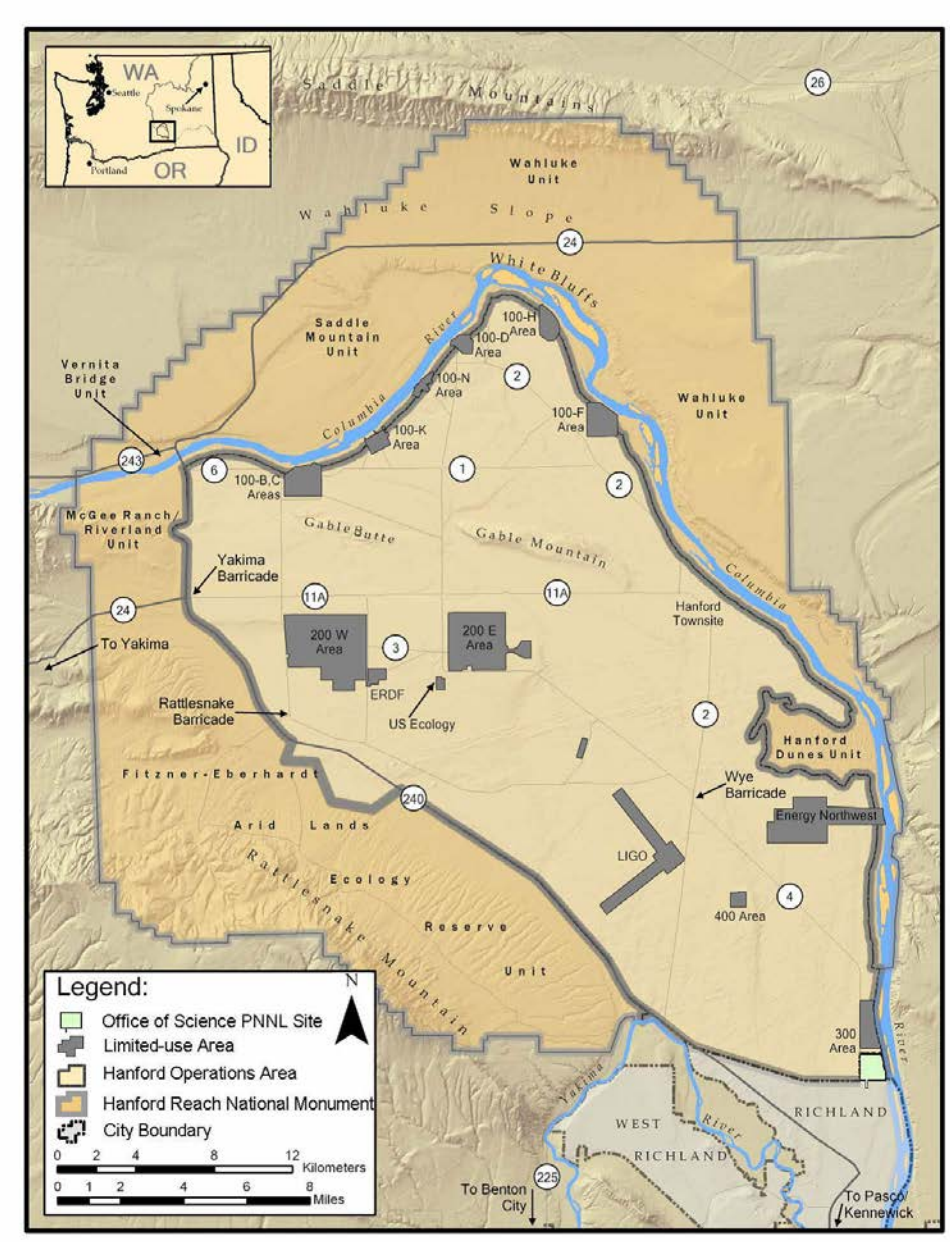

Figure 1.2. Location of the Hanford Site in Relation to the PNNL Site

1.1.1 Historical Background

DOE chartered the Pacific Northwest Site Office in December 2003 within the Office of Science to oversee the operation of the PNNL, which was established in 1965. Battelle is contracted to the DOE to operate PNNL (contract DE-AC06-76RL01830), and has operated PNNL since 1965. The PNNL Site, with boundaries identified in Figure 1.1 (yellow boundary), was established in the last decade. The PNNL Site is currently occupied by two facilities: the Environmental Molecular Sciences Laboratory (EMSL) and the Physical Sciences Facility (PSF). PNNL also conducts research and administrative functions in a number of facilities on the PNNL Campus (Figure 1.1, orange boundary). Several PNNL Campus facilities, RTL-520 and -530, and LSLII, were brought under the DOE PNNL Site RAEL-05 in

October 2012 and are now considered for Subpart H compliance determination. The locations of PSF, EMSL, LSLII, and RTL facilities are identified in Figure 1.1. The remaining facilities in the PNNL Campus have been owned or leased by Battelle since the mid 1960s.

EMSL is a single 224,000 gross ft^2 building that was constructed in 1997 and is designated as a national scientific user facility. The EMSL facility was exempted from the air permitting process in 2004 and is authorized to conduct work with volumetrically released materials and limited non-dispersible materials released from radiological controls.

The nine buildings subject to Subpart H reporting are listed in Table 1.1. The five buildings of the PSF (3400 series buildings in Table 1.1) were constructed in 2009 and 2010 to replace aging laboratory infrastructure on the Hanford Site. The LSLII and RTL facilities had been regulated previously under a private Battelle license but were brought under the DOE radioactive air emissions license in October 2012. No change in radiological operations at these facilities occurred during the year.

Table 1.1. PNNL Site Licensed Facilities

Building	Start Date of DOE-SC Radiological Operations
3410 Building – Materials Sciences and Technology Laboratory	August 2010
3420 Building – Radiation Detection Laboratory	August 2010
3425 Building – Underground Laboratory	October 2010
3430 Building – Ultra-Trace Laboratory	July 2010
3440 Building – Large Detector Laboratory	September 2010[(a)]
3020 Building – Environmental Molecular Sciences Laboratory	2004[(b)]
LSLII – Life Science Laboratory II	October 2012[(c, d)]
RTL-520 – Research Technology Laboratory-520	October 2012[(d)]
RTL-530 – Research Technology Laboratory Radioactive Storage	October 2012[(d)]

(a) Sealed sources only.
(b) EMSL operations commenced in 1997 and came under DOE-SC oversight in 2004.
(c) Residual contamination in ducts only, no active radiological operations.
(d) Date of contractual transfer from Battelle private operations to DOE-SC with no change in operations from earlier in the calendar year.

As research buildings, the PSF and RTL facilities are expected to host changing types of research over time. The LSLII facility had historically been used for radiological operations. No new or planned radiological operations occur at LSLII, other than removal of radiologically-contaminated ductwork from past operations. Ductwork contamination levels are low and continue to be monitored. More detailed descriptions of buildings subject to 40 CFR 61, Subpart H (2002) reporting are provided in Section 1.2.2.

The Hanford Site history is briefly described here because of its proximity adjacent to the PNNL Site and because it is a source of radiological airborne emissions that could impact the PNNL Site. From the mid 1940s, 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. More recently, major efforts have been underway 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. The Hanford Site 300 Area, which is closest to the PNNL Site, contains research and development laboratories. The two principal DOE Offices that manage

programs at the Hanford Site are the Richland Operations Office (DOE-RL) and the Office of River Protection (DOE-ORP).

1.1.2 PNNL Site Facilities and 2012 Activities

Point source emission units are characterized as major or minor. The label for the emission unit considers whether radiological emissions are expected to result in a member-of-the-public potential dose greater or less than 0.1 mrem/yr. In addition, a source could be characterized as a fugitive emission if a potential source of radioactive material is not actively monitored or ventilated at the point of release.[1] The DOE licensed facilities contain both major and minor emission units or fugitive release sites (Table 1.2; Figure 1.3 and Figure 1.1).

Table 1.2. Types of Emission Units Under the DOE PNNL Site License

Facility/Building ID	Building Name	Emission Unit Type
PSF/3410	Materials Sciences and Technology Laboratory	Major
PSF/3420	Radiation Detection Laboratory	Major and Minor
PSF/3425	Underground Laboratory	Fugitive
PSF/3430	Ultra-Trace Laboratory	Major and Minor
PSF/3440	Large Detector Laboratory	None
EMSL/3020	Environmental Molecular Sciences Laboratory	Fugitive
- /LSLII	Life Science Laboratory II	Minor
RTL/RTL-520	Research Technology Laboratory	Minor
RTL/RTL-530	RTL Radioactive Material Storage	Fugitive

Figure 1.3. PNNL Site Physical Sciences Facility (PSF) with Indication of Building Locations

Notable events in calendar year 2012 relevant to radioactive airborne emissions monitoring and reporting are summarized as follows:

[1] A more detailed discussion of fugitive emissions is provided in Section 4.0.

- Radioactive air emission units on the PNNL Campus (LSLII, RTL-520, and RTL-530) were removed from the Battelle Radioactive Materials License (WN-L027-1) and added to the DOE PNNL Site RAEL-05 in October 2012.
- Completion of an evaluation of the radioactive ambient air monitoring program to consider the addition of LSLII and RTL to the DOE air license (Barnett et al. 2012). A fourth ambient air monitoring station was established in the southern portion of the PNNL Campus, as a result.
- Ambient air monitoring station locations PNL-1 and PNL-2 were re-located to permanent sites and a new monitoring station was sited. The new PNL-1 and PNL-2 monitoring stations are solar-powered.

1.1.3 Prime Contractor

Battelle is contracted to operate PNNL for DOE-SC. PNNL manages operations at the PNNL Campus, and other leased/occupied research and office areas nearby. Activities at the PNNL Campus include research and development in the physical, chemical, life, and environmental sciences; and relevant environmental monitoring.

1.1.4 Facilities Adjacent to the PNNL Site

Land adjacent to the PNNL Site is occupied by the U.S. DOE Hanford Site (Figure 1.2); office and research facilities; and a smaller number of local businesses (e.g., restaurants, offices). Just north of the PNNL Site, the Hanford Site 300 Area has radiological operations that need to be considered in conjunction with releases, dose estimates, and environmental monitoring of the PNNL Campus. Many Hanford Site operations are currently focused on environmental cleanup associated with past production of radioactive materials for the U.S. nuclear weapons program. The current Hanford Site 300 Area activities are cleanup, research, and office facilities. Radiological emissions from the Hanford Site are described in the Hanford Site Radionuclide Air Emissions Report (Rokkan, Perkins, and Snyder 2013).

In addition to DOE's Hanford Site, some privately and publicly owned facilities capable of generating airborne radioactive emissions are located adjacent to or near the PNNL Site. These facilities include 1) a low-level waste burial site operated by U.S. Ecology on the Hanford Site 200 Area plateau; 2) the Energy Northwest Columbia Generating Station commercial nuclear power reactor and office buildings, near the Columbia River, north of the Hanford Site 300 Area; 3) the Test America, Richland Laboratory south of the PNNL Site; 4) the AREVA Federal Services LLC fuel fabrication facility, west of the PNNL Site; 5) Perma-Fix Northwest, Inc., adjacent to the east side of the AREVA Federal Services LLC; and 6) Interstate Nuclear Services, southwest of the PNNL Site. AREVA is a nuclear reactor fuel fabrication facility and Perma-Fix NW manages and treats low-level and mixed radioactive waste. These facilities will be discussed in this report to the extent necessary. Emissions from these facilities are not included in this report because they are regulated separately from the PNNL Site.

1.2 Point Source Descriptions

This section includes descriptions of point sources at the PNNL Site. A point source is reported in this document if it met the following four criteria during 2012:

- required continuous monitoring or periodic confirmatory measurements (PCMs) in accordance with 40 CFR 61, Subpart H (2002), and with WAC 246-247 (2011)

- was described in the Washington State Department of Health (WDOH)-issued RAEL-05
- emitted or had the potential to emit radionuclides
- was monitored using effluent sampling.

The PNNL Site emission units registered with the WDOH for radiological emissions are given in Table 1.3.

Table 1.3. PNNL Site Registered Radioactive Air Emissions Units

Building	Discharge Point ID	Discharge Point Description	Compliance Method
3410	EP-3410-01-S	Major point source. Main Stack.	Continuous sampling
3420	EP-3420-01-S	Major point source. Main Stack.	Continuous sampling
	EP-3420-02-S	Minor point source. Areas not exhausted to main stack. Calculations used to determine radionuclide emissions in lieu of monitoring.	Appendix D[(a)]
3425	J-3425	Fugitive emissions. Calculations used to determine radionuclide emissions in lieu of monitoring.	Appendix D[(a)]
3430	EP-3430-01-S	Major point source. Main Stack.	Continuous sampling
	EP-3430-02-S	Minor point source. Areas not exhausted to main stack. Calculations used to determine radionuclide emissions in lieu of monitoring.	Appendix D[(a)]
	EP-3430-1606P-S	Minor point source. Room 1606 perchloric acid hood. Calculations used to determine radionuclide emissions in lieu of monitoring.	Appendix D[(a)]
	EP-3430-1608P-S	Minor point source. Room 1608 perchloric acid hood. Calculations used to determine radionuclide emissions in lieu of monitoring.	Appendix D[(a)]
	EP-3430-1610P-S	Minor point source. Room 1610 perchloric acid hood. Calculations used to determine radionuclide emissions in lieu of monitoring.	Appendix D[(a)]
	EP-3430-1612P-S	Minor point source. Room 1612 perchloric acid hood. Calculations used to determine radionuclide emissions in lieu of monitoring.	Appendix D[(a)]
	EP-3430-1614P-S	Minor point source. Room 1614 perchloric acid hood. Calculations used to determine radionuclide emissions in lieu of monitoring.	Appendix D[(a)]
3020	J-3020	Fugitive emissions. Activities limited to volumetrically released and non-dispersible materials.	None[(b)]
LSLII	EP-LSLII-01-V	Minor point source. Calculations used to determine radionuclide emissions in lieu of monitoring.	Appendix D[(a)]
	EP-LSLII-02-V	Minor point source. Calculations used to determine radionuclide emissions in lieu of monitoring.	Appendix D[(a)]
RTL-520	EP-RTL-10-V	Minor point source. Periodic confirmatory sampling conducted.	Periodic Sampling
	EP-RTL-11-V	Minor point source. Periodic confirmatory sampling conducted.	Periodic Sampling
RTL-530	J-RTL530	Fugitive emissions. Activities limited to waste management and storage.	Appendix D[(a)]

(a) Values are calculated from in-facility material inventories and estimates and 40 CFR 61, Appendix D (1989).
(b) The 3020 Building was exempted from the permitting process for limited work with radioactive materials not considered viable for emissions.

1.2.1 Emission Point Characteristics

In general, radionuclide air emissions from point sources are discharged from stacks and vents. Emission point characteristics for the sampled emission units are indicated in Table 1.4. Effective discharge heights used in modeling range from 33 ft (10 m) for PSF fugitive emission points to a conservative 98 ft (14 m) applied to all PSF stack emissions. RTL-520 was conservatively modeled with an effective discharge height of 70.5 ft (20.5 m) and LSLII was 65 ft (20 m).

Table 1.4. Characteristics of Sampled Emission Points

Unit Type/ Emission Point ID	Average Flow Rate	Physical Discharge Height	Physical Discharge Diameter	Effective Discharge Height	Abatement Technology
Major EP-3410-01-S	17,640 ft^3/min (8.32 m^3/s)	45 ft (13.7 m)	3.3 ft (1.02 m)	98.5 ft (30.0 m)	Single-stage HEPA filter
Major EP-3420-01-S	34,050 ft^3/min (16.1 m^3/s)	45 ft (13.8 m)	4.3ft (1.3 m)	121 ft (36.9 m)	Single-stage HEPA filter
Major EP-3430-01-S	33,070 ft^3/min (15.6 m^3/s)	44 ft (13.4 m)	3.7 ft (1.1 m)	115 ft (35.1 m)	Single-stage HEPA filter
Minor EP-RTL-10-V	14,400 ft^3/min (6.80 m^3/s)	26 ft (7.9 m)	2.7 ft (0.81 m)	67.6 ft (20.6 m)	Single-stage HEPA filter
Minor EP-RTL-11-V	19,600 ft^3/min (9.25 m^3/s)	26 ft (7.9 m)	2.7 ft (0.81 m)	73.5 ft (22.4 m)	Single-stage HEPA filter

A point source is designated *major* when, hypothetically, in the absence of all pollution-control equipment, its potential maximum emissions can cause a dose greater than 0.1 mrem/yr EDE to the nearest member of the public not employed by DOE or its contractors associated with the PNNL Site and who lives near and/or has unrestricted access to a place of employment on the PNNL 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.

Fugitive sources of radioactive emissions are generally those not actively ventilated, not sealed to prevent the escape of volatile or resuspended radioactive material to the ambient air, and not as amenable to routine sampling in a controlled manner as is done with stacks. Potential unabated emissions from PNNL Site fugitive source locations would be expected to have an extremely small dose impact even under worst-case release conditions.

The principal emission abatement method used at the major emission units to remove radioactive constituents from stack emissions during 2012 was high-efficiency particulate air (HEPA) filters. In general, one stage of HEPA filtration was used as the final particulate-removal method before an air emission stream was exhausted to the atmosphere (see Table 1.4 for a listing of emission abatement technology at each stack).

The average operating characteristics of each PNNL Site sampled emission units are indicated in Table 1.4. The single-stage HEPA filter abatement technology listed in the table has a minimum acceptable test criteria rating of 99.95% efficient.

1.2.2 PNNL Site Radiological Operations

The following paragraphs describe the handling and processing of radioactive material in each facility on the PNNL Site.

Physical Science Facility (PSF) Buildings

3410 Building – Materials Sciences and Technology Laboratory

The 3410 Building provides laboratory space and infrastructure to continue research capabilities associated with performance and life of materials in high-temperature, high-radiation, and corrosive environments found in next-generation technologies and applications in the areas of energy, construction, and transportation. Activities include work with metals, ceramics, polymeric materials, composites, and specialized coatings and surface treatments to address these situations.

3420 Building – Radiation Detection Laboratory

The 3420 Building contains laboratories for research to perform a wide variety of radionuclide measurements. Projects support research in radionuclide measurement technologies and capabilities used or under development include state-of-the-art analytical chemistry, radiation physics, light detection, particle detection, chromatography, scintillation materials, sorbents/ "smart" materials, and field-deployable forensics instrumentation. Applications for these capabilities range from fundamental science, such as neutrino mass detection, to applied systems for prevention of nuclear proliferation and radiation portal monitoring at U.S. borders.

3425 Building – Underground Laboratory (Deep Lab)

The 3425 Building is an underground laboratory protected from background radiation to support the radiation detection capabilities in the 3420 Building. Research areas are located 40 ft (12 m) below ground. Projects support homeland and national security missions including the development and advancement of radiation detection technologies. Additional activities include radiation physics experiments, development of ultra-low radioactivity materials, and other fundamental sciences studies.

3430 Building – Ultra-Trace Laboratory

The 3430 Building provides ultra-trace radio-analytical capabilities for nuclear forensics in support of critical national needs. These capabilities include highly sensitive analytical systems, such as mass spectrometers, optical microscopes, and electron microscopes, to provide isotopic analyses and ultra-low-level radionuclide detection in a wide variety of sample matrices.

3440 Building – Large Detector Laboratory

The 3440 Building and the accompanying Radiation Portal Monitoring Test Track support the development and testing of radiation detection technologies designed to be deployed at U.S. borders and ports of entry. There were no radioactive air emissions from 3440 Building in 2012.

Environmental Molecular Sciences Laboratory (EMSL)

3020 Building – Environmental Molecular Sciences Laboratory

Since 1997, EMSL has supported world-class research in biological, chemical, and environmental sciences. Research focuses on integrating computational and experimental capabilities. It is a national user facility and has radiological operations limited to sealed source use and authorized work with volumetrically released and non-dispersible materials.

Research Technology Laboratory (RTL) Facilities

RTL - 520

RTL-520 provides laboratory, office and storage space in support of a variety of research and development activities. Research includes chemical toxicology, environmental health physics, dosimetry, atmospheric science modeling, and soil and groundwater contamination studies. Coating and coating technologies; laser and electrochemical machining; and electrodeposition research is performed. Additionally, research related to the solid-liquid interface of geologic materials is conducted.

RTL - 530

RTL-530 is a small (136 ft^2) concrete block and brick storage area just west of the RTL-520, used for the temporary storage of radioactive materials.

Life Sciences Laboratory (LSL) Facility

LSLII

LSLII Building consists primarily of two laboratory floors with mechanical/electrical service rooms attached at the North and South ends of the building. Research conducted in this facility includes applied research, prototype development and testing, and system validation for engineered structural materials. Mechanical design, automation, computational mechanics, and advanced materials characterization activities are also conducted in LSLII. Some electronic technology development and wet chemical work are performed, as well.

2.0 Radionuclide Air Emissions

This section presents information on quantities of radionuclide emissions at the PNNL Site. The point sources listed are actively ventilated stacks using electrically powered exhausters and from which emissions are discharged under controlled conditions. Also included are minor and fugitive emission units.

Data on 2012 radioactive emissions at the PNNL Campus are provided. There were no emissions from the 3440 Building of PSF; the 3020 Building (EMSL); nor RTL-530 in 2012. Table 2.1 indicates emissions from monitored point sources. Table 2.2 shows the emissions that result in 99% of the dose impact from unmonitored sources, whereas Table 2.3 shows the remaining 1%. A summary of the nuclide activity emissions from major, minor, and fugitive emissions that result in 99% or more of the dose impact to the MEI is provided in Table 2.4.

Table 2.1. PNNL Site Radionuclide Emissions (Ci) from Monitored Point Sources in 2012

Nuclide	EP-3410-01-S 3410 Building	EP-3420-01-S 3420 Building	EP-3430-01-S 3430 Building	EP-RTL-10-V RTL-520	EP-RTL-11-V RTL-520	Total (Ci)
gross α [(a)]	2.25E-08	1.94E-08	1.78E-08	ND	3.41E-09	6.3E-08
gross β [(a)]	2.41E-07	3.41E-07	2.01E-07	2.67E-08	4.06E-08	8.5E-07
^{3}H	3.12E-06[(b)]	NA	NA	NA	NA	3.1E-06
^{60}Co	4.97E-09	7.08E-09	8.86E-09	NA	NA	2.1E-08
^{133}Xe	NA	9.02E-09[(b)]	NA	NA	NA	9.0E-09
^{222}Rn[(c)]	NA	1.97E-04[(b)]	NA	NA	NA	2.0E-04
$^{233/234}U$	NA	NA	1.01E-10	NA	NA	1.0E-10
^{238}Pu	8.70E-11	5.65E-11	ND	NA	NA	1.4E-10
$^{239/240}Pu$	9.52E-10	2.02E-09	5.19E-10	NA	NA	3.5E-09
^{241}Am	8.70E-11	5.65E-11	1.39E-11	NA	NA	1.6E-10
^{243}Am	3.42E-08	1.80E-08	1.13E-08	NA	NA	6.3E-08
^{244}Cm	3.76E-11	4.98E-11	ND	NA	NA	8.8E-11

(a) Maximum of the biweekly or composited average measurement.
(b) Value based on release records.
(c) Radon dose to MEI presented in Sections 3.4.2 and 3.6.3
ND = not detected
NA = not applicable

Table 2.2. PNNL Site Appendix D Calculated Radionuclide Emissions (Ci) from Minor Emissions Units and Fugitive Sources of Significance for Dose in 2012[(a),(b)]

Nuclide	EP-3420-02-S 3420 Building PSF	EP-3430-02-S 3430 Building PSF	EP-3430-nnnnP-S 3430 Building PSF[(c)]	J-3425 3425 Building PSF	EP-LSLII-01-V, -02-V Total LSLII[(d)]	Total Appendix D (Ci)
^{24}Na	-	1.30E-08	-	-	-	1.3E-08
^{60}Co	1.86E-10	2.77E-11	-	6.35E-12	-	2.2E-10
^{82}Br	-	1.30E-08	-	-	-	1.3E-08
^{89}Sr	1.09E-09	-	-	2.51E-12	-	1.1E-09
^{88}Y	3.26E-10	3.78E-11	-	1.15E-11	-	3.8E-10
^{109}Cd	1.02E-09	1.66E-10	-	3.17E-11	-	1.2E-09
^{129}I	-	1.00E-12	-	-	-	1.0E-12
^{131}I	2.08E-10	-	-	8.85E-12	-	2.2E-10
^{132}I	2.26E-09	-	-	7.85E-12	-	2.3E-09
^{137}Cs	1.51E-10	1.93E-11	-	5.01E-12	8.40E-12	1.8E-10
^{140}Ba	2.10E-09	-	-	7.21E-12	-	2.1E-09
^{210}Pb	5.14E-10	2.52E-12	-	2.30E-11	-	5.4E-10
^{226}Ra	-	1.19E-09	-	-	-	1.2E-09
^{229}Th	9.30E-13	-	-	-	-	9.3E-13
^{232}Th	-	1.00E-12	-	-	-	1.0E-12
$^{233/234}$U	1.36E-10	2.00E-12	-	1.20E-11	-	1.5E-10
^{236}Np	9.01E-12	-	1.39E-17	-	-	9.0E-12
^{237}Np	-	1.00E-12	3.95E-19	-	-	1.0E-12
^{238}Pu	1.15E-13	1.00E-12	5.69E-18	-	-	1.1E-12
^{239}Pu	3.10E-11	1.00E-12	1.27E-16	-	-	3.2E-11
^{240}Pu	1.42E-14	1.00E-12	4.57E-17	-	-	1.0E-12
^{242}Pu	1.68E-16	1.00E-12	1.94E-19	-	-	1.0E-12
^{244}Pu	9.01E-12	1.00E-12	6.61E-20	-	-	1.0E-11
^{241}Am	8.68E-11	1.88E-11	1.70E-17	2.32E-12	9.50E-13	1.1E-10
^{243}Am	2.73E-13	1.00E-12	5.12E-16	-	-	1.3E-12

(a) Values are not from actual measurements but calculated from in-facility material inventories and estimates (Ballinger et al. 2011) and 40 CFR 61, Appendix D (1989).
(b) Listed nuclides account for over 99% of dose impact from Minor and Fugitive sources in 2012.
(c) Total from perchloric acid hoods in 3430 Building, where nnnn = 1606, 1608, 1610, 1612, and 1614.
(d) LSLII beta emitters conservatively assumed to be ^{137}Cs; alpha-emitters assumed to be ^{241}Am.

Table 2.3. Non-significant PNNL Site Radionuclide Emissions (Ci) from Minor Emission Units and Fugitive Sources in 2012

Nuclide	Release (Ci)	Nuclide	Release (Ci)	Nuclide	Release (Ci)	Nuclide	Release (Ci)
^{108m}Ag	5.5E-18	^{203}Hg	1.4E-10	^{143}Pr	2.0E-09	^{127}Te	5.7E-11
^{110m}Ag	3.1E-16	^{133}I	3.5E-11	^{144}Pr	1.1E-10	^{127m}Te	6.7E-13
^{242}Am	1.0E-16	^{114m}In	7.5E-20	^{144m}Pr	1.5E-12	^{129}Te	1.7E-10
^{242m}Am	1.0E-16	^{115}In	5.4E-17	^{241}Pu	2.0E-12	^{129m}Te	2.7E-10
^{137m}Ba	7.2E-12	^{115m}In	3.1E-12	^{103m}Rh	4.0E-10	^{131}Te	1.2E-11
^{14}C	9.9E-13	^{192}Ir	1.2E-16	^{105}Rh	3.5E-10	^{131m}Te	5.5E-11
^{47}Ca	2.0E-11	^{83m}Kr[(a)]	4.0E-13	^{106}Rh	2.8E-16	^{132}Te	2.2E-09
^{115}Cd	2.9E-12	^{85}Kr[(a)]	2.4E-10	^{103}Ru	4.1E-10	^{230}Th	1.0E-12
^{115m}Cd	1.6E-19	^{140}La	2.4E-09	^{106}Ru	2.8E-16	^{231}Th	3.5E-12
^{139}Ce	5.2E-11	^{54}Mn	3.3E-16	^{125}Sb	3.7E-15	^{235}U	6.0E-12
^{141}Ce	9.5E-10	^{99}Mo	2.9E-09	^{127}Sb	6.0E-11	^{236}U	1.1E-12
^{143}Ce	1.3E-09	^{22}Na	1.8E-18	^{46}Sc	4.4E-13	^{237}U	6.1E-17
^{144}Ce	1.1E-10	^{93m}Nb	3.9E-17	^{47}Sc	2.2E-11	^{238}U	1.8E-12
^{252}Cf	3.6E-18	^{94}Nb	3.9E-13	^{75}Se	4.0E-13	^{240}U	1.9E-15
^{242}Cm	8.5E-17	^{95}Nb	1.4E-10	^{151}Sm	5.0E-15	^{131m}Xe[(a)]	5.7E-13
^{243}Cm	7.9E-16	^{95m}Nb	4.3E-12	^{153}Sm	3.5E-11	^{133m}Xe[(a)]	2.3E-13
^{245}Cm	4.6E-17	^{97}Nb	1.7E-10	^{113}Sn	1.8E-10	^{135}Xe[(a)]	1.7E-13
^{246}Cm	4.7E-17	^{97m}Nb	1.5E-10	^{121}Sn	3.7E-16	^{90}Y	3.4E-11
^{57}Co	4.3E-11	^{147}Nd	8.4E-10	^{121m}Sn	4.8E-16	^{90m}Y	5.4E-13
^{134}Cs	3.6E-14	^{63}Ni	1.3E-19	^{85}Sr	2.3E-10	^{91}Y	2.7E-12
^{152}Eu	3.2E-17	^{239}Np	1.0E-12	^{90}Sr	7.1E-12	^{93}Y	1.1E-13
^{154}Eu	5.6E-14	^{240}Np	2.0E-15	^{182}Ta	2.6E-13	^{65}Zn	1.4E-13
^{155}Eu	1.2E-14	^{147}Pm	4.4E-12	^{99}Tc	1.1E-14	^{93}Zr	6.2E-17
^{55}Fe	6.7E-18	^{149}Pm	8.8E-10	^{99m}Tc	2.8E-09	^{95}Zr	5.7E-10
^{59}Fe	5.3E-21	^{151}Pm	4.2E-11	^{125m}Te	9.1E-16	^{97}Zr	1.6E-10
						Total	**2.1E-08**

(a) Value based on release records. Other emissions are calculated from in-facility material inventories and estimates (Ballinger et al. 2011) and 40 CFR 61, Appendix D (1989).

Table 2.4. PNNL Site Total Radionuclide Emissions (Ci) in 2012

Nuclide	Major Emissions Units	Minor and Fugitive Emissions Units[a]	Total (Ci)
gross α [b]	6.3E-08	-	6.3E-08
gross β [b]	8.5E-07	-	8.5E-07
^{3}H	3.1E-06 [c]	1.1E-14[d]	3.1E-06
^{24}Na	-	1.3E-08	1.3E-08
^{60}Co	2.1E-08	2.2E-10	2.1E-08
^{82}Br	-	1.3E-08	1.3E-08
^{89}Sr	-	1.1E-09	1.1E-09
^{88}Y	-	3.8E-10	3.8E-10
^{109}Cd	-	1.2E-09	1.2E-09
^{133}Xe	9.0E-09[c]	1.6E-11[c]	9.1E-09
^{129}I	-	1.0E-12	1.0E-12
^{131}I	-	2.2E-10	2.2E-10
^{132}I	-	2.3E-09	2.3E-09
^{137}Cs	-	1.8E-10	1.8E-10
^{140}Ba	-	2.1E-09	2.1E-09
^{210}Pb	-	5.4E-10	5.4E-10
^{226}Ra	-	1.2E-09	1.2E-09
^{229}Th	-	9.3E-13	9.3E-13
^{232}Th	-	1.0E-12	1.0E-12
$^{233/234}U$	1.0E-10	1.5E-10	2.5E-10
^{236}Np	-	9.0E-12	9.0E-12
^{237}Np	-	1.0E-12	1.0E-12
^{238}Pu	1.4E-10	1.1E-12	1.4E-10
$^{239/240}Pu$	3.5E-09	3.3E-11	3.5E-09
^{242}Pu	-	1.0E-12	1.0E-12
^{244}Pu	-	1.0E-11	1.0E-11
^{241}Am	1.6E-10	1.1E-10	2.7E-10
^{243}Am	6.3E-08	1.3E-12	6.3E-08
^{244}Cm	8.8E-11	4.2E-13[d]	8.8E-11

(a) Nuclides that contribute 99% of the dose to the MEI from minor and fugitive sources. See Table 2.3 for the nuclides that contribute the remaining 1% of dose impact.
(b) Maximum of the biweekly or semi-annual average measurement.
(c) Value based on release records.
(d) Non-significant contributor to dose relative to the major emission unit release.

3.0 Dose Assessment

Dose from radiological emissions from the PNNL Site is evaluated in this section.

3.1 Description of Dose Model

The dose to the MEI was calculated using the dose-modeling program Clean Air Act Assessment Package 1988-Personal Computer (CAP88-PC) Version 3 (EPA 2007), approved by the EPA. This dose value was used to determine the compliance of the PNNL Site with the dose standard of 10 mrem/yr EDE to any member of the public in 40 CFR 61, Subpart H (2002) and WAC 246-247 (2011).

CAP88-PC Version 3 is an environmental dispersion model that allows user-entered emission point characteristics, annual emissions, site-specific meteorology, and public exposure characteristics to be used to calculate the dose to an exposed individual. Environmental dispersion and impact models are used to determine the dose to the MEI from PNNL Site radionuclide emissions (Table 2.4).

The nearest location (e.g., dwelling, business, school, office) relative to the PNNL Campus is determined for a public receptor who has the potential to receive the maximum exposure to RAEL-05 permitted emissions. This may be a hypothetical person but there must be some potential for continued occupancy at the location indicated. For example, the PNNL Site northwest fence line location was not considered because no one individual routinely occupies this location, which is in a shrub-steppe field. In addition to the physically nearest location, the location determined to have the greatest impact from emissions is provided. Due to the close proximity of the offsite businesses and the annual variability of dispersion estimates at close distances, several options for maximally impacted locations are presented (Table 3.1) based on evaluations of average meteorology from 1983 through 2006, and individual year meteorology from 2006 through 2009. The PNNL Site locations of nearest public receptors were determined. Information on these nearest receptors is provided in Table 3.1, including distances to the nearest farms that produce milk, meat, and vegetables.

Table 3.1. Locations of PNNL Campus Potential Receptors

Locale	Distance relative to PSF km (mi)	Distance relative to RTL-520 km (mi)	Distance relative to LSLII km (mi)
Offsite residence			
Condominiums (“Condos”)	0.97 (0.60) SE	1.18 NE	0.84 (0.52) E
Offsite business			
Physically nearest business[(a)]	0.17 (0.11) SSE	0.30 (0.19) SSE	0.43 (0.27) E
Location of maximum impact			
NSB Parking Lot and George Washington Way[(b)]	0.55 (0.34) SSE	1.22 (0.76) N	0.46 (0.29) NE
Onsite public receptor			
Physically nearest (ISB1 maintenance staff)	0.24 (0.15) SSE	0.52 (0.32) NNE	1.46 (0.91) N
Farm with potential for crops or livestock			
Nearest to PSF (east of Columbia River)	1.5 (0.93) E	1.81 (1.1) E	1.86 (1.2) E
PNNL Site historic MEIs			
CY2011	0.55 (0.34) SSE	n/a	n/a
CY2010	0.48 (0.30) SSE	n/a	n/a
Hanford Site historic MEIs (Rokkan et al. 2012)			
Sagemoor Rd (46.368, -119.257)	2.47 (1.5) NE	3.85 (2.4) NNE	3.14 (1.9) NNE
Ringold (46.485, -119.255)	15.22 (9.5) N	16.89 (10.5) N	15.99 (9.9) N

(a) Business varies for each reference location.
(b) No individual resides at this location, but long-term meteorology indicates this would be the region of greatest particulate air concentrations from a facility with emissions units like those of PSF (Snyder 2011).

The PNNL Site MEI is a member of the public who hypothetically receives the highest calculated radiological dose attributable to exposure to PNNL Site emissions in one calendar year. Selection of the annual MEI is contingent on the MEI's place of residence or employment.

For information purposes only, the location of the historic Hanford Site MEI near Sagemoor Road, directly east and across the Columbia River from the Hanford Site 300 Area is also indicated. This information is can be used determine dose to the Hanford Site MEI from PNNL Site emissions in order to compare the impacts of radiological emissions from the two DOE sites.

When the potential MEI locations of Table 3.1, as well as year 2012 annual meteorological data (Appendix A) were evaluated with CAP88-PC Version 3 models, the 2012 receptor of maximum impact from PSF emissions (i.e., the MEI) was determined to be 550 m SSE of PSF (Figure 3.1). This is the same as last year's MEI location. The MEI location is a routinely occupied business office location on George Washington Way. This receptor could not reasonably produce his or her own food supply at this location, but it was conservatively assumed that this was the case, in accordance with State requirements.

3.2 Summary of Input Parameters

The PNNL Site dose calculations were performed in a manner very similar to the established standards used for the Hanford Site NESHAP dose calculations (refer to DOE 2008). Radionuclide emissions data from the PNNL Site (Table 2.4) were used in the dose calculations. Emissions from 3410 Building major emission unit has been determined by modeling to most greatly impact the MEI location, primarily as a result of its lower effective release height relative to the other buildings. Therefore, the dose assessment conservatively assumes that all PSF emissions were emitted from the 3410 Building. Also, PSF emissions reported as gross alpha or gross beta were conservatively evaluated as $^{239/240}$Pu or ^{90}Sr, respectively.

Additional data used for dose calculations can be found in Appendix A; all other radionuclide-specific parameters used were default values in CAP88-PC Version 3 data libraries. Maximum individual exposure and consumption parameters are assumed to be the same as those routinely used for the Hanford Site analyses (DOE 2008). The entire hypothetical MEI diet was constructed using the "local" food production option in CAP88-PC Version 3 for ingestion-pathway parameters. This assumption greatly overestimates the dose to the MEI because no food is produced at this MEI location.

Figure 3.1. Locations of PNNL Campus Potential Receptors

3.3 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 Ci/m^3 per Ci/second (or s/m^3). Applying these factors to the annual average release rates yields an estimate of average radionuclide air concentrations for the year.

Radionuclide air concentrations at receptor locations are determined using the site-specific meteorological data. Joint-frequency distributions and CAP88-PC Version 3 wind files were prepared from data collected at the Hanford Site 300 Area weather station just north of the PNNL Site (Figure 5.1) and represent the average of hourly data recorded in 2012. Meteorological data for 2012 are presented in Appendix A as joint frequency of wind speed, wind direction, and stability category for the station located at the Hanford Site 300 Area. The close proximity of the Hanford Site 300 Area meteorological station (1500 m from PSF and less than 500 m from the PNNL Site boundary) and lack of turbulent interference allows the Hanford Site 300 Area meteorological data to be used to represent the PNNL Site meteorology.

3.4 Compliance Assessment

3.4.1 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 (2002) and applies to radionuclide air emissions, other than radon, from DOE facilities. For calendar year 2012, the PNNL Site MEI location was 0.55 km (0.34 mi) SSE of the PSF. The dose to the PNNL Site MEI from routine and nonroutine point source emissions was 9.2E-6 mrem (9.2E-8 mSv) EDE. Table 3.2 shows the relative contributions of each nuclide to the MEI dose.

For information purposes, the nearby Hanford Site, the adjacent DOE site with major emissions units, was also considered for comparative evaluation. PNNL Site air compliance is a distinctly separate issue, but the dose from such nearby major radiological emitters is worthy of consideration for total DOE-source impacts to the region. Hanford Site 300 Area emissions and the Hanford Site MEI for calendar year 2012 were reviewed. Both the PNNL Site and the Hanford Site (Rokkan, Perkins, and Snyder 2013) are in compliance with the 10 mrem/yr regulatory standard for calendar year 2012 radiological emissions. The calendar year 2012 Hanford Site MEI location was on the PNNL Site, directly south of the Hanford Site 300 Area. As a result, no dose to the Hanford Site MEI from PNNL Site emissions was estimated for 2012. The dose to the PNNL Site MEI from the Hanford Site 300 Area emissions excluding radon (emissions listed in Table 3-1 of Rokkan, Perkins, and Snyder 2013), was estimated to be 1.7E-2 mrem (1.7E-4 mSv) EDE. The majority of the impact from Hanford Site 300 Area emissions to the PNNL Site MEI is attributable to ^3H emissions (99.9%).[1]

[1] Exclusion of Hanford Site 300 Area tritium emissions results in an estimated dose to the PNNL Site MEI of 2E-5 mrem (2E-7 mSv), the majority of that dose results from the conservative assumptions used to calculate gross alpha and gross beta contributions.

Table 3.2. PNNL Site 2012 Combined Radionuclide Emissions and Dose Contributions by Nuclide from Major and Minor Emission Units and Fugitive Emissions

Radionuclide	Releases (Ci)	Dose to MEI (mrem EDE)	% of Total EDE percent
^{3}H	3.1E-06	9.1E-10	<1%
^{24}Na[a]	1.3E-08	2.0E-10	<1%
^{60}Co	2.1E-08	1.2E-08	<1%
^{82}Br[a]	1.3E-08	3.1E-10	<1%
^{89}Sr[a]	1.1E-09	4.9E-10	<1%
^{90}Sr [b]	7.8E-07	2.2E-06	**24%**
^{88}Y[a]	3.8E-10	3.5E-10	<1%
^{109}Cd[a]	1.2E-09	9.5E-10	<1%
^{133}Xe[a]	9.1E-09	5.0E-14	<1%
^{129}I[a]	1.0E-12	2.1E-10	<1%
^{131}I[a]	2.2E-10	2.5E-10	<1%
^{132}I[a]	2.3E-09	5.7E-12	<1%
^{137}Cs[b]	6.8E-08	9.6E-08	**1%**
^{140}Ba[a]	2.1E-09	4.3E-10	<1%
^{210}Pb[a]	5.4E-10	1.7E-08	<1%
^{226}Ra[a],[c]	1.2E-09	5.0E-08	**1%**
^{229}Th[a]	9.3E-13	4.5E-10	<1%
^{232}Th[a]	1.0E-12	1.7E-10	<1%
$^{233/234}U$	2.5E-10	4.1E-09	<1%
^{236}Np[a]	9.0E-12	2.0E-10	<1%
^{237}Np[a]	1.0E-12	1.6E-10	<1%
^{238}Pu	1.4E-10	7.9E-09	<1%
$^{239/240}Pu$[d]	3.5E-09	3.8E-06	**41%**
^{242}Pu[a]	1.0E-12	3.2E-10	<1%
^{244}Pu[a]	1.0E-11	3.4E-09	<1%
^{241}Am[e]	2.7E-10	3.8E-08	<1%
^{243}Am	6.3E-08	3.0E-06	**32%**
^{244}Cm	8.8E-11	3.1E-09	<1%
Table 2.3 nuclides	2.1E-08	1.2E-09	<1%
Total	**4.1E-06**	**9.2E-06**	**100%**[f]

(a) Release based on 40 CFR 61, Appendix D (1989) or release records.
(b) Gross beta from PSF building monitoring assumed to be ^{90}Sr. Gross beta from RTL-520 monitoring assumed to be ^{137}Cs. Also, calculated ^{137}Cs release based on 40 CFR 61, Appendix D (1989) and LSLII gross beta.
(c) Dose includes progeny isotope ^{222}Rn.
(d) Gross alpha from PSF building and RTL-520 monitoring assumed to be ^{239}Pu. Also includes ^{239}Pu and ^{240}Pu calculated based on 40 CFR 61, Appendix D (1989).
(e) Gross alpha from LSLII assigned as ^{241}Am.
(f) Tabulated nuclide-specific values do not add to 100% due to rounding.

As indicated earlier, the 10 mrem/y EDE standard in Subpart H applies to radionuclide air emissions, other than radon, from DOE facilities. Figure 3.2 shows the PNNL Site dose relative to the 10 mrem standard; it also includes the 2010 through 2012 Hanford Site doses (Rokkan et al. 2012; Rokkan, Perkins, and Snyder 2013) for comparison. The figure indicates the comparative radiological impact of each closely situated DOE site with respect to its MEI. In Figure 3.2, MEI_Hanford is the Hanford Site's Sagemoor Road MEI (2010 and 2011) and MEI_PNNL is the PNNL Site's MEI located SSE of PSF.

Figure 3.2. Doses to the PNNL Site and Hanford Site MEIs Due to Emissions from the PNNL Site and the Hanford Site, 2010 through 2012

3.4.2 Washington Administrative Code 246-247

For PNNL 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 40 CFR 61, Subpart H (2002). 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, and nonroutine events. The total dose to the MEI from all PNNL Campus radionuclide emissions, including major and minor points, fugitive emissions, and radon-222, is 1E-5 mrem (1E-7 mSv) EDE. There were no nonroutine emissions (refer to section 3.5) in 2012 that would contribute to dose that is considered for compliance determination with the WAC 246-247 (2011) standard.

Dose due to routine major and minor point source emissions is 9E-6 mrem (9E-8 mSv) EDE. Dose from unmonitored PNNL licensed sources were1E-7 mrem (1E-9 mSv) EDE and dose from radon is 2E-6 mrem (2E-8 mSv) EDE. The total dose of 1E-5 mrem (1E-7 mSv) EDE is 100,000 times smaller than the 10 mrem/yr WAC 246-247 (2011) limit.

3.5 Nonroutine Releases of Radionuclides to the Atmosphere

No instances of nonroutine emissions were reported in 2012.

3.6 Additional Compliance Information

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

The WDOH license (RAEL-05) requires that an environmental monitoring program be established for the PNNL Site as a condition of operation. Environmental monitoring supplements the required stack

monitoring and provides additional assurance that airborne radiological releases comply with federal and state standards. The site selection and sampling program optimization requirements are documented in Barnett et al. 2012. Particulate air sampling stations were established at three locations in mid-2010. These operated for the first full calendar year in 2011. Some monitoring station locations were re-located in 2012, based on Barnett et al. 2012. The PNNL Site Environmental Monitoring Plan is documented in Snyder et al. 2011.

3.6.2 Construction Projects and Modifications Exempted from 40 CFR 61.96

No exemptions of the approval process under 40 CFR 61.96 were requested or granted in 2012.

3.6.3 Radon-220 and Radon-222 Emissions

^{220}Radon was not emitted from PNNL Site operations in 2012. However, the 40 CFR 61, Appendix D (1989) estimate of ^{226}Ra emissions includes its progeny ^{222}Rn in the impact estimate (Table 3.2). In addition, 1.97E-4 Ci of ^{222}Rn was emitted from EP-3420-01-S in 2012. This emission resulted in a 2.0E-6 mrem (2.0E-8 mSv) EDE dose to the MEI. Radon is exempted from consideration in determining compliance with the dose standard of 40 CFR 61, Subpart H (2002) but it is encompassed by state regulations, as in WAC-246-247-040(6) (2011), which states that "[a]ll emissions of radionuclides . . . are subject to the standards of this section . . . "

4.0 Fugitive Sources of Emissions

The Clean Air Act (i.e., 40 CFR 61, Subpart H [2002]) governs emissions of radionuclides from DOE facilities and the resulting radiological doses to members of the public. A dose standard of 10 mrem/yr EDE was implemented, to which compliance is expected for radionuclide emissions emanating from both point and fugitive sources. Measuring and/or modeling these emissions are fundamental to demonstrating compliance with the standard.

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 as amenable to routine sampling in a controlled manner as is done with stacks. Emissions released from buildings to the ambient air via passive ventilation systems are also considered fugitive because they lack a measurable flow. These emissions mix with ambient air, which may also include emissions from point sources. Emissions from all PNNL Site sources are monitored by four offsite particulate air sampling stations. The air surveillance program conducted in 2012 is described in Section 5.3.

Measuring emissions from point sources (i.e., generally stacks) is ordinarily a prescriptive process, using well-defined technical methods, as described in 40 CFR 61, Subpart H, or alternatives approved by EPA, and includes applying atmospheric transport models to emissions measured at the facility stack. Subpart H monitoring methods, however, are not intended for, nor amenable to, measuring fugitive emissions.

With respect to dose effects from fugitive emissions, WDOH regulations are consistent with a mutual inter-agency Memorandum of Understanding (DOE 1995), 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 some 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. Past operations at the nearby Hanford Site created a number of fugitive sources within the landscape, whose emissions could impact the PNNL Site. The Hanford Site fugitive emissions are evaluated in detail in their Radiological Air Emissions Report (e.g., Rokkan et al. 2012). The PNNL Site contains no comparable non-facility-specific fugitive emission sources.

The PNNL Site has three sources characterized as fugitive sources from Site facilities. Only one of these (3425 Building) had emissions in 2012. This source and several minor sources were grouped for purposes of estimating the MEI dose with emissions estimated using 40 CFR Part 61, Appendix D (1989) methodologies (Table 2.2 and Table 2.3). Because the PNNL Site emission units are well characterized, emissions from the fugitive and minor sources have been estimated in this manner, previously approved by WDOH and EPA. For this report, doses from fugitive and minor emission units have been calculated using CAP88-PC Version 3 and are included with the dose from major point source emissions, for purposes of demonstrating compliance with the dose standard. Doses from only the fugitive and minor sources are 1E-7 mrem (1E-9 mSv) EDE.

5.0 Supplemental Information

This section provides supplemental information related to PNNL Site radionuclide air emissions in 2012 and consists of the following:

- population dose estimate
- compliance status with 40 CFR 61, Subparts Q (2000) and T (2000)
- radionuclide emission estimates and periodic confirmatory measurement information related to Notices of Construction (NOCs)
- ambient air sampling measurements
- quality assurance (QA) program status of compliance with 40 CFR 61, Appendix B (2000), Method 114.

5.1 Population Dose Estimate

The estimated regional population radiation dose (i.e., the collective EDE) from PNNL Site air emissions in 2012 was calculated using a simplified method that overestimates the population dose. The population consists of approximately 432,000 people residing within a 50-mi (80-km) radius of the Hanford Site 300 Area (Hamilton and Snyder 2011). The close proximity of the Hanford Site 300 Area and relatively rural region within 50 mi of the PNNL Site permits the Hanford Site 300 Area 50-mi population estimate to be applicable. Pathways evaluated for population exposure include inhalation, air submersion, ground-shine, and consumption of food.

Population exposure to radionuclide air emissions was determined using the MEI dose estimate (9.2E-6 mrem) times the 50-mi population (432,117). The 2012 total population dose from radionuclide air emissions estimated in this very conservative manner from nuclides that originate from the PNNL Site was 0.0040 person-rem (4.0E-5 person-Sv). This represents a decrease over the 2011 estimate of 0.0073 person-rem (Snyder et al. 2012). See Section 6.0 for the corrigendum of the reported population dose for 2011 emissions.

5.2 Compliance Status with 40 CFR 61, Subparts Q and T

In 40 CFR 61, Subpart Q (2000), "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 emit ^{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 $pCi/m^2/s$. No operations from the storage and disposal of radium-bearing material resulting in radon emissions are conducted at the PNNL Site.

Activities at the PNNL Site were evaluated for compliance with 40 CFR 61, Subpart T (2000), "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. No uranium milling and uranium-ore processing activities are conducted at the PNNL Site.

Subparts T and Q do not apply to the PNNL Site for calendar year 2012 operations.

5.3 Environmental Surveillance for the PNNL Site

A particulate air sampling network was established in 2010 to monitor radioactive particulates in ambient air near the PNNL Site. This sampling was initiated prior to the start of radiological operations at the new PSF buildings. The first full calendar year of air surveillance was conducted in 2011. To satisfy air permit requirements, throughout 2012 sampling data was collected at four ambient air samplers at locations within and along the perimeter of the PNNL Campus (Figure 5.1). In addition to PNNL Site emissions, these samplers can collect radioactive particulates released from other nearby sources. During 2012, the Hanford Site 300 Area would have contributed most of the non-PNNL particulates detected from offsite facilities.

5.3.1 Environmental Surveillance

Routine surveillance activities at the PNNL Site include air sampling for particulate radionuclides. The air surveillance program is described in Snyder et al. 2011 and attachments (Meier 2011; Bisping 2011; Snyder 2011). The air surveillance monitoring locations were reevaluated in 2012 (Barnett et al. 2012) based on two factors: the expanded footprint of DOE-permitted radiological operations locations (i.e., the addition of LSLII and RTL facilities) and the re-location of the PNL-1 and PNL-2 monitoring stations to their permanent locations. The initial location of PNL-1 and PNL-2 were sufficient, but not ideal, as siting was partially driven by access to electrical infrastructure. Solar panels are used to operate the permanent PNL-1 and PNL-2 location equipment.

During the first six months of 2012, environmental air surveillance continued to be performed at the three original sampling stations of 2011; PNL-1, PNL-2, and PNL-3 (Figure 5.1). In June 2012, two original air monitoring stations, PNL-1 and PNL-2 were discontinued and removed. Simultaneously, two new solar-powered air monitoring stations where established on the PNNL Site. The solar-powered stations were positioned to cover the same area as the discontinued stations and continue to be called PNL-1 and PNL-2. At the same time, a fourth air sampling station, PNL-4, was added to the sampling network, southwest of the Battelle baseball field. PNL-4 provides ambient monitoring for the southern extent of the PNNL Campus (Barnett et al. 2012) and only represents the second half of 2012, when the RTL facilities were brought under the DOE license.

CAP88-PC Version 3 modeling was used to calculate an adjustment factor to approximate the PNL-1 and PNL-2 particulate air concentrations to model each station's results, as if the air was monitored at the final PNL-1 and PNL-2 positions. The adjustment factors were based on full 2012 meteorology rather than just the six months that the original PNL-1 and PNL-2 locations were operational. The adjustment factor for PNL-1 was 2.6 and the adjustment factor for PNL-2 was 1.6. Table 5.1 indicates the PNL1- and PNL-2 unadjusted and adjusted results for each sampler type and location.

Figure 5.1. Air Surveillance Station Locations for the PNNL Campus

Table 5.1. Summary of 2012 Air Sampling Results for PNL-1 and PNL-2

Radionuclide	Location[a]	No. of Samples	No. of Detections	Average ± 2 sd (pCi/m^3)	Adj Factor[b]	Adjusted PNL-1 and PNL-2 Average ± 2 sd (pCi/m^3)
Gross Alpha	PNL-1	13	12	5.1E-04 ± 3.1E-04	2.6	1.0E-03 ± 6.3E-04
	PNL-1 Solar	12	12	7.3E-04 ± 4.5E-04		
	PNL-2	12	9	5.3E-04 ± 4.3E-04	1.6	8.4E-04 ± 6.3E-04
	PNL-2 Solar	13	13	8.5E-04 ± 5.8E-04		
Gross Beta	PNL-1	13	13	1.4E-02 ± 8.7E-03	2.6	2.8E-02 ± 1.8E-02
	PNL-1 Solar	12	12	2.0E-02 ± 1.4E-02		
	PNL-2	12	12	1.5E-02 ± 9.1E-03	1.6	2.2E-02 ± 1.5E-02
	PNL-2 Solar	13	13	2.1E-02 ± 1.5E-02		
Cobalt-60	PNL-1	2	0	2.7E-04 ± 2.0E-04	2.6	4.7E-04 ± 4.7E-04
	PNL-1 Solar	1[c]	0	2.5E-04 ± 4.3E-04		
	PNL-2	2	0	1.6E-04 ± 8.5E-06	1.6	1.0E-04 ± 2.7E-04
	PNL-2 Solar	1[c]	0	-5.5E-05 ± 5.2E-04		
Uranium-234	PNL-1	1[c]	1	4.3E-05 ± 1.7E-05	2.6	8.0E-05 ± 2.7E-05
	PNL-1 Solar	1[c]	1	4.6E-05 ± 1.0E-05		
	PNL-2	1[c]	1	5.3E-05 ± 1.5E-05	1.6	6.6E-05 ± 1.7E-05
	PNL-2 Solar	1[c]	1	4.7E-05 ± 1.0E-05		
Plutonium 238	PNL-1	1[c]	0	1.6E-06 ± 2.3E-06	2.6	1.7E-06 ± 4.1E-06
	PNL-1 Solar	1[c]	0	-6.8E-07 ± 2.1E-06		
	PNL-2	1[c]	0	-3.4E-07 ± 2.1E-06	1.6	-1.8E-08 ± 2.6E-06
	PNL-2 Solar	1[c]	0	5.1E-07 ± 1.8E-06		
Plutonium 239/240	PNL-1	1[c]	1	4.3E-06 ± 3.1E-06	2.6	6.1E-06 ± 5.1E-06
	PNL-1 Solar	1[c]	0	8.5E-07 ± 2.1E-06		
	PNL-2	1[c]	1	3.4E-06 ± 2.6E-06	1.6	2.5E-06 ± 3.2E-06
	PNL-2 Solar	1[c]	0	-5.1E-07 ± 2.3E-06		
Americium-241[d]	PNL-1	1[c]	0	8.5E-07 ± 2.6E-06	2.6	1.1E-06 ± 4.8E-06
	PNL-1 Solar	1[c]	0	0.0E+00 ± 2.8E-06		
	PNL-2	1[c]	0	1.3E-06 ± 5.1E-06	1.6	1.8E-06 ± 6.9E-06
	PNL-2 Solar	1[c]	0	1.5E-06 ± 5.7E-06		
Americium-243	PNL-1	1[c]	0	1.8E-06 ± 7.5E-06	2.6	1.5E-06 ± 1.2E-05
	PNL-1 Solar	1[c]	0	-1.6E-06 ± 3.7E-06		
	PNL-2	1[c]	0	1.4E-06 ± 4.1E-06	1.6	2.4E-06 ± 5.8E-06
	PNL-2 Solar	1[c]	0	2.6E-06 ± 5.1E-06		
Curium-243/244	PNL-1	1[c]	0	-1.4E-07 ± 3.7E-06	2.6	-1.0E-06 ± 6.4E-06
	PNL-1 Solar	1[c]	0	-1.7E-06 ± 3.2E-06		
	PNL-2	1[c]	0	-1.2E-06 ± 2.5E-06	1.6	-1.4E-06 ± 5.0E-06
	PNL-2 Solar	1[c]	0	-8.7E-07 ± 6.0E-06		

(a) Refer to Figure 5.1.
(b) January -June 2012 PNL-1 and PNL-2 ran as 120V near the Hanford Site 300 Area. Second half of 2012, both stations transitioned to solar (24V) and moved to permanent locations; adjustment factor applies to first half of 2012 and was determined by using modeling program CAP88-PC Version 3.
(c) Single result ± total propagated analytical error.
(d) ^{241}Am values reported are for the analyses done by the more sensitive alpha spectroscopy method.

Particulate air samples are routinely analyzed for gross alpha activity, gross beta activity, gamma-emitting isotopes, uranium isotopes (^{234}U[1], ^{235}U, and ^{238}U), and plutonium isotopes (^{238}Pu and $^{239/240}$Pu). Gamma-emitting isotope concentrations reported in 2012 include ^{60}Co. In addition, americium isotopes (^{241}Am and ^{243}Am) and $^{243/244}$Cm are analyzed. Also, the Hanford Site has several nearby community sampling locations within a 30-mi (48-km) radius of the PNNL Site as well as a background location at a single distant community station in Yakima (MSA 2013). The Yakima station is upwind of both the PNNL Site (60 mi WNW) and the Hanford Site (36 mi W), and is considered to be unaffected by either of the DOE operations.

[1] ^{234}U is a naturally-occurring radionuclide. It is co-reported with ^{233}U by the analytical laboratory because the emission peaks overlap.

5.3.2 Air Sampling Results for Calendar Year 2012 Operations

The particulate air sampling results are provided in Appendix C, Table C.2, for the calendar year 2012 PNNL Site sampling, as well as the Yakima background station. Results are summarized in Table 5.2 for the PNNL Site stations and the Yakima background station. With the exception of results for Am and Cm isotopes (for which no background samples were available), all results at the PNNL Site sample stations were within 2 standard deviations (sd) of the Yakima background levels. The Am and Cm results were less than 40 CFR Part 61 Appendix E (1989), Table 5.2 values. There was no indication of substantially elevated levels of monitored particulate radionuclides in the vicinity of the PNNL Site from either onsite or other nearby sources.

Table 5.2. Summary of 2012 Air Sampling Results

Radionuclide	Location[a]	No. of Samples	No. of Detections	Average ± 2 sd (pCi/m3)			Adjusted Average ± Adjusted 2 sd (pCi/m^3)[b]		
Gross Alpha	PNL-1	25	24	6.2E-04	±	4.4E-04	1.0E-03	±	6.3E-04
	PNL-2	25	22	6.9E-04	±	6.0E-04	8.4E-04	±	6.3E-04
	PNL-3	24	17	6.3E-04	±	6.9E-04			
	PNL-4	13	13	6.7E-04	±	3.1E-04			
	Yakima	26	23	6.2E-04	±	8.2E-04			
Gross Beta	PNL-1	25	25	1.7E-02	±	1.3E-02	2.8E-02	±	1.8E-02
	PNL-2	25	25	1.8E-02	±	1.3E-02	2.2E-02	±	1.5E-02
	PNL-3	24	24	1.6E-02	±	1.1E-02			
	PNL-4	13	13	1.9E-02	±	1.1E-02			
	Yakima	26	26	1.4E-02	±	1.2E-02			
Cobalt-60	PNL-1	3	0	2.6E-04	±	1.4E-04	4.7E-04	±	4.7E-04
	PNL-2	3	0	9.0E-05	±	2.5E-04	1.0E-04	±	2.7E-04
	PNL-3	3	0	2.3E-04	±	2.2E-04			
	PNL-4	1[c]	0	3.9E-04	±	3.8E-04			
	Yakima	4	0	7.9E-05	±	4.6E-04			
Uranium-233/234	PNL-1	2	2	4.5E-05	±	4.0E-06	8.0E-05	±	2.7E-05
	PNL-2	2	2	5.0E-05	±	8.8E-06	6.6E-05	±	1.7E-05
	PNL-3	2	2	4.1E-05	±	1.2E-05			
	PNL-4	1[c]	1	4.6E-05	±	1.0E-05			
Uranium-234	Yakima	4	0	3.8E-05	±	6.5E-05			
Plutonium 238	PNL-1	2	0	4.5E-07	±	3.2E-06	1.7E-06	±	4.1E-06
	PNL-2	2	0	8.4E-08	±	1.2E-06	-1.8E-08	±	2.6E-06
	PNL-3	2	0	4.2E-07	±	8.0E-08			
	PNL-4	1[c]	0	-5.5E-07	±	1.7E-06			
	Yakima	4	0	-1.1E-06	±	7.0E-06			
Plutonium 239/240	PNL-1	2	1	2.6E-06	±	4.9E-06	6.1E-06	±	5.1E-06
	PNL-2	2	1	1.5E-06	±	5.5E-06	2.5E-06	±	3.2E-06
	PNL-3	2	1	3.5E-06	±	2.2E-06			
	PNL-4	1[c]	0	-4.8E-07	±	2.3E-06			
	Yakima	4	0	3.0E-07	±	3.3E-06			
Americium-241[d]	PNL-1	2	0	4.2E-07	±	1.2E-06	1.1E-06	±	4.8E-06
	PNL-2	2	0	1.4E-06	±	2.4E-07	1.8E-06	±	6.9E-06
	PNL-3	2	0	-1.5E-06	±	1.4E-05			
	PNL-4	1[c]	0	1.8E-06	±	4.9E-06			
	Yakima	0	0		NA				

Table 5.2. (contd)

Radionuclide	Location[(a)]	No. of Samples	No. of Detections	Average ± 2 sd (pCi/m3)			Adjusted Average ± Adjusted 2 sd (pCi/m^3)[(b)]		
Americium-243	PNL-1	2	0	8.5E-08	±	4.8E-06	1.5E-06	±	1.2E-05
	PNL-2	2	0	2.0E-06	±	1.7E-06	2.4E-06	±	5.8E-06
	PNL-3	2	0	-4.0E-06	±	1.2E-05			
	PNL-4	1[(c)]	0	1.0E-06	±	5.4E-06			
	Yakima	0	0		NA				
Curium-243/244	PNL-1	2	0	-9.0E-07	±	2.2E-06	-1.0E-06	±	6.4E-06
	PNL-2	2	0	-1.0E-06	±	4.0E-07	-1.4E-06	±	5.0E-06
	PNL-3	2	0	-7.9E-07	±	2.6E-06			
	PNL-4	1[(c)]	0	-1.0E-06	±	3.0E-06			
	Yakima	0	0		NA				

NA = Not Analyzed
(a) Refer to Figure 5.1.
(b) January -June 2012 PNL-1 and PNL-2 ran as 120V near the Hanford Site 300 Area. Second half of 2012, both stations transitioned to solar (24V) and moved to permanent locations; adjustment factor applies to first half of 2012 and was determined by using modeling program CAP88-PC Version 3.
(c) Single result ± total propagated analytical error.
(d) ^{241}Am values reported are for the analyses done by the more sensitive alpha spectroscopy method.

5.4 Quality Assurance Program Compliance Status

Air emissions data reported in this document reflect the product of many QA activities concerned with the collecting, handling, analyzing, validating, and reporting of samples and the resultant analytical data. Those activities are identified in the QA plans (PNNL 2012) and in the PNNL Site Environmental Monitoring Plan (Snyder et al. 2011). The effluent monitoring QA elements described in PNNL (2012) are compatible with one or more of the documents shown in Table 5.3 during calendar year 2012. QA requirements were implemented, as appropriate, at the PNNL Site as new facilities became operational and programmatic plans were developed.

Table 5.3. Summary List of Quality Assurance-Related Documents

10 CFR 830 (2001), *Nuclear Safety Management*
40 CFR 61, Appendix B (2000), "*Method 114 – Test Methods for Measuring Radionuclide Emissions from Stationary Sources*"
ANSI/ASME NQA-1-2000, *Quality Assurance Requirements for Nuclear Facilities*
DOE Order 414.1D (2011), *Quality Assurance*
DOE Order 450.1A (2008), *Environmental Protection Program*
DOE Order 458.1 (2011), *Radiation Protection of the Public and the Environment*
DOE/EH-0173T (1991), Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance
EPA QA/R-5 (2001), EPA Requirements for Quality Assurance Project Plans

6.0 Corrigendum to the 2011 Population Dose

A units conversion error was identified in the population dose estimate for calendar year 2011 emissions of Snyder et al. 2012. The 2011 population dose estimate was reported to be 7.3 person-rem, but the correct value is 0.0073 person-rem.

7.0 References

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Appendix A

Dose Modeling and Meteorological Data

Appendix A

Dose Modeling and Meteorological Data

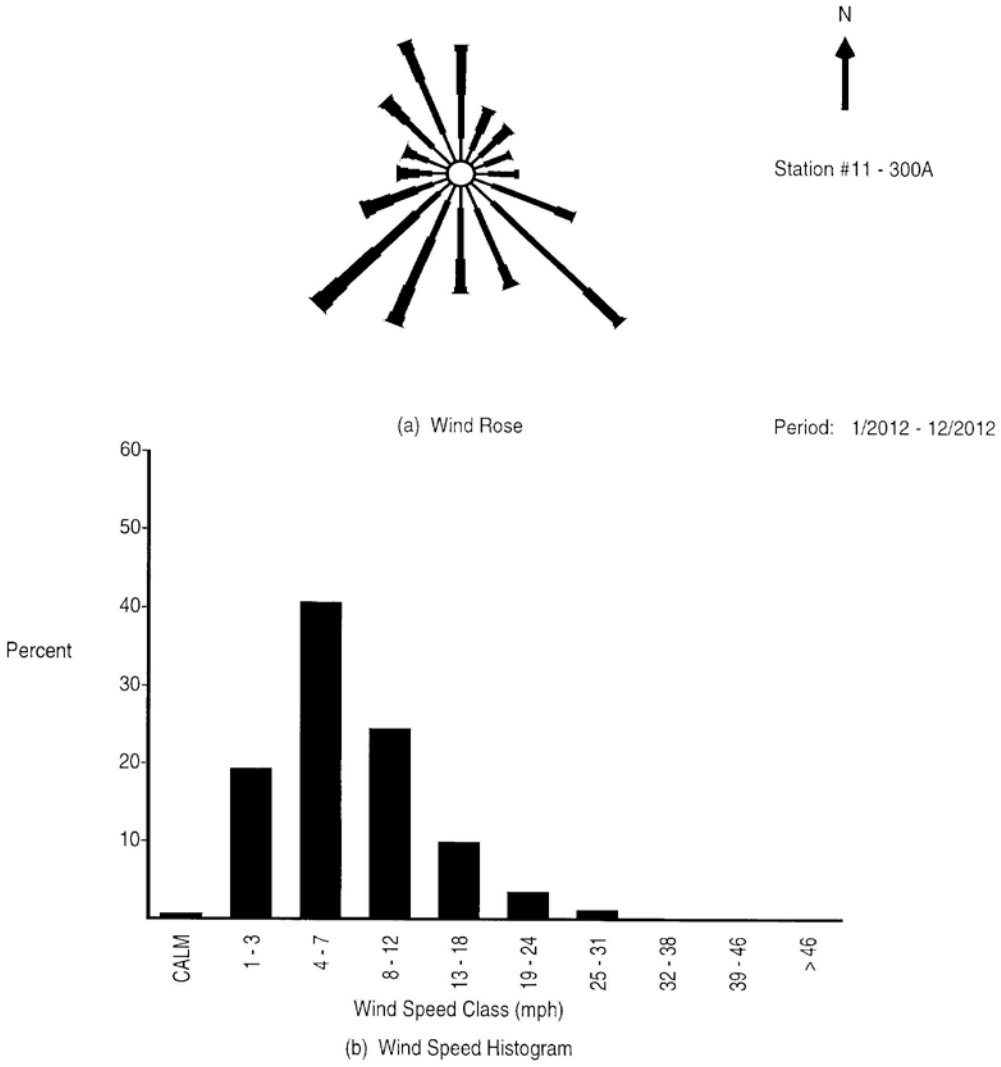

Figure A.1. Hanford Site 300 Area Meteorological Station Wind Rose and Histogram for 2012

Table A.1. Annual Average Joint Frequency during 2012 (as percent of time) of Wind Speed, Stability Class, and Direction for the Hanford Site 300 Area (Station 11) 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	0.02	0.03	0.03	0	0.01	0.02	0.02	0.02	0.02	0.01	0	0	0	0	0	0	0.18
	B	0.01	0.04	0.04	0.05	0.07	0.03	0.04	0.01	0.01	0.01	0	0.02	0.03	0.01	0.03	0.02	0.42
	C	0.06	0.04	0.15	0.09	0.09	0.04	0.08	0.13	0.04	0.02	0.01	0.04	0.01	0	0.01	0.02	0.83
	D	0.29	0.12	0.21	0.18	0.19	0.27	0.34	0.23	0.27	0.24	0.18	0.11	0.17	0.28	0.24	0.31	3.63
	E	0.39	0.29	0.21	0.21	0.25	0.35	0.70	0.55	0.47	0.52	0.40	0.35	0.29	0.39	0.48	0.81	6.66
	F	0.47	0.22	0.10	0.10	0.13	0.35	0.46	0.51	0.43	0.23	0.36	0.35	0.29	0.50	0.57	0.59	5.66
	G	0.21	0.11	0.05	0.09	0.10	0.17	0.27	0.26	0.23	0.14	0.09	0.10	0.13	0.16	0.27	0.26	2.64
	Total	**1.45**	**0.85**	**0.79**	**0.72**	**0.84**	**1.23**	**1.91**	**1.71**	**1.47**	**1.17**	**1.04**	**0.97**	**0.92**	**1.34**	**1.60**	**2.01**	**20.02**
2.65	A	0.02	0.09	0.38	0.53	0.53	0.53	0.36	0.20	0.17	0.28	0.23	0.11	0.07	0.01	0.02	0.02	3.55
	B	0.08	0.09	0.40	0.51	0.38	0.39	0.37	0.23	0.14	0.19	0.19	0.06	0.03	0.03	0.03	0.03	3.15
	C	0.06	0.08	0.22	0.27	0.24	0.34	0.50	0.25	0.21	0.14	0.11	0.05	0.04	0.06	0.07	0.07	2.71
	D	0.80	0.43	0.19	0.13	0.23	0.64	1.24	0.64	0.52	0.56	0.34	0.19	0.12	0.18	0.52	0.90	7.63
	E	1.02	0.32	0.08	0.05	0.10	0.95	2.16	0.91	1.11	0.89	0.64	0.51	0.37	0.34	0.99	1.30	11.74
	F	0.53	0.16	0.04	0	0.05	1.02	2.53	1.30	0.90	0.38	0.30	0.15	0.12	0.17	0.46	0.94	9.05
	G	0.24	0.04	0.01	0	0.03	0.30	0.81	0.45	0.24	0.13	0.07	0.02	0.02	0.02	0.14	0.30	2.82
	Total	**2.75**	**1.21**	**1.32**	**1.49**	**1.56**	**4.17**	**7.97**	**3.98**	**3.29**	**2.57**	**1.88**	**1.09**	**0.77**	**0.81**	**2.23**	**3.56**	**40.65**
4.70	A	0.11	0.31	0.57	0.11	0.10	0.19	0.36	0.13	0.16	0.37	0.43	0.14	0.05	0.03	0.01	0.01	3.08
	B	0.11	0.23	0.21	0.04	0.09	0.14	0.29	0.11	0.17	0.43	0.26	0.07	0.04	0.02	0.01	0.04	2.26
	C	0.11	0.18	0.09	0	0.03	0.09	0.23	0.05	0.15	0.37	0.28	0.10	0.02	0	0.05	0.06	1.81
	D	0.47	0.21	0.03	0	0.03	0.12	0.53	0.15	0.31	0.61	0.79	0.44	0.23	0.15	0.30	0.59	4.96
	E	0.93	0.19	0.05	0.03	0.01	0.27	0.60	0.49	0.62	0.99	1.19	0.67	0.26	0.21	0.34	0.76	7.61
	F	0.69	0.11	0	0	0.03	0.23	0.52	0.15	0.30	0.54	0.34	0.19	0.08	0.02	0.11	0.35	3.66
	G	0.29	0.06	0	0	0.01	0.05	0.14	0.03	0.09	0.15	0.13	0	0	0	0.01	0.09	1.05
	Total	**2.71**	**1.29**	**0.95**	**0.18**	**0.30**	**1.09**	**2.67**	**1.11**	**1.80**	**3.46**	**3.42**	**1.61**	**0.68**	**0.43**	**0.83**	**1.90**	**24.43**
7.15	A	0.10	0.15	0.10	0	0	0	0.01	0.01	0.05	0.27	0.71	0.32	0.06	0	0.07	0.02	1.87
	B	0.04	0.01	0.01	0	0	0	0.01	0.01	0.02	0.15	0.25	0.08	0.03	0.01	0.05	0.01	0.68
	C	0.07	0	0	0	0	0	0.01	0	0.02	0.13	0.24	0.09	0.05	0.02	0.04	0.05	0.72
	D	0.02	0.02	0	0	0.01	0.03	0.07	0.04	0.08	0.53	0.69	0.35	0.20	0.12	0.31	0.27	2.74
	E	0.12	0.04	0.05	0.02	0	0.06	0.10	0.10	0.13	0.62	0.89	0.33	0.12	0.04	0.27	0.22	3.11
	F	0.04	0	0.06	0.03	0	0	0.01	0	0.04	0.12	0.14	0.06	0.01	0.01	0.04	0.08	0.64
	G	0.02	0.01	0	0	0	0	0	0	0.01	0.05	0.03	0	0	0	0	0	0.12
	Total	**0.41**	**0.23**	**0.22**	**0.05**	**0.01**	**0.09**	**0.21**	**0.16**	**0.35**	**1.87**	**2.95**	**1.23**	**0.47**	**0.20**	**0.78**	**0.65**	**9.88**

Table A.1. (contd)

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**
9.8	A	0.03	0.05	0.01	0	0	0	0.02	0	0.03	0.07	0.19	0.18	0.08	0.02	0	0	0.68
	B	0.01	0.01	0	0	0	0	0	0	0	0.05	0.08	0.05	0	0	0.01	0	0.21
	C	0	0	0	0	0	0	0	0	0	0.03	0.13	0.03	0.02	0.01	0	0	0.22
	D	0.02	0.02	0.03	0	0	0	0.01	0.01	0.05	0.13	0.37	0.13	0.05	0.06	0.14	0.08	1.10
	E	0	0	0	0	0	0	0.05	0.18	0.02	0.27	0.41	0.06	0.01	0	0.08	0.02	1.10
	F	0	0	0	0	0	0	0	0	0.01	0.01	0.13	0	0	0	0	0	0.15
	G	0	0	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0.02
	Total	**0.06**	**0.08**	**0.04**	**0.00**	**0.00**	**0.00**	**0.08**	**0.19**	**0.11**	**0.56**	**1.33**	**0.45**	**0.16**	**0.09**	**0.23**	**0.10**	**3.48**
12.7	A	0	0	0	0	0	0	0	0	0	0	0.03	0.13	0.01	0	0	0	0.17
	B	0	0	0	0	0	0	0	0	0	0	0.07	0.03	0.01	0	0	0	0.11
	C	0	0	0	0	0	0	0	0	0	0.01	0.07	0.02	0.01	0	0.01	0	0.12
	D	0	0	0	0	0	0	0	0	0	0.04	0.32	0.07	0.02	0.01	0.06	0	0.52
	E	0.01	0	0	0	0	0	0	0.04	0.02	0.04	0.17	0	0	0	0.01	0	0.29
	F	0	0	0	0	0	0	0	0	0	0	0	0.01	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**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.04**	**0.02**	**0.09**	**0.66**	**0.26**	**0.05**	**0.01**	**0.08**	**0.00**	**1.22**
15.6	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0.01
	B	0	0	0	0	0	0	0	0	0	0	0	0.01	0.02	0.01	0	0	0.04
	C	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0.01	0	0	0	0.03
	D	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0	0	0	0.03
	E	0	0	0	0	0	0	0	0	0	0.02	0.04	0	0	0	0	0	0.06
	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	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.03**	**0.08**	**0.01**	**0.03**	**0.02**	**0.00**	**0.00**	**0.17**
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	0.02	0	0	0	0	0	0.02
	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	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**

Table A.1. (contd)

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**
Total	A	0.28	0.63	1.09	0.64	0.64	0.74	0.77	0.36	0.43	1.00	1.59	0.88	0.27	0.07	0.10	0.05	9.54
	B	0.25	0.38	0.66	0.60	0.54	0.56	0.71	0.36	0.34	0.83	0.85	0.32	0.16	0.08	0.13	0.10	6.87
	C	0.30	0.30	0.46	0.36	0.36	0.47	0.82	0.43	0.42	0.71	0.85	0.33	0.16	0.09	0.18	0.20	6.44
	D	1.60	0.80	0.46	0.31	0.46	1.06	2.19	1.07	1.23	2.11	2.72	1.29	0.79	0.80	1.57	2.15	20.61
	E	2.47	0.84	0.39	0.31	0.36	1.63	3.61	2.27	2.37	3.35	3.76	1.92	1.05	0.98	2.17	3.11	30.59
	F	1.73	0.49	0.20	0.13	0.21	1.60	3.52	1.96	1.68	1.28	1.27	0.76	0.50	0.70	1.18	1.96	19.17
	G	0.76	0.22	0.06	0.09	0.14	0.52	1.22	0.74	0.57	0.47	0.34	0.12	0.15	0.18	0.42	0.65	6.65
	Total	**7.39**	**3.66**	**3.32**	**2.44**	**2.71**	**6.58**	**12.84**	**7.19**	**7.04**	**9.75**	**11.38**	**5.62**	**3.08**	**2.90**	**5.75**	**8.22**	**99.87**

Table A.2. Radionuclide Data on Clearance Type, Particle Size, Scavenging Coefficient, and Deposition Velocity Used for CAP88-PC Version 3 Dose Calculations

Radionuclide	Clearance type	Particle size (1 m)	Scavenging Coefficient (per second)	Deposition Velocity (m/s)
^{3}H (vapor)	V	0	0	0
^{3}H (elemental)	G	0	0	0
^{24}Na	M	1.0	1.60 E-06	1.80 E-03
^{60}Co	M	1.0	1.60 E-06	1.80 E-03
^{82}Br	M	1.0	1.60 E-06	1.80 E-03
^{85}Kr	G	0	0	0
^{90}Sr	M	1.0	1.60 E-06	1.80 E-03
^{99}Tc	M	1.0	1.60 E-06	1.80 E-03
^{131m}Xe	G	0	0	0
^{133}Xe	G	0	0	0
^{133m}Xe	G	0	0	0
^{135}Xe	G	0	0	0
^{137m}Ba	M	1.0	1.60 E-06	1.80 E-03
^{137}Cs	F	1.0	1.60 E-06	1.80 E-03
^{151}Sm	M	1.0	1.60 E-06	1.80 E-03
^{155}Eu	M	1.0	1.60 E-06	1.80 E-03
^{188}W	M	1.0	1.60 E-06	1.80 E-03
^{220}Rn	G	0	0	0
^{222}Rn	G	0	0	0
^{228}Th	S	1.0	1.60 E-06	1.80 E-03
^{232}Th	S	1.0	1.60 E-06	1.80 E-03
^{232}U	M	1.0	1.60 E-06	1.80 E-03
^{233}U	M	1.0	1.60 E-06	1.80 E-03
^{234}U	M	1.0	1.60 E-06	1.80 E-03
^{235}U	M	1.0	1.60 E-06	1.80 E-03
^{236}U	M	1.0	1.60 E-06	1.80 E-03
^{238}U	M	1.0	1.60 E-06	1.80 E-03
^{238}Pu	M	1.0	1.60 E-06	1.80 E-03
^{239}Pu	M	1.0	1.60 E-06	1.80 E-03
^{241}Pu	M	1.0	1.60 E-06	1.80 E-03
^{242}Pu	M	1.0	1.60 E-06	1.80 E-03
^{241}Am	M	1.0	1.60 E-06	1.80 E-03
^{243}Am	M	1.0	1.60 E-06	1.80 E-03
^{244}Cm	M	1.0	1.60 E-06	1.80 E-03
^{250}Cf[(a)]	M	1.0	1.60 E-06	1.80 E-03

(a) ^{250}Cf is an EPA-approved surrogate for ^{252}Cf, used here due to issues with CAP88-PC Version 3 computational errors related to ^{252}Cf (Rhoads and Barnett 2009).
V = vapor (water vapor for tritium); G = gas (elemental gas for tritium); S = particulate, slow clearance rate; M = particulate, moderate clearance rate; F = particulate, fast clearance rate

Table A.3. Radionuclide Data on Decay Constant and Transfer Coefficient Used for CAP88-PC Version 3 Dose Calculations

	Decay constant (per day)			Transfer coefficient	
Radionuclide	**Radioactive**	**Surface**	**Water**	**Milk[(a)]**	**Meat[(b)]**
^{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
^{24}Na	1.11 E+00	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
^{82}Br	4.71 E-01	5.48 E-05	0	2.00 E-02	5.00 E-02
^{85}Kr	1.77 E–04	5.48 E–05	0	0	0
^{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
^{131m}Xe	5.82 E–02	5.48 E–05	0	0	0
^{133}Xe	1.32 E–01	5.48 E–05	0	0	0
^{133m}Xe	1.32 E–01	5.48 E–05	0	0	0
^{135}Xe	1.83 E+00	5.48 E–05	0	0	0
^{137m}Ba	3.91 E+02	5.48 E-05	0	5.00 E-04	2.00 E-04
^{137}Cs	6.32 E–05	5.48 E–05	0	0	0
^{151}Sm	2.11 E-05	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
^{183}Ta	1.36 E-01	5.48 E-05	0	5.00 E-06	5.00 E-06
^{188}W	9.99 E-03	5.48 E-05	0	3.00 E-04	4.00 E-02
^{220}Rn	1.08 E+03	5.48 E–05	0	0	0
^{222}Rn	1.81 E–01	5.48 E–05	0	0	0
^{228}Th	9.92 E-04	5.48 E-05	0	5.00 E-06	1.00 E-04
^{232}Th	1.35 E-13	5.48 E-05	0	5.00 E-06	1.00 E-04
^{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
^{236}U	8.10 E-11	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
^{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
^{242}Pu	5.04 E-09	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
^{244}Cm	1.05 E–04	5.48 E–05	0	2.00 E–06	2.00 E–05
^{250}Cf [(c)]	1.45 E-04	5.48 E-05	0	2.00 E-06	6.00 E-05

(a) Fraction of animal's daily intake of nuclide that appears in each liter of milk, in days/L.
(b) Fraction of animal's daily intake of nuclide that appears in each kg of meat, in days/kg.
(c) ^{250}Cf is a surrogate for ^{252}Cf (Rhoads and Barnett 2009).

Table A.4. Radionuclide Data on Concentration Uptake Factor and Gastric Intestinal Uptake Fraction Used for CAP88-PC Version 3 Dose Calculations

	Concentration uptake factor		GI uptake fraction	
Radionuclide	**Forage[(a)]**	**Edible[(b)]**	**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
^{24}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
^{82}Br	2.00 E+00	4.00 E-01	1.00 E+00	1.00 E+00
^{85}Kr	0	0	0	0
^{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
^{131m}Xe	0	0	0	0
^{133}Xe	0	0	0	0
^{133m}Xe	0	0	0	0
^{135}Xe	0	0	0	0
^{137m}Ba	1.00 E-01	1.00 E-02	2.00 E-01	2.00 E-01
^{137}Cs	1.00 E+00	2.00 E–01	1.00 E+00	1.00 E+00
^{151}Sm	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
^{188}W	3.00 E+00	8.00 E-01	3.00 E-01	3.00 E-01
^{220}Rn	0	0	0	0
^{222}Rn	0	0	0	0
^{228}Th	1.00 E-01	1.00 E-03	5.00 E-04	5.00 E-04
^{232}Th	1.00 E-01	1.00 E-03	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
^{236}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
^{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
^{242}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
^{244}Cm	1.00 E–01	1.00 E–03	5.00 E–04	5.00 E–04
^{250}Cf[(c)]	1.00 E–01	1.00 E–03	5.00 E–04	5.00 E–04

GI = gastric intestinal

(a) Concentration factor for uptake of nuclide from soil for pasture and forage, in pCi/kg dry weight per pCi/kg dry soil.

(b) Concentration factor for uptake of nuclide from soil by edible parts of crops, in pCi/kg wet weight per pCi/kg dry soil.

(c) ^{250}Cf is a surrogate for ^{252}Cf (Rhoads and Barnett 2009).

Table A.5. Exposure and Consumption Data for the PNNL Site

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

Food	Local	Regional	Imported
Vegetable	1.000	0.000	0.000
Meat	1.000	0.000	0.000
Milk	1.000	0.000	0.000

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) = 365

DELAY TIMES
Ingestion of pasture grass by animals (hr) = 0.00 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

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

Table A.5. (contd.)

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 = 0.00 E+00
Meat = 0.00 E+00
Milk = 0.00 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

The following meteorological data describe the PNNL Site for application in CAP88-PC Version 3 (EPA 2007).

Table A.6. PNNL Site Meteorological Data — General 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 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

List of Radioactive Materials Handled or Potentially Handled at the PNNL Site in 2012

Appendix B

List of Radioactive Materials Handled or Potentially Handled at the PNNL Site in 2012

Table B.1. Radionuclides Used and/or Potentially Used at the PNNL Site in 2012 (2 sheets)

Ac-225	Br-82	Cs-134	Hg-203	Lu-177m	Pb-209	Rb-87
Ac-227	Br-82m	Cs-134m	Ho-163	Mg-27	Pb-210	Rb-88
Ac-228	Br-83	Cs-135	Ho-166	Mg-28	Pb-211	Rb-89
Ag-108	Br-84	Cs-136	Ho-166m	Mn-52	Pb-212	Rb-90
Ag-108m	Br-84m	Cs-137	I-122	Mn-54	Pb-214	Rb-90m
Ag-109m	Br-85	Cs-138	I-123	Mn-56	Pd-103	Re-186
Ag-110	C-11	Cs-139	I-125	Mo-93	Pd-107	Re-187
Ag-110m	C-14	Cs-140	I-126	Mo-99	Pd-109	Re-188
Ag-111	C-15	Cs-141	I-128	Mo-103	Pm-143	Rh-101
Al-26	Ca-41	Cu-64	I-129	Mo-104	Pm-144	Rh-102
Al-28	Ca-45	Cu-66	I-130	Mo-105	Pm-145	Rh-102m
Am-241	Ca-47	Dy-159	I-130m	N-13	Pm-146	Rh-103m
Am-242	Cd-107	Dy-165	I-131	Na-22	Pm-147	Rh-104
Am-242m	Cd-109	Dy-169	I-132	Na-24	Pm-148	Rh-105
Am-243	Cd-111m	Er-169	I-132m	Na-24m	Pm-148m	Rh-105m
Am-245	Cd-113	Er-171	I-133	Nb-91	Pm-149	Rh-106
Am-246	Cd-113m	Es-254	I-133m	Nb-91m	Pm-151	Rn-219
Ar-37	Cd-115	Eu-150	I-134	Nb-92	Po-208	Rn-220
Ar-39	Cd-115m	Eu-152	I-134m	Nb-93m	Po-209	Rn-222
Ar-41	Cd-117	Eu-152m	I-135	Nb-94	Po-210	Rn-224
Ar-42	Cd-117m	Eu-154	In-106	Nb-95	Po-211	Ru-97
As-74	Ce-139	Eu-155	In-111	Nb-95m	Po-212	Ru-103
As-76	Ce-141	Eu-156	In-113m	Nb-97	Po-213	Ru-105
As-77	Ce-142	Eu-157	In-114	Nb-97m	Po-214	Ru-106
At-217	Ce-143	F-18	In-114m	Nb-98	Po-215	S-35
Au-195	Ce-144	Fe-55	In-115	Nb-100	Po-216	Sb-122
Au-198	Cf-249	Fe-59	In-115m	Nb-101	Po-218	Sb-124
Au-198m	Cf-250	Fr-221	In-116	Nb-103	Pr-143	Sb-125
Ba-131	Cf-251	Fr-223	In-116m	Nd-144	Pr-144	Sb-126
Ba-133	Cf-252	Ga-67	In-117	Nd-147	Pr-144m	Sb-126m
Ba-133m	Cl-36	Ga-68	In-117m	Ni-56	Pu-234	Sb-127
Ba-137m	Cm-241	Ga-70	Ir-192	Ni-59	Pu-236	Sb-129
Ba-139	Cm-242	Ga-72	K-40	Ni-63	Pu-237	Sc-44
Ba-140	Cm-243	Gd-148	K-42	Ni-65	Pu-238	Sc-46
Ba-141	Cm-244	Gd-149	Kr-81	Np-235	Pu-239	Sc-47
Ba-142	Cm-245	Gd-151	Kr-81m	Np-236	Pu-240	Se-75
Ba-143	Cm-246	Gd-152	Kr-83m	Np-237	Pu-241	Se-79
Be-7	Cm-247	Gd-153	Kr-85	Np-238	Pu-242	Se-79m
Be-10	Cm-248	Ge-68	Kr-85m	Np-239	Pu-243	Si-31
Bi-207	Cm-250	Ge-71	Kr-87	Np-240	Pu-244	Si-32
Bi-208	Co-56	Ge-71m	Kr-88	Np-240m	Pu-246	Sm-145
Bi-210	Co-57	Ge-75	Kr-89	O-15	Ra-223	Sm-146
Bi-210m	Co-58	Ge-77	Kr-90	O-19	Ra-224	Sm-147
Bi-211	Co-60	Ge-77m	La-137	Os-191	Ra-225	Sm-148
Bi-212	Co-60m	H-3	La-138	P-32	Ra-226	Sm-151
Bi-213	Cr-49	Hf-175	La-140	P-33	Ra-228	Sm-153
Bi-214	Cr-51	Hf-178m	La-141	Pa-231	Rb-81	Sm-157
Bk-247	Cr-55	Hf-179m	La-142	Pa-233	Rb-83	Sn-113
Bk-249	Cs-131	Hf-181	La-144	Pa-234	Rb-84	Sn-117m
Bk-250	Cs-132	Hf-182	Lu-177	Pa-234m	Rb-86	Sn-119m

Table B.1. (contd)

Sn-121	Tc-95m	Te-133	Tm-170	Xe-127m	Zn-65	
Sn-121m	Tc-97	Te-133m	Tm-171	Xe-129m	Zn-69	
Sn-123	Tc-97m	Te-134	U-232	Xe-131m	Zn-69m	
Sn-125	Tc-98	Th-227	U-233	Xe-133	Zr-88	
Sn-126	Tc-99	Th-228	U-234	Xe-133m	Zr-89	
Sr-85	Tc-99m	Th-229	U-235	Xe-135	Zr-93	
Sr-87m	Tc-101	Th-230	U-236	Xe-135m	Zr-95	
Sr-89	Tc-103	Th-231	U-237	Xe-137	Zr-97	
Sr-90	Tc-106	Th-232	U-238	Xe-138	Zr-98	
Sr-91	Te-121	Th-233	U-239	Xe-139	Zr-99	
Sr-92	Te-121m	Th-234	U-240	Y-88	Zr-100	
Ta-179	Te-123	Ti-44	V-48	Y-90		
Ta-180	Te-123m	Ti-45	V-49	Y-90m		
Ta-182	Te-125m	Ti-51	W-181	Y-91		
Ta-182m	Te-127	Tl-201	W-185	Y-91m		
Ta-183	Te-127m	Tl-204	W-187	Y-92		
Tb-157	Te-129	Tl-206	W-188	Y-93		
Tb-158	Te-129m	Tl-207	Xe-122	Yb-164		
Tb-160	Te-131	Tl-208	Xe-123	Yb-169		
Tb-161	Te-131m	Tl-209	Xe-125	Yb-175		
Tc-95	Te-132	Tm-168	Xe-127	Yb-177		

Appendix C

Ambient Air Sampling Results for PNNL Site Air Surveillance in 2012

Appendix C

Ambient Air Sampling Results for PNNL Site Air Surveillance in 2012

Table C.1. Definitions for Air Sampling Data

Column Heading	Data Type/Format	Content
SAMP_SITE_NAME	text	Location of sampling station. Yakima = background location; PNL-1, PNL-2, PNL-3 = PNNL Site sampling stations.
SAMP_MTHD	text	The method used to collect the sample.
LAB_SAMP_ID	9-digit number	
SAMP_DATE_TIME_ON	date (dd-month-yy)	Date when air sampling started.
SAMP_DATE_TIME	date (dd-month-yy)	Date when air sampling ended.
CON_SHORT_NAME	text	ALPHA, BETA, Am-241, Am-241 gamma, Am-243, Be-7, BETA, Cm-243/244, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, H-3, K-40, Pu-238, Pu-239/240, Ru-106, Sb-125, Sr-90, U-234, U-235, U-238. The Am-241 is the result from alpha spectroscopy, which also is done for the Cm. The Am-241 gamma is the gamma spectroscopy result, which is the less sensitive evaluation. The U-234 result is the sum of U-233 and U-234, the analytical method available for U-233 reporting.
VALUE_RPTD	number (usually scientific notation)	Result reported by the analytical laboratory.
ANAL_UNITS_RPTD	text	pCi per cubic meter. Units associated with the values shown in the VALUE_RPTD, COUNTING_ERROR, and TOTAL_ANAL_ERROR 2-SIGMA columns.
COUNTING_ERROR	number (usually scientific notation)	The 2-sigma counting error for the radioanalytical results only.
TOTAL_ANAL_ERROR 2-SIGMA	number (usually scientific notation)	The 2-sigma total analytical error for the radioanalytical results only.
LAB_QUALIFIER	text or blank	If “U”, the constituent Value_Rptd is less than the counting error, total analytical error, minimum detectable activity. If blank, no qualifier was needed. If “X”, and the VALUE_RPTD column is not blank, see comment regarding radio-analysis.
RESULT_COMMENT	text or blank	Comment on the result. If blank, no comment was needed. Not indicated in pre-operations samples, because all were blank.
COMPOSITE_FLAG	Y or blank	If “Y”, several samples from the same sampling station were composited and the composite measured for radioactivity. If blank, a single sample was evaluated.

Further details on each PNNL Site sample (e.g., analysis method) can be obtained from the full database (Hanford Environmental Information System [HEIS] 1989).

Table C.2. Air Sampling Results for the PNNL Site and the Yakima Background Station for Calendar Year 2012

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
PNL-1	FILTER2	294057001	28-Dec-11	11-Jan-12	ALPHA	4.84E-04	pCi/m^3	3.04E-04	3.07E-04			
PNL-1	FILTER2	294922001	11-Jan-12	25-Jan-12	ALPHA	3.93E-04	pCi/m^3	2.40E-04	2.40E-04			
PNL-1	FILTER2	295804002	25-Jan-12	8-Feb-12	ALPHA	3.90E-04	pCi/m^3	2.62E-04	2.66E-04			
PNL-1	FILTER2	296515002	8-Feb-12	22-Feb-12	ALPHA	7.10E-04	pCi/m^3	3.46E-04	3.55E-04			
PNL-1	FILTER2	297353001	22-Feb-12	7-Mar-12	ALPHA	5.12E-04	pCi/m^3	3.04E-04	3.10E-04			
PNL-1	FILTER2	298151003	7-Mar-12	21-Mar-12	ALPHA	3.20E-04	pCi/m^3	2.57E-04	2.58E-04			
PNL-1	FILTER2	301307001	21-Mar-12	4-Apr-12	ALPHA	2.25E-04	pCi/m^3	2.14E-04	2.14E-04	U		
PNL-1	FILTER2	303118001	4-Apr-12	18-Apr-12	ALPHA	7.04E-04	pCi/m^3	3.38E-04	3.41E-04			
PNL-1	FILTER2	303809001	18-Apr-12	2-May-12	ALPHA	5.72E-04	pCi/m^3	2.89E-04	2.90E-04			
PNL-1	FILTER2	304651001	2-May-12	16-May-12	ALPHA	7.57E-04	pCi/m^3	3.72E-04	3.74E-04			
PNL-1	FILTER2	305301004	16-May-12	30-May-12	ALPHA	5.05E-04	pCi/m^3	2.73E-04	2.74E-04			
PNL-1	FILTER2	306381001	30-May-12	13-Jun-12	ALPHA	5.02E-04	pCi/m^3	2.53E-04	2.53E-04			
PNL-1	FILTER2	306835004	13-Jun-12	27-Jun-12	ALPHA	5.38E-04	pCi/m^3	3.08E-04	3.12E-04			
PNL-1	FILTER2 SOLAR	307737001	27-Jun-12	11-Jul-12	ALPHA	6.86E-04	pCi/m^3	3.23E-04	3.23E-04			
PNL-1	FILTER2 SOLAR	308584001	11-Jul-12	25-Jul-12	ALPHA	8.62E-04	pCi/m^3	3.33E-04	3.34E-04			
PNL-1	FILTER2 SOLAR	309457001	25-Jul-12	8-Aug-12	ALPHA	6.34E-04	pCi/m^3	2.87E-04	2.88E-04			
PNL-1	FILTER2 SOLAR	310939001	22-Aug-12	5-Sep-12	ALPHA	7.87E-04	pCi/m^3	3.58E-04	3.60E-04			
PNL-1	FILTER2 SOLAR	311736001	5-Sep-12	19-Sep-12	ALPHA	8.95E-04	pCi/m^3	3.38E-04	3.39E-04			
PNL-1	FILTER2 SOLAR	312507001	19-Sep-12	3-Oct-12	ALPHA	6.88E-04	pCi/m^3	3.15E-04	3.16E-04			
PNL-1	FILTER2 SOLAR	313495001	3-Oct-12	17-Oct-12	ALPHA	1.02E-03	pCi/m^3	3.73E-04	3.74E-04			
PNL-1	FILTER2 SOLAR	314353001	17-Oct-12	31-Oct-12	ALPHA	4.61E-04	pCi/m^3	2.95E-04	2.95E-04			
PNL-1	FILTER2 SOLAR	315315001	31-Oct-12	14-Nov-12	ALPHA	9.37E-04	pCi/m^3	3.81E-04	3.82E-04			
PNL-1	FILTER2 SOLAR	315910001	14-Nov-12	28-Nov-12	ALPHA	3.73E-04	pCi/m^3	2.44E-04	2.44E-04			
PNL-1	FILTER2 SOLAR	316721001	28-Nov-12	12-Dec-12	ALPHA	9.95E-04	pCi/m^3	4.01E-04	4.03E-04		REFER TO DISCREPANCY RPT EMP13-001. ORIGINAL VALUE REPLACED BY RECOUNT VALUE TO MEET MINIMUM 96 HOUR HOLD TIME.	

Table C.2. (contd)

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
PNL-1	FILTER2 SOLAR	317383001	12-Dec-12	26-Dec-12	ALPHA	4.17E-04	pCi/m^3	2.42E-04	2.42E-04			
PNL-1	FILTER2	315514001	28-Dec-11	27-Jun-12	Am-241	8.46E-07	pCi/m^3	2.63E-06	2.63E-06	U		Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	Am-241	0.00E+00	pCi/m^3	2.80E-06	2.81E-06	U		Y
PNL-1	FILTER2	315514001	28-Dec-11	27-Jun-12	Am-243	1.78E-06	pCi/m^3	7.52E-06	7.52E-06	U		Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	Am-243	-1.61E-06	pCi/m^3	3.72E-06	3.73E-06	U		Y
PNL-1	FILTER2	315514001	28-Dec-11	27-Jun-12	Cm-243/244	-1.35E-07	pCi/m^3	3.74E-06	3.74E-06	U		Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	Cm-243/244	-1.66E-06	pCi/m^3	3.14E-06	3.15E-06	U		Y
PNL-1	FILTER2	294057001	28-Dec-11	11-Jan-12	BETA	1.74E-02	pCi/m^3	1.15E-03	1.31E-03			
PNL-1	FILTER2	294922001	11-Jan-12	25-Jan-12	BETA	2.04E-02	pCi/m^3	1.22E-03	1.44E-03			
PNL-1	FILTER2	295804002	25-Jan-12	8-Feb-12	BETA	1.77E-02	pCi/m^3	1.15E-03	1.33E-03			
PNL-1	FILTER2	296515002	8-Feb-12	22-Feb-12	BETA	2.24E-02	pCi/m^3	1.29E-03	1.55E-03			
PNL-1	FILTER2	297353001	22-Feb-12	7-Mar-12	BETA	1.11E-02	pCi/m^3	9.21E-04	9.56E-04			
PNL-1	FILTER2	298151003	7-Mar-12	21-Mar-12	BETA	1.05E-02	pCi/m^3	9.77E-04	1.07E-03			
PNL-1	FILTER2	301307001	21-Mar-12	4-Apr-12	BETA	9.47E-03	pCi/m^3	8.82E-04	9.34E-04			
PNL-1	FILTER2	303118001	4-Apr-12	18-Apr-12	BETA	1.11E-02	pCi/m^3	8.70E-04	1.38E-03			
PNL-1	FILTER2	303809001	18-Apr-12	2-May-12	BETA	1.08E-02	pCi/m^3	8.92E-04	9.94E-04			
PNL-1	FILTER2	304651001	2-May-12	16-May-12	BETA	1.62E-02	pCi/m^3	1.07E-03	1.13E-03			
PNL-1	FILTER2	305301004	16-May-12	30-May-12	BETA	1.35E-02	pCi/m^3	9.72E-04	1.09E-03			
PNL-1	FILTER2	306381001	30-May-12	13-Jun-12	BETA	9.70E-03	pCi/m^3	8.48E-04	8.82E-04			
PNL-1	FILTER2	306835004	13-Jun-12	27-Jun-12	BETA	9.34E-03	pCi/m^3	7.87E-04	7.97E-04			
PNL-1	FILTER2 SOLAR	307737001	27-Jun-12	11-Jul-12	BETA	1.60E-02	pCi/m^3	1.12E-03	1.21E-03			
PNL-1	FILTER2 SOLAR	308584001	11-Jul-12	25-Jul-12	BETA	1.74E-02	pCi/m^3	1.12E-03	1.25E-03			
PNL-1	FILTER2 SOLAR	309457001	25-Jul-12	8-Aug-12	BETA	1.71E-02	pCi/m^3	1.08E-03	1.28E-03			
PNL-1	FILTER2 SOLAR	310939001	22-Aug-12	5-Sep-12	BETA	1.59E-02	pCi/m^3	1.05E-03	1.13E-03			
PNL-1	FILTER2 SOLAR	311736001	5-Sep-12	19-Sep-12	BETA	2.31E-02	pCi/m^3	1.26E-03	1.57E-03			
PNL-1	FILTER2 SOLAR	312507001	19-Sep-12	3-Oct-12	BETA	3.27E-02	pCi/m^3	1.56E-03	2.04E-03			
PNL-1	FILTER2 SOLAR	313495001	3-Oct-12	17-Oct-12	BETA	3.28E-02	pCi/m^3	1.49E-03	1.76E-03			
PNL-1	FILTER2 SOLAR	314353001	17-Oct-12	31-Oct-12	BETA	1.36E-02	pCi/m^3	9.90E-04	1.06E-03			

Table C.2. (contd)

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
PNL-1	FILTER2 SOLAR	315315001	31-Oct-12	14-Nov-12	BETA	2.03E-02	pCi/m^3	1.27E-03	1.55E-03			
PNL-1	FILTER2 SOLAR	315910001	14-Nov-12	28-Nov-12	BETA	1.71E-02	pCi/m^3	1.11E-03	1.21E-03			
PNL-1	FILTER2 SOLAR	316721001	28-Nov-12	12-Dec-12	BETA	1.76E-02	pCi/m^3	1.11E-03	1.34E-03		REFER TO DISCREPANCY RPT EMP13-001. ORIGINAL VALUE REPLACED BY RECOUNT VALUE TO MEET MINIMUM 96 HOUR HOLD TIME.	
PNL-1	FILTER2 SOLAR	317383001	12-Dec-12	26-Dec-12	BETA	1.12E-02	pCi/m^3	9.18E-04	9.71E-04			
PNL-1	FILTER2	306156001	28-Dec-11	4-Apr-12	Am-241-GAMMA	9.04E-04	pCi/m^3	1.58E-03	1.63E-03	U		Y
PNL-1	FILTER2	306156001	28-Dec-11	4-Apr-12	Be-7	5.72E-02	pCi/m^3	2.27E-02	2.28E-02			Y
PNL-1	FILTER2	310956001	4-Apr-12	27-Jun-12	Be-7	6.07E-02	pCi/m^3	1.28E-02	1.28E-02			Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	Be-7	3.24E-02	pCi/m^3	7.76E-03	8.23E-03			Y
PNL-1	FILTER2	306156001	28-Dec-11	4-Apr-12	Co-60	1.96E-04	pCi/m^3	6.43E-04	6.49E-04	U		Y
PNL-1	FILTER2	310956001	4-Apr-12	27-Jun-12	Co-60	3.36E-04	pCi/m^3	4.09E-04	4.36E-04	U		Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	Co-60	2.47E-04	pCi/m^3	4.18E-04	4.33E-04	U		Y
PNL-1	FILTER2	306156001	28-Dec-11	4-Apr-12	Cs-134	-4.26E-06	pCi/m^3	6.40E-04	6.40E-04	U		Y
PNL-1	FILTER2	310956001	4-Apr-12	27-Jun-12	Cs-134	6.11E-05	pCi/m^3	3.38E-04	3.39E-04	U		Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	Cs-134	8.95E-05	pCi/m^3	2.99E-04	3.02E-04	U		Y
PNL-1	FILTER2	306156001	28-Dec-11	4-Apr-12	Cs-137	-2.77E-04	pCi/m^3	5.67E-04	5.81E-04	U		Y
PNL-1	FILTER2	310956001	4-Apr-12	27-Jun-12	Cs-137	8.00E-05	pCi/m^3	2.79E-04	2.81E-04	U		Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	Cs-137	-9.92E-05	pCi/m^3	2.94E-04	2.98E-04	U		Y
PNL-1	FILTER2	306156001	28-Dec-11	4-Apr-12	Eu-152	4.11E-04	pCi/m^3	1.66E-03	1.67E-03	U		Y
PNL-1	FILTER2	310956001	4-Apr-12	27-Jun-12	Eu-152	1.74E-04	pCi/m^3	6.86E-04	6.90E-04	U		Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	Eu-152	-2.44E-04	pCi/m^3	8.18E-04	8.26E-04	U		Y
PNL-1	FILTER2	306156001	28-Dec-11	4-Apr-12	Eu-154	1.28E-03	pCi/m^3	1.67E-03	1.76E-03	U		Y
PNL-1	FILTER2	310956001	4-Apr-12	27-Jun-12	Eu-154	-3.02E-04	pCi/m^3	9.85E-04	9.95E-04	U		Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	Eu-154	1.80E-04	pCi/m^3	1.03E-03	1.04E-03	U		Y
PNL-1	FILTER2	306156001	28-Dec-11	4-Apr-12	Eu-155	4.44E-04	pCi/m^3	1.54E-03	1.55E-03	U		Y

Table C.2. (contd)

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
PNL-1	FILTER2	310956001	4-Apr-12	27-Jun-12	Eu-155	-2.74E-05	pCi/m^3	4.14E-04	4.14E-04	U		Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	Eu-155	-2.11E-04	pCi/m^3	7.61E-04	7.67E-04	U		Y
PNL-1	FILTER2	306156001	28-Dec-11	4-Apr-12	K-40	-1.71E-03	pCi/m^3	6.98E-03	7.02E-03	U		Y
PNL-1	FILTER2	310956001	4-Apr-12	27-Jun-12	K-40	4.87E-03	pCi/m^3	3.67E-03	4.28E-03	U		Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	K-40	2.14E-03	pCi/m^3	4.66E-03	4.76E-03	U		Y
PNL-1	FILTER2	306156001	28-Dec-11	4-Apr-12	Ru-106	-7.02E-04	pCi/m^3	5.87E-03	5.88E-03	U		Y
PNL-1	FILTER2	310956001	4-Apr-12	27-Jun-12	Ru-106	1.24E-03	pCi/m^3	2.74E-03	2.80E-03	U		Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	Ru-106	-2.10E-03	pCi/m^3	2.94E-03	3.10E-03	U		Y
PNL-1	FILTER2	306156001	28-Dec-11	4-Apr-12	Sb-125	3.58E-04	pCi/m^3	1.55E-03	1.56E-03	U		Y
PNL-1	FILTER2	310956001	4-Apr-12	27-Jun-12	Sb-125	-6.98E-04	pCi/m^3	7.23E-04	7.89E-04	U		Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	Sb-125	-1.93E-04	pCi/m^3	8.55E-04	8.59E-04	U		Y
PNL-1	FILTER2	315514001	28-Dec-11	27-Jun-12	Pu-238	1.58E-06	pCi/m^3	2.33E-06	2.33E-06	U		Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	Pu-238	-6.84E-07	pCi/m^3	2.11E-06	2.11E-06	U		Y
PNL-1	FILTER2	315514001	28-Dec-11	27-Jun-12	Pu-239/240	4.34E-06	pCi/m^3	3.10E-06	3.11E-06			Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	Pu-239/240	8.48E-07	pCi/m^3	2.14E-06	2.14E-06	U		Y
PNL-1	FILTER2	315514001	28-Dec-11	27-Jun-12	U-233/234	4.34E-05	pCi/m^3	1.55E-05	1.66E-05			Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	U-233/234	4.64E-05	pCi/m^3	8.27E-06	1.02E-05			Y
PNL-1	FILTER2	315514001	28-Dec-11	27-Jun-12	U-235	4.56E-06	pCi/m^3	6.32E-06	6.34E-06	U		Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	U-235	1.18E-06	pCi/m^3	2.99E-06	2.99E-06	U		Y
PNL-1	FILTER2	315514001	28-Dec-11	27-Jun-12	U-238	4.06E-05	pCi/m^3	1.30E-05	1.40E-05			Y
PNL-1	FILTER2 SOLAR	318770003	27-Jun-12	26-Dec-12	U-238	5.98E-05	pCi/m^3	8.60E-06	1.14E-05			Y
PNL-2	FILTER2	294057002	28-Dec-11	11-Jan-12	ALPHA	4.53E-04	pCi/m^3	2.54E-04	2.59E-04			
PNL-2	FILTER2	294922002	11-Jan-12	25-Jan-12	ALPHA	6.20E-04	pCi/m^3	3.08E-04	3.10E-04			
PNL-2	FILTER2	295804003	25-Jan-12	8-Feb-12	ALPHA	7.67E-04	pCi/m^3	3.41E-04	3.46E-04			
PNL-2	FILTER2	296515003	8-Feb-12	22-Feb-12	ALPHA	7.29E-04	pCi/m^3	2.84E-04	2.90E-04			
PNL-2	FILTER2	297353002	22-Feb-12	7-Mar-12	ALPHA	4.11E-04	pCi/m^3	2.35E-04	2.36E-04			
PNL-2	FILTER2	298151004	7-Mar-12	21-Mar-12	ALPHA	1.81E-04	pCi/m^3	1.71E-04	1.71E-04	U		
PNL-2	FILTER2	301307002	21-Mar-12	4-Apr-12	ALPHA	3.37E-04	pCi/m^3	2.94E-04	2.95E-04	U		
PNL-2	FILTER2	303118002	4-Apr-12	18-Apr-12	ALPHA	8.07E-04	pCi/m^3	3.83E-04	3.87E-04			
PNL-2	FILTER2	304651002	2-May-12	16-May-12	ALPHA	6.70E-04	pCi/m^3	3.50E-04	3.52E-04			

Table C.2. (contd)

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
PNL-2	FILTER2	305301005	16-May-12	30-May-12	ALPHA	6.77E-04	pCi/m^3	3.26E-04	3.27E-04			
PNL-2	FILTER2	306381002	30-May-12	13-Jun-12	ALPHA	2.17E-04	pCi/m^3	2.08E-04	2.08E-04	U		
PNL-2	FILTER2	306835005	13-Jun-12	27-Jun-12	ALPHA	4.42E-04	pCi/m^3	2.72E-04	2.73E-04			
PNL-2	FILTER2 SOLAR	307737002	27-Jun-12	11-Jul-12	ALPHA	9.94E-04	pCi/m^3	3.82E-04	3.83E-04			
PNL-2	FILTER2 SOLAR	308584002	11-Jul-12	25-Jul-12	ALPHA	8.88E-04	pCi/m^3	3.61E-04	3.65E-04			
PNL-2	FILTER2 SOLAR	309457002	25-Jul-12	8-Aug-12	ALPHA	6.29E-04	pCi/m^3	2.90E-04	2.91E-04			
PNL-2	FILTER2 SOLAR	310090002	8-Aug-12	22-Aug-12	ALPHA	1.03E-03	pCi/m^3	3.81E-04	3.82E-04			
PNL-2	FILTER2 SOLAR	310939002	22-Aug-12	5-Sep-12	ALPHA	4.66E-04	pCi/m^3	3.29E-04	3.30E-04			
PNL-2	FILTER2 SOLAR	311736002	5-Sep-12	19-Sep-12	ALPHA	9.50E-04	pCi/m^3	3.79E-04	3.80E-04			
PNL-2	FILTER2 SOLAR	312507002	19-Sep-12	3-Oct-12	ALPHA	1.39E-03	pCi/m^3	5.05E-04	5.08E-04			
PNL-2	FILTER2 SOLAR	313495002	3-Oct-12	17-Oct-12	ALPHA	8.93E-04	pCi/m^3	3.93E-04	3.95E-04			
PNL-2	FILTER2 SOLAR	314353002	17-Oct-12	31-Oct-12	ALPHA	3.89E-04	pCi/m^3	2.76E-04	2.77E-04			
PNL-2	FILTER2 SOLAR	315315002	31-Oct-12	14-Nov-12	ALPHA	1.11E-03	pCi/m^3	4.22E-04	4.25E-04			
PNL-2	FILTER2 SOLAR	315910002	14-Nov-12	28-Nov-12	ALPHA	6.31E-04	pCi/m^3	3.33E-04	3.34E-04			
PNL-2	FILTER2 SOLAR	316721002	28-Nov-12	12-Dec-12	ALPHA	1.07E-03	pCi/m^3	4.00E-04	4.02E-04		REFER TO DISCREPANCY RPT EMP13-001. ORIGINAL VALUE REPLACED BY RECOUNT VALUE TO MEET MINIMUM 96 HOUR HOLD TIME.	
PNL-2	FILTER2 SOLAR	317383002	12-Dec-12	26-Dec-12	ALPHA	5.77E-04	pCi/m^3	3.82E-04	3.83E-04			
PNL-2	FILTER2	315514002	28-Dec-11	27-Jun-12	Am-241	1.34E-06	pCi/m^3	5.09E-06	5.09E-06	U		Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	Am-241	1.51E-06	pCi/m^3	5.68E-06	5.69E-06	U		Y
PNL-2	FILTER2	315514002	28-Dec-11	27-Jun-12	Am-243	1.38E-06	pCi/m^3	4.10E-06	4.10E-06	U		Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	Am-243	2.57E-06	pCi/m^3	5.05E-06	5.08E-06	U		Y

Table C.2. (contd)

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
PNL-2	FILTER2	315514002	28-Dec-11	27-Jun-12	Cm-243/244	-1.15E-06	pCi/m^3	2.50E-06	2.50E-06	U		Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	Cm-243/244	-8.70E-07	pCi/m^3	6.01E-06	6.02E-06	U		Y
PNL-2	FILTER2	294057002	28-Dec-11	11-Jan-12	BETA	1.75E-02	pCi/m^3	1.02E-03	1.22E-03			
PNL-2	FILTER2	294922002	11-Jan-12	25-Jan-12	BETA	2.29E-02	pCi/m^3	1.31E-03	1.62E-03			
PNL-2	FILTER2	295804003	25-Jan-12	8-Feb-12	BETA	1.89E-02	pCi/m^3	1.21E-03	1.59E-03			
PNL-2	FILTER2	296515003	8-Feb-12	22-Feb-12	BETA	2.01E-02	pCi/m^3	1.04E-03	1.51E-03			
PNL-2	FILTER2	297353002	22-Feb-12	7-Mar-12	BETA	1.10E-02	pCi/m^3	7.96E-04	8.36E-04			
PNL-2	FILTER2	298151004	7-Mar-12	21-Mar-12	BETA	9.46E-03	pCi/m^3	8.10E-04	8.66E-04			
PNL-2	FILTER2	301307002	21-Mar-12	4-Apr-12	BETA	1.11E-02	pCi/m^3	1.05E-03	1.11E-03			
PNL-2	FILTER2	303118002	4-Apr-12	18-Apr-12	BETA	1.43E-02	pCi/m^3	1.11E-03	1.41E-03			
PNL-2	FILTER2	304651002	2-May-12	16-May-12	BETA	1.86E-02	pCi/m^3	1.18E-03	1.28E-03			
PNL-2	FILTER2	305301005	16-May-12	30-May-12	BETA	1.59E-02	pCi/m^3	1.10E-03	1.38E-03			
PNL-2	FILTER2	306381002	30-May-12	13-Jun-12	BETA	1.07E-02	pCi/m^3	9.28E-04	9.75E-04			
PNL-2	FILTER2	306835005	13-Jun-12	27-Jun-12	BETA	1.04E-02	pCi/m^3	8.68E-04	9.25E-04			
PNL-2	FILTER2 SOLAR	307737002	27-Jun-12	11-Jul-12	BETA	1.59E-02	pCi/m^3	1.10E-03	1.20E-03			
PNL-2	FILTER2 SOLAR	308584002	11-Jul-12	25-Jul-12	BETA	1.64E-02	pCi/m^3	1.09E-03	1.22E-03			
PNL-2	FILTER2 SOLAR	309457002	25-Jul-12	8-Aug-12	BETA	1.79E-02	pCi/m^3	1.09E-03	1.28E-03			
PNL-2	FILTER2 SOLAR	310090002	8-Aug-12	22-Aug-12	BETA	2.25E-02	pCi/m^3	1.31E-03	1.50E-03			
PNL-2	FILTER2 SOLAR	310939002	22-Aug-12	5-Sep-12	BETA	1.69E-02	pCi/m^3	1.12E-03	1.19E-03			
PNL-2	FILTER2 SOLAR	311736002	5-Sep-12	19-Sep-12	BETA	2.23E-02	pCi/m^3	1.31E-03	1.35E-03			
PNL-2	FILTER2 SOLAR	312507002	19-Sep-12	3-Oct-12	BETA	3.76E-02	pCi/m^3	1.71E-03	2.21E-03			
PNL-2	FILTER2 SOLAR	313495002	3-Oct-12	17-Oct-12	BETA	3.28E-02	pCi/m^3	1.52E-03	1.72E-03			
PNL-2	FILTER2 SOLAR	314353002	17-Oct-12	31-Oct-12	BETA	1.45E-02	pCi/m^3	1.04E-03	1.10E-03			
PNL-2	FILTER2 SOLAR	315315002	31-Oct-12	14-Nov-12	BETA	2.37E-02	pCi/m^3	1.34E-03	1.61E-03			
PNL-2	FILTER2 SOLAR	315910002	14-Nov-12	28-Nov-12	BETA	1.83E-02	pCi/m^3	1.18E-03	1.26E-03			

Table C.2. (contd)

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
PNL-2	FILTER2 SOLAR	316721002	28-Nov-12	12-Dec-12	BETA	1.95E-02	pCi/m^3	1.18E-03	1.30E-03		REFER TO DISCREPANCY RPT EMP13-001. ORIGINAL VALUE REPLACED BY RECOUNT VALUE TO MEET MINIMUM 96 HOUR HOLD TIME.	
PNL-2	FILTER2 SOLAR	317383002	12-Dec-12	26-Dec-12	BETA	1.19E-02	pCi/m^3	9.62E-04	1.01E-03			
PNL-2	FILTER2	306156002	28-Dec-11	4-Apr-12	Am-241-GAMMA	-3.18E-03	pCi/m^3	3.77E-03	4.04E-03	U		Y
PNL-2	FILTER2	306156002	28-Dec-11	4-Apr-12	Be-7	4.02E-02	pCi/m^3	2.34E-02	2.34E-02			Y
PNL-2	FILTER2	310956002	4-Apr-12	27-Jun-12	Be-7	9.61E-02	pCi/m^3	2.25E-02	2.26E-02			Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	Be-7	3.98E-02	pCi/m^3	1.01E-02	1.07E-02			Y
PNL-2	FILTER2	306156002	28-Dec-11	4-Apr-12	Co-60	1.65E-04	pCi/m^3	5.88E-04	5.93E-04	U		Y
PNL-2	FILTER2	310956002	4-Apr-12	27-Jun-12	Co-60	1.59E-04	pCi/m^3	5.85E-04	5.90E-04	U		Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	Co-60	-5.51E-05	pCi/m^3	5.22E-04	5.23E-04	U		Y
PNL-2	FILTER2	306156002	28-Dec-11	4-Apr-12	Cs-134	2.66E-04	pCi/m^3	6.43E-04	6.54E-04	U		Y
PNL-2	FILTER2	310956002	4-Apr-12	27-Jun-12	Cs-134	2.61E-04	pCi/m^3	5.51E-04	5.63E-04	U		Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	Cs-134	-1.33E-04	pCi/m^3	6.78E-04	6.81E-04	U		Y
PNL-2	FILTER2	306156002	28-Dec-11	4-Apr-12	Cs-137	2.88E-04	pCi/m^3	6.92E-04	7.04E-04	U		Y
PNL-2	FILTER2	310956002	4-Apr-12	27-Jun-12	Cs-137	-1.65E-04	pCi/m^3	4.99E-04	5.04E-04	U		Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	Cs-137	-1.21E-04	pCi/m^3	5.95E-04	5.98E-04	U		Y
PNL-2	FILTER2	306156002	28-Dec-11	4-Apr-12	Eu-152	2.13E-04	pCi/m^3	1.75E-03	1.75E-03	U		Y
PNL-2	FILTER2	310956002	4-Apr-12	27-Jun-12	Eu-152	-4.38E-04	pCi/m^3	1.43E-03	1.45E-03	U		Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	Eu-152	2.71E-04	pCi/m^3	1.23E-03	1.23E-03	U		Y
PNL-2	FILTER2	306156002	28-Dec-11	4-Apr-12	Eu-154	-5.65E-04	pCi/m^3	1.75E-03	1.77E-03	U		Y
PNL-2	FILTER2	310956002	4-Apr-12	27-Jun-12	Eu-154	4.39E-04	pCi/m^3	1.53E-03	1.54E-03	U		Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	Eu-154	2.08E-06	pCi/m^3	1.45E-03	1.45E-03	U		Y
PNL-2	FILTER2	306156002	28-Dec-11	4-Apr-12	Eu-155	-7.40E-04	pCi/m^3	1.90E-03	1.93E-03	U		Y
PNL-2	FILTER2	310956002	4-Apr-12	27-Jun-12	Eu-155	3.22E-04	pCi/m^3	1.37E-03	1.38E-03	U		Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	Eu-155	1.63E-04	pCi/m^3	1.03E-03	1.04E-03	U		Y
PNL-2	FILTER2	306156002	28-Dec-11	4-Apr-12	K-40	1.13E-03	pCi/m^3	7.55E-03	7.57E-03	U		Y

Table C.2. (contd)

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
PNL-2	FILTER2	310956002	4-Apr-12	27-Jun-12	K-40	1.81E-03	pCi/m^3	7.01E-03	7.06E-03	U		Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	K-40	4.65E-03	pCi/m^3	6.57E-03	6.91E-03	U		Y
PNL-2	FILTER2	306156002	28-Dec-11	4-Apr-12	Ru-106	1.92E-04	pCi/m^3	6.34E-03	6.34E-03	U		Y
PNL-2	FILTER2	310956002	4-Apr-12	27-Jun-12	Ru-106	-3.09E-04	pCi/m^3	5.52E-03	5.52E-03	U		Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	Ru-106	1.05E-04	pCi/m^3	4.55E-03	4.55E-03	U		Y
PNL-2	FILTER2	306156002	28-Dec-11	4-Apr-12	Sb-125	-7.99E-04	pCi/m^3	1.74E-03	1.78E-03	U		Y
PNL-2	FILTER2	310956002	4-Apr-12	27-Jun-12	Sb-125	2.45E-04	pCi/m^3	1.43E-03	1.44E-03	U		Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	Sb-125	7.15E-04	pCi/m^3	1.37E-03	1.41E-03	U		Y
PNL-2	FILTER2	315514002	28-Dec-11	27-Jun-12	Pu-238	-3.41E-07	pCi/m^3	2.11E-06	2.11E-06	U		Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	Pu-238	5.09E-07	pCi/m^3	1.80E-06	1.80E-06	U		Y
PNL-2	FILTER2	315514002	28-Dec-11	27-Jun-12	Pu-239/240	3.40E-06	pCi/m^3	2.58E-06	2.59E-06			Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	Pu-239/240	-5.09E-07	pCi/m^3	2.28E-06	2.28E-06	U		Y
PNL-2	FILTER2	315514002	28-Dec-11	27-Jun-12	U-233/234	5.33E-05	pCi/m^3	1.33E-05	1.50E-05			Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	U-233/234	4.71E-05	pCi/m^3	7.79E-06	9.86E-06			Y
PNL-2	FILTER2	315514002	28-Dec-11	27-Jun-12	U-235	6.79E-06	pCi/m^3	5.26E-06	5.33E-06			Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	U-235	5.64E-06	pCi/m^3	3.09E-06	3.17E-06			Y
PNL-2	FILTER2	315514002	28-Dec-11	27-Jun-12	U-238	4.19E-05	pCi/m^3	1.09E-05	1.21E-05			Y
PNL-2	FILTER2 SOLAR	318770004	27-Jun-12	26-Dec-12	U-238	4.99E-05	pCi/m^3	7.60E-06	9.83E-06			Y
PNL-3	FILTER2	294057003	28-Dec-11	11-Jan-12	ALPHA	2.67E-04	pCi/m^3	2.91E-04	2.91E-04	U		
PNL-3	FILTER2	295804004	25-Jan-12	8-Feb-12	ALPHA	6.47E-04	pCi/m^3	3.31E-04	3.34E-04			
PNL-3	FILTER2	296515004	8-Feb-12	22-Feb-12	ALPHA	7.39E-04	pCi/m^3	3.30E-04	3.30E-04			
PNL-3	FILTER2	297353003	22-Feb-12	7-Mar-12	ALPHA	4.48E-04	pCi/m^3	2.77E-04	2.78E-04			
PNL-3	FILTER2	298151005	7-Mar-12	21-Mar-12	ALPHA	5.83E-04	pCi/m^3	2.97E-04	2.97E-04			
PNL-3	FILTER2	301307003	21-Mar-12	4-Apr-12	ALPHA	4.40E-04	pCi/m^3	2.66E-04	2.68E-04			
PNL-3	FILTER2	303118003	4-Apr-12	18-Apr-12	ALPHA	5.24E-04	pCi/m^3	2.85E-04	2.86E-04			
PNL-3	FILTER2	303809003	18-Apr-12	2-May-12	ALPHA	4.16E-04	pCi/m^3	2.54E-04	2.55E-04			
PNL-3	FILTER2	304651003	2-May-12	16-May-12	ALPHA	1.07E-03	pCi/m^3	4.22E-04	4.25E-04			
PNL-3	FILTER2	305301006	16-May-12	30-May-12	ALPHA	4.53E-04	pCi/m^3	3.42E-04	3.42E-04	U		
PNL-3	FILTER2	306381003	30-May-12	13-Jun-12	ALPHA	3.63E-04	pCi/m^3	2.81E-04	2.81E-04	U		
PNL-3	FILTER2	306835006	13-Jun-12	27-Jun-12	ALPHA	3.28E-04	pCi/m^3	2.69E-04	2.71E-04	U		
PNL-3	FILTER2	307737003	27-Jun-12	11-Jul-12	ALPHA	6.66E-04	pCi/m^3	3.43E-04	3.44E-04			
PNL-3	FILTER2	308584003	11-Jul-12	25-Jul-12	ALPHA	7.36E-04	pCi/m^3	3.27E-04	3.31E-04			

Table C.2. (contd)

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
PNL-3	FILTER2	309457003	25-Jul-12	8-Aug-12	ALPHA	5.93E-04	pCi/m^3	2.99E-04	3.00E-04			
PNL-3	FILTER2	310090003	8-Aug-12	22-Aug-12	ALPHA	9.36E-04	pCi/m^3	3.72E-04	3.77E-04			
PNL-3	FILTER2	310939003	22-Aug-12	5-Sep-12	ALPHA	4.60E-04	pCi/m^3	2.69E-04	2.70E-04			
PNL-3	FILTER2	311736003	5-Sep-12	19-Sep-12	ALPHA	8.54E-04	pCi/m^3	3.62E-04	3.63E-04			
PNL-3	FILTER2	313495003	3-Oct-12	17-Oct-12	ALPHA	1.21E-03	pCi/m^3	4.42E-04	4.44E-04			
PNL-3	FILTER2	314353003	17-Oct-12	31-Oct-12	ALPHA	2.45E-04	pCi/m^3	3.04E-04	3.04E-04	U		
PNL-3	FILTER2	315315003	31-Oct-12	14-Nov-12	ALPHA	1.70E-03	pCi/m^3	4.96E-04	5.00E-04			
PNL-3	FILTER2	315910003	14-Nov-12	28-Nov-12	ALPHA	3.48E-04	pCi/m^3	2.95E-04	2.95E-04	U		
PNL-3	FILTER2	316721003	28-Nov-12	12-Dec-12	ALPHA	8.41E-04	pCi/m^3	3.39E-04	3.41E-04		REFER TO DISCREPANCY RPT EMP13-001. ORIGINAL VALUE REPLACED BY RECOUNT VALUE TO MEET MINIMUM 96 HOUR HOLD TIME.	
PNL-3	FILTER2	317383003	12-Dec-12	26-Dec-12	ALPHA	2.78E-04	pCi/m^3	3.06E-04	3.06E-04	U		
PNL-3	FILTER2	315514003	28-Dec-11	27-Jun-12	Am-241	3.38E-06	pCi/m^3	4.10E-06	4.12E-06	U		Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	Am-241	-6.33E-06	pCi/m^3	1.09E-05	1.10E-05	U		Y
PNL-3	FILTER2	315514003	28-Dec-11	27-Jun-12	Am-243	-8.05E-06	pCi/m^3	5.75E-06	5.75E-06	U		Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	Am-243	1.18E-07	pCi/m^3	8.76E-06	8.78E-06	U		Y
PNL-3	FILTER2	315514003	28-Dec-11	27-Jun-12	Cm-243/244	-1.71E-06	pCi/m^3	2.71E-06	2.71E-06	U		Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	Cm-243/244	1.34E-07	pCi/m^3	9.90E-06	9.92E-06	U		Y
PNL-3	FILTER2	294057003	28-Dec-11	11-Jan-12	BETA	2.46E-02	pCi/m^3	1.63E-03	2.11E-03			
PNL-3	FILTER2	295804004	25-Jan-12	8-Feb-12	BETA	1.88E-02	pCi/m^3	1.21E-03	1.38E-03			
PNL-3	FILTER2	296515004	8-Feb-12	22-Feb-12	BETA	2.40E-02	pCi/m^3	1.39E-03	1.76E-03			
PNL-3	FILTER2	297353003	22-Feb-12	7-Mar-12	BETA	1.08E-02	pCi/m^3	9.33E-04	9.71E-04			
PNL-3	FILTER2	298151005	7-Mar-12	21-Mar-12	BETA	9.75E-03	pCi/m^3	8.67E-04	9.62E-04			
PNL-3	FILTER2	301307003	21-Mar-12	4-Apr-12	BETA	9.34E-03	pCi/m^3	8.66E-04	9.06E-04			
PNL-3	FILTER2	303118003	4-Apr-12	18-Apr-12	BETA	1.30E-02	pCi/m^3	1.01E-03	1.04E-03			
PNL-3	FILTER2	303809003	18-Apr-12	2-May-12	BETA	1.19E-02	pCi/m^3	9.45E-04	1.13E-03			
PNL-3	FILTER2	304651003	2-May-12	16-May-12	BETA	1.72E-02	pCi/m^3	1.19E-03	1.25E-03			
PNL-3	FILTER2	305301006	16-May-12	30-May-12	BETA	1.41E-02	pCi/m^3	1.09E-03	1.13E-03			
PNL-3	FILTER2	306381003	30-May-12	13-Jun-12	BETA	9.77E-03	pCi/m^3	8.67E-04	9.26E-04			
PNL-3	FILTER2	306835006	13-Jun-12	27-Jun-12	BETA	9.47E-03	pCi/m^3	8.18E-04	8.27E-04			
PNL-3	FILTER2	307737003	27-Jun-12	11-Jul-12	BETA	1.51E-02	pCi/m^3	1.06E-03	1.38E-03			
PNL-3	FILTER2	308584003	11-Jul-12	25-Jul-12	BETA	1.53E-02	pCi/m^3	1.03E-03	1.12E-03			
PNL-3	FILTER2	309457003	25-Jul-12	8-Aug-12	BETA	1.68E-02	pCi/m^3	1.06E-03	1.38E-03			
PNL-3	FILTER2	310090003	8-Aug-12	22-Aug-12	BETA	2.11E-02	pCi/m^3	1.22E-03	1.42E-03			
PNL-3	FILTER2	310939003	22-Aug-12	5-Sep-12	BETA	1.34E-02	pCi/m^3	9.72E-04	1.11E-03			
PNL-3	FILTER2	311736003	5-Sep-12	19-Sep-12	BETA	2.14E-02	pCi/m^3	1.25E-03	1.31E-03			

Table C.2. (contd)

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
PNL-3	FILTER2	313495003	3-Oct-12	17-Oct-12	BETA	2.58E-02	pCi/m^3	1.28E-03	1.35E-03			
PNL-3	FILTER2	314353003	17-Oct-12	31-Oct-12	BETA	1.34E-02	pCi/m^3	9.49E-04	9.72E-04			
PNL-3	FILTER2	315315003	31-Oct-12	14-Nov-12	BETA	2.35E-02	pCi/m^3	1.25E-03	2.01E-03			
PNL-3	FILTER2	315910003	14-Nov-12	28-Nov-12	BETA	1.53E-02	pCi/m^3	1.00E-03	1.03E-03			
PNL-3	FILTER2	316721003	28-Nov-12	12-Dec-12	BETA	1.66E-02	pCi/m^3	1.06E-03	1.11E-03		REFER TO DISCREPANCY RPT EMP13-001. ORIGINAL VALUE REPLACED BY RECOUNT VALUE TO MEET MINIMUM 96 HOUR HOLD TIME.	
PNL-3	FILTER2	317383003	12-Dec-12	26-Dec-12	BETA	9.79E-03	pCi/m^3	8.35E-04	8.49E-04			
PNL-3	FILTER2	306156003	28-Dec-11	4-Apr-12	Am-241-GAMMA	-1.20E-03	pCi/m^3	1.84E-03	1.92E-03	U		Y
PNL-3	FILTER2	306156003	28-Dec-11	4-Apr-12	Be-7	5.80E-02	pCi/m^3	2.08E-02	2.08E-02			Y
PNL-3	FILTER2	310956003	4-Apr-12	27-Jun-12	Be-7	6.98E-02	pCi/m^3	1.72E-02	1.73E-02			Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	Be-7	3.18E-02	pCi/m^3	1.22E-02	1.24E-02			Y
PNL-3	FILTER2	306156003	28-Dec-11	4-Apr-12	Co-60	3.04E-04	pCi/m^3	5.46E-04	5.63E-04	U		Y
PNL-3	FILTER2	310956003	4-Apr-12	27-Jun-12	Co-60	2.69E-04	pCi/m^3	5.10E-04	5.24E-04	U		Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	Co-60	1.01E-04	pCi/m^3	6.50E-04	6.52E-04	U		Y
PNL-3	FILTER2	306156003	28-Dec-11	4-Apr-12	Cs-134	-3.93E-04	pCi/m^3	6.08E-04	6.33E-04	U		Y
PNL-3	FILTER2	310956003	4-Apr-12	27-Jun-12	Cs-134	-8.62E-05	pCi/m^3	5.13E-04	5.15E-04	U		Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	Cs-134	1.85E-04	pCi/m^3	6.37E-04	6.43E-04	U		Y
PNL-3	FILTER2	306156003	28-Dec-11	4-Apr-12	Cs-137	-2.98E-04	pCi/m^3	6.10E-04	6.24E-04	U		Y
PNL-3	FILTER2	310956003	4-Apr-12	27-Jun-12	Cs-137	6.18E-05	pCi/m^3	4.47E-04	4.48E-04	U		Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	Cs-137	1.01E-04	pCi/m^3	5.65E-04	5.67E-04	U		Y
PNL-3	FILTER2	306156003	28-Dec-11	4-Apr-12	Eu-152	3.84E-04	pCi/m^3	1.47E-03	1.48E-03	U		Y
PNL-3	FILTER2	310956003	4-Apr-12	27-Jun-12	Eu-152	3.84E-04	pCi/m^3	1.17E-03	1.18E-03	U		Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	Eu-152	-2.45E-04	pCi/m^3	1.45E-03	1.45E-03	U		Y
PNL-3	FILTER2	306156003	28-Dec-11	4-Apr-12	Eu-154	4.19E-04	pCi/m^3	1.79E-03	1.80E-03	U		Y
PNL-3	FILTER2	310956003	4-Apr-12	27-Jun-12	Eu-154	1.14E-03	pCi/m^3	1.25E-03	1.35E-03	U		Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	Eu-154	-3.53E-04	pCi/m^3	1.66E-03	1.67E-03	U		Y
PNL-3	FILTER2	306156003	28-Dec-11	4-Apr-12	Eu-155	-1.73E-04	pCi/m^3	1.57E-03	1.58E-03	U		Y
PNL-3	FILTER2	310956003	4-Apr-12	27-Jun-12	Eu-155	3.15E-04	pCi/m^3	9.01E-04	9.12E-04	U		Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	Eu-155	5.12E-05	pCi/m^3	1.14E-03	1.14E-03	U		Y
PNL-3	FILTER2	306156003	28-Dec-11	4-Apr-12	K-40	1.10E-03	pCi/m^3	8.16E-03	8.17E-03	U		Y
PNL-3	FILTER2	310956003	4-Apr-12	27-Jun-12	K-40	5.01E-03	pCi/m^3	8.64E-03	8.64E-03	U		Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	K-40	5.24E-03	pCi/m^3	6.95E-03	6.97E-03	U		Y
PNL-3	FILTER2	306156003	28-Dec-11	4-Apr-12	Ru-106	1.33E-03	pCi/m^3	5.16E-03	5.20E-03	U		Y
PNL-3	FILTER2	310956003	4-Apr-12	27-Jun-12	Ru-106	-8.48E-04	pCi/m^3	4.53E-03	4.54E-03	U		Y

Table C.2. (contd)

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	Ru-106	-3.90E-04	pCi/m^3	5.40E-03	5.41E-03	U		Y
PNL-3	FILTER2	306156003	28-Dec-11	4-Apr-12	Sb-125	3.88E-06	pCi/m^3	1.68E-03	1.68E-03	U		Y
PNL-3	FILTER2	310956003	4-Apr-12	27-Jun-12	Sb-125	5.71E-04	pCi/m^3	1.17E-03	1.20E-03	U		Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	Sb-125	9.70E-04	pCi/m^3	1.57E-03	1.63E-03	U		Y
PNL-3	FILTER2	315514003	28-Dec-11	27-Jun-12	Pu-238	3.85E-07	pCi/m^3	1.85E-06	1.85E-06	U		Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	Pu-238	4.45E-07	pCi/m^3	3.02E-06	3.02E-06	U		Y
PNL-3	FILTER2	315514003	28-Dec-11	27-Jun-12	Pu-239/240	4.22E-06	pCi/m^3	3.01E-06	3.03E-06			Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	Pu-239/240	2.67E-06	pCi/m^3	3.59E-06	3.60E-06	U		Y
PNL-3	FILTER2	315514003	28-Dec-11	27-Jun-12	U-233/234	4.52E-05	pCi/m^3	1.43E-05	1.56E-05			Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	U-233/234	3.67E-05	pCi/m^3	1.30E-05	1.40E-05			Y
PNL-3	FILTER2	315514003	28-Dec-11	27-Jun-12	U-235	5.92E-06	pCi/m^3	5.47E-06	5.52E-06			Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	U-235	4.24E-06	pCi/m^3	5.51E-06	5.54E-06	U		Y
PNL-3	FILTER2	315514003	28-Dec-11	27-Jun-12	U-238	4.87E-05	pCi/m^3	1.28E-05	1.42E-05			Y
PNL-3	FILTER2	318770001	27-Jun-12	26-Dec-12	U-238	3.64E-05	pCi/m^3	1.15E-05	1.24E-05			Y
PNL-4	FILTER2	307737004	27-Jun-12	11-Jul-12	ALPHA	7.44E-04	pCi/m^3	3.10E-04	3.10E-04			
PNL-4	FILTER2	308584004	11-Jul-12	25-Jul-12	ALPHA	5.26E-04	pCi/m^3	2.90E-04	2.91E-04			
PNL-4	FILTER2	309457004	25-Jul-12	8-Aug-12	ALPHA	5.35E-04	pCi/m^3	2.70E-04	2.71E-04			
PNL-4	FILTER2	310090004	8-Aug-12	22-Aug-12	ALPHA	6.23E-04	pCi/m^3	2.92E-04	2.95E-04			
PNL-4	FILTER2	310939004	22-Aug-12	5-Sep-12	ALPHA	6.05E-04	pCi/m^3	2.85E-04	2.86E-04			
PNL-4	FILTER2	311736004	5-Sep-12	19-Sep-12	ALPHA	7.39E-04	pCi/m^3	3.18E-04	3.18E-04			
PNL-4	FILTER2	312507004	19-Sep-12	3-Oct-12	ALPHA	8.11E-04	pCi/m^3	3.27E-04	3.29E-04			
PNL-4	FILTER2	313495004	3-Oct-12	17-Oct-12	ALPHA	9.49E-04	pCi/m^3	4.25E-04	4.34E-04			
PNL-4	FILTER2	314353004	17-Oct-12	31-Oct-12	ALPHA	6.59E-04	pCi/m^3	3.83E-04	3.88E-04			
PNL-4	FILTER2	315315004	31-Oct-12	14-Nov-12	ALPHA	5.30E-04	pCi/m^3	2.85E-04	2.92E-04			
PNL-4	FILTER2	315910004	14-Nov-12	28-Nov-12	ALPHA	5.01E-04	pCi/m^3	3.57E-04	3.59E-04			
PNL-4	FILTER2	316721004	28-Nov-12	12-Dec-12	ALPHA	9.10E-04	pCi/m^3	3.80E-04	3.80E-04		REFER TO DISCREPANCY RPT EMP13-001. ORIGINAL VALUE REPLACED BY RECOUNT VALUE TO MEET MINIMUM 96 HOUR HOLD TIME.	
PNL-4	FILTER2	317383004	12-Dec-12	26-Dec-12	ALPHA	5.14E-04	pCi/m^3	2.96E-04	2.96E-04			
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	Am-241	1.77E-06	pCi/m^3	4.87E-06	4.88E-06	U		Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	Am-243	9.63E-07	pCi/m^3	5.35E-06	5.36E-06	U		Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	Cm-243/244	-9.87E-07	pCi/m^3	2.98E-06	2.99E-06	U		Y
PNL-4	FILTER2	307737004	27-Jun-12	11-Jul-12	BETA	1.63E-02	pCi/m^3	1.10E-03	1.17E-03			
PNL-4	FILTER2	308584004	11-Jul-12	25-Jul-12	BETA	1.57E-02	pCi/m^3	1.11E-03	1.15E-03			
PNL-4	FILTER2	309457004	25-Jul-12	8-Aug-12	BETA	1.66E-02	pCi/m^3	1.07E-03	1.12E-03			
PNL-4	FILTER2	310090004	8-Aug-12	22-Aug-12	BETA	2.02E-02	pCi/m^3	1.14E-03	1.28E-03			

Table C.2. (contd)

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
PNL-4	FILTER2	310939004	22-Aug-12	5-Sep-12	BETA	1.24E-02	pCi/m^3	9.27E-04	1.04E-03			
PNL-4	FILTER2	311736004	5-Sep-12	19-Sep-12	BETA	1.99E-02	pCi/m^3	1.13E-03	1.25E-03			
PNL-4	FILTER2	312507004	19-Sep-12	3-Oct-12	BETA	2.90E-02	pCi/m^3	1.31E-03	2.00E-03			
PNL-4	FILTER2	313495004	3-Oct-12	17-Oct-12	BETA	2.89E-02	pCi/m^3	1.38E-03	1.44E-03			
PNL-4	FILTER2	314353004	17-Oct-12	31-Oct-12	BETA	1.38E-02	pCi/m^3	9.86E-04	1.00E-03			
PNL-4	FILTER2	315315004	31-Oct-12	14-Nov-12	BETA	1.84E-02	pCi/m^3	1.14E-03	1.26E-03			
PNL-4	FILTER2	315910004	14-Nov-12	28-Nov-12	BETA	1.83E-02	pCi/m^3	1.17E-03	1.25E-03			
PNL-4	FILTER2	316721004	28-Nov-12	12-Dec-12	BETA	1.90E-02	pCi/m^3	1.20E-03	1.24E-03		REFER TO DISCREPANCY RPT EMP13-001. ORIGINAL VALUE REPLACED BY RECOUNT VALUE TO MEET MINIMUM 96 HOUR HOLD TIME.	
PNL-4	FILTER2	317383004	12-Dec-12	26-Dec-12	BETA	1.29E-02	pCi/m^3	1.02E-03	1.05E-03			
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	Be-7	2.18E-02	pCi/m^3	6.18E-03	6.47E-03			Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	Co-60	3.85E-04	pCi/m^3	3.30E-04	3.75E-04	U		Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	Cs-134	1.54E-04	pCi/m^3	3.59E-04	3.66E-04	U		Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	Cs-137	5.39E-05	pCi/m^3	3.35E-04	3.36E-04	U		Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	Eu-152	-6.67E-04	pCi/m^3	9.49E-04	9.97E-04	U		Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	Eu-154	9.90E-05	pCi/m^3	7.82E-04	7.83E-04	U		Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	Eu-155	-2.60E-04	pCi/m^3	9.23E-04	9.31E-04	U		Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	K-40	3.38E-03	pCi/m^3	4.01E-03	4.02E-03	U		Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	Ru-106	-1.58E-03	pCi/m^3	2.57E-03	2.67E-03	U		Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	Sb-125	1.63E-04	pCi/m^3	7.47E-04	7.51E-04	U		Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	Pu-238	-5.51E-07	pCi/m^3	1.70E-06	1.70E-06	U		Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	Pu-239/240	-4.84E-07	pCi/m^3	2.25E-06	2.25E-06	U		Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	U-233/234	4.64E-05	pCi/m^3	7.46E-06	9.56E-06			Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	U-235	3.47E-06	pCi/m^3	2.88E-06	2.92E-06	U		Y
PNL-4	FILTER2	318770002	27-Jun-12	26-Dec-12	U-238	5.08E-05	pCi/m^3	7.56E-06	9.88E-06			Y
YAKIMA	FILTER1		28-Dec-11	11-Jan-12	ALPHA	3.1E-04	pCi/m^3		2.7E-04	U		
YAKIMA	FILTER1		11-Jan-12	25-Jan-12	ALPHA	7.8E-04	pCi/m^3		3.7E-04			
YAKIMA	FILTER1		25-Jan-12	8-Feb-12	ALPHA	9.4E-04	pCi/m^3		4.2E-04			
YAKIMA	FILTER1		8-Feb-12	22-Feb-12	ALPHA	7.1E-04	pCi/m^3		4.4E-04			
YAKIMA	FILTER1		22-Feb-12	7-Mar-12	ALPHA	5.5E-04	pCi/m^3		3.0E-04			
YAKIMA	FILTER1		7-Mar-12	21-Mar-12	ALPHA	8.2E-04	pCi/m^3		4.2E-04			
YAKIMA	FILTER1		21-Mar-12	4-Apr-12	ALPHA	1.9E-04	pCi/m^3		2.5E-04	U		
YAKIMA	FILTER1		4-Apr-12	18-Apr-12	ALPHA	4.2E-04	pCi/m^3		2.3E-04			
YAKIMA	FILTER1		18-Apr-12	2-May-12	ALPHA	1.5E-04	pCi/m^3		1.4E-04	U		
YAKIMA	FILTER1		2-May-12	16-May-12	ALPHA	6.2E-04	pCi/m^3		2.9E-04			

Table C.2. (contd)

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
YAKIMA	FILTER1		16-May-12	30-May-12	ALPHA	2.7E-04	pCi/m^3		1.8E-04			
YAKIMA	FILTER1		30-May-12	13-Jun-12	ALPHA	3.5E-04	pCi/m^3		2.4E-04			
YAKIMA	FILTER1		13-Jun-12	27-Jun-12	ALPHA	3.8E-04	pCi/m^3		2.1E-04			
YAKIMA	FILTER1		27-Jun-12	11-Jul-12	ALPHA	4.1E-04	pCi/m^3		2.1E-04			
YAKIMA	FILTER1		11-Jul-12	25-Jul-12	ALPHA	3.4E-04	pCi/m^3		2.2E-04			
YAKIMA	FILTER1		25-Jul-12	8-Aug-12	ALPHA	5.0E-04	pCi/m^3		2.8E-04			
YAKIMA	FILTER1		8-Aug-12	22-Aug-12	ALPHA	9.6E-04	pCi/m^3		3.3E-04			
YAKIMA	FILTER1		22-Aug-12	5-Sep-12	ALPHA	3.9E-04	pCi/m^3		2.3E-04			
YAKIMA	FILTER1		5-Sep-12	19-Sep-12	ALPHA	1.5E-03	pCi/m^3		5.0E-04			
YAKIMA	FILTER1		19-Sep-12	3-Oct-12	ALPHA	2.0E-03	pCi/m^3		6.2E-04			
YAKIMA	FILTER1		3-Oct-12	17-Oct-12	ALPHA	5.9E-04	pCi/m^3		2.7E-04			
YAKIMA	FILTER1		17-Oct-12	31-Oct-12	ALPHA	5.5E-04	pCi/m^3		2.8E-04			
YAKIMA	FILTER1		31-Oct-12	14-Nov-12	ALPHA	6.0E-04	pCi/m^3		2.8E-04			
YAKIMA	FILTER1		14-Nov-12	28-Nov-12	ALPHA	6.8E-04	pCi/m^3		2.9E-04			
YAKIMA	FILTER1		28-Nov-12	12-Dec-12	ALPHA	9.0E-04	pCi/m^3		3.3E-04			
YAKIMA	FILTER1		12-Dec-12	27-Dec-12	ALPHA	3.0E-04	pCi/m^3		2.0E-04			
YAKIMA	FILTER1		28-Dec-11	11-Jan-12	BETA	1.4E-02	pCi/m^3		1.8E-03			
YAKIMA	FILTER1		11-Jan-12	25-Jan-12	BETA	1.8E-02	pCi/m^3		2.3E-03			
YAKIMA	FILTER1		25-Jan-12	8-Feb-12	BETA	1.9E-02	pCi/m^3		2.3E-03			
YAKIMA	FILTER1		8-Feb-12	22-Feb-12	BETA	2.2E-02	pCi/m^3		3.0E-03			
YAKIMA	FILTER1		22-Feb-12	7-Mar-12	BETA	1.2E-02	pCi/m^3		2.0E-03			
YAKIMA	FILTER1		7-Mar-12	21-Mar-12	BETA	1.0E-02	pCi/m^3		1.4E-03			
YAKIMA	FILTER1		21-Mar-12	4-Apr-12	BETA	1.0E-02	pCi/m^3		1.5E-03			
YAKIMA	FILTER1		4-Apr-12	18-Apr-12	BETA	8.5E-03	pCi/m^3		7.7E-04			
YAKIMA	FILTER1		18-Apr-12	2-May-12	BETA	3.9E-03	pCi/m^3		5.3E-04			
YAKIMA	FILTER1		2-May-12	16-May-12	BETA	1.2E-02	pCi/m^3		9.2E-04			
YAKIMA	FILTER1		16-May-12	30-May-12	BETA	8.9E-03	pCi/m^3		8.3E-04			
YAKIMA	FILTER1		30-May-12	13-Jun-12	BETA	7.6E-03	pCi/m^3		7.4E-04			
YAKIMA	FILTER1		13-Jun-12	27-Jun-12	BETA	5.8E-03	pCi/m^3		6.5E-04			
YAKIMA	FILTER1		27-Jun-12	11-Jul-12	BETA	1.5E-02	pCi/m^3		9.5E-04			
YAKIMA	FILTER1		11-Jul-12	25-Jul-12	BETA	1.0E-02	pCi/m^3		1.1E-03			
YAKIMA	FILTER1		25-Jul-12	8-Aug-12	BETA	1.6E-02	pCi/m^3		1.6E-03			
YAKIMA	FILTER1		8-Aug-12	22-Aug-12	BETA	1.9E-02	pCi/m^3		1.8E-03			
YAKIMA	FILTER1		22-Aug-12	5-Sep-12	BETA	1.3E-02	pCi/m^3		1.3E-03			
YAKIMA	FILTER1		5-Sep-12	19-Sep-12	BETA	1.8E-02	pCi/m^3		1.6E-03			
YAKIMA	FILTER1		19-Sep-12	3-Oct-12	BETA	3.1E-02	pCi/m^3		2.9E-03			
YAKIMA	FILTER1		3-Oct-12	17-Oct-12	BETA	1.8E-02	pCi/m^3		1.7E-03			
YAKIMA	FILTER1		17-Oct-12	31-Oct-12	BETA	1.3E-02	pCi/m^3		1.3E-03			
YAKIMA	FILTER1		31-Oct-12	14-Nov-12	BETA	1.6E-02	pCi/m^3		1.6E-03			
YAKIMA	FILTER1		14-Nov-12	28-Nov-12	BETA	1.5E-02	pCi/m^3		1.6E-03			

Table C.2. (contd)

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
YAKIMA	FILTER1		28-Nov-12	12-Dec-12	BETA	1.9E-02	pCi/m^3		1.8E-03			
YAKIMA	FILTER1		12-Dec-12	27-Dec-12	BETA	1.1E-02	pCi/m^3		1.2E-03			
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	Am-241-Gamma	-9.2E-04	pCi/m^3		1.7E-03	U		Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	Am-241-Gamma	-2.2E-03	pCi/m^3		3.7E-03	U		Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	Am-241-Gamma	-4.8E-03	pCi/m^3		5.0E-03	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	Am-241-Gamma	-9.9E-04	pCi/m^3		1.8E-03	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	Co-60	-4.4E-05	pCi/m^3		4.4E-04	U		Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	Co-60	2.9E-04	pCi/m^3		8.0E-04	U		Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	Co-60	-1.8E-04	pCi/m^3		7.5E-04	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	Co-60	2.5E-04	pCi/m^3		6.3E-04	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	Cs-134	7.1E-04	pCi/m^3		1.4E-03	U		Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	Cs-134	-4.8E-04	pCi/m^3		7.6E-04	U		Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	Cs-134	4.1E-04	pCi/m^3		8.0E-04	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	Cs-134	5.1E-05	pCi/m^3		5.1E-04	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	Cs-137	-1.8E-04	pCi/m^3		1.2E-03	U		Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	Cs-137	2.1E-04	pCi/m^3		7.0E-04	U		Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	Cs-137	-7.8E-04	pCi/m^3		8.8E-04	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	Cs-137	1.3E-04	pCi/m^3		5.3E-04	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	Eu-152	-1.8E-04	pCi/m^3		1.8E-03	U		Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	Eu-152	1.2E-03	pCi/m^3		2.1E-03	U		Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	Eu-152	1.2E-03	pCi/m^3		2.3E-03	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	Eu-152	-2.7E-04	pCi/m^3		1.5E-03	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	Eu-154	1.2E-04	pCi/m^3		1.2E-03	U		Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	Eu-154	-2.5E-04	pCi/m^3		2.0E-03	U		Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	Eu-154	2.1E-03	pCi/m^3		2.2E-03	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	Eu-154	-1.9E-04	pCi/m^3		1.4E-03	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	Eu-155	-2.3E-04	pCi/m^3		2.3E-03	U		Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	Eu-155	8.4E-04	pCi/m^3		2.2E-03	U		Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	Eu-155	5.4E-04	pCi/m^3		2.3E-03	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	Eu-155	8.5E-04	pCi/m^3		1.4E-03	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	K-40	-6.0E-03	pCi/m^3		1.3E-02	U		Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	K-40	4.1E-03	pCi/m^3		1.0E-02	U		Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	K-40	1.1E-02	pCi/m^3		1.2E-02	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	K-40	-4.6E-03	pCi/m^3		6.9E-03	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	Ru-106	-1.6E-02	pCi/m^3		1.4E-02	U		Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	Ru-106	4.4E-03	pCi/m^3		7.7E-03	U		Y

Table C.2. (contd)

Samp Site Name	Samp Mthd	LAB Samp ID	Samp Date Time On	Samp Date Time	Con Short Name	Value Rptd	Anal Units Rptd	Couting Error	Total Anal Error 2-sigma	Lab Qualifier	Result Comment	Composite Flag
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	Ru-106	6.0E-03	pCi/m^3		7.3E-03	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	Ru-106	1.1E-03	pCi/m^3		4.9E-03	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	Sb-125	7.7E-04	pCi/m^3		3.0E-03	U		Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	Sb-125	1.4E-03	pCi/m^3		2.1E-03	U		Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	Sb-125	-4.4E-04	pCi/m^3		2.0E-03	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	Sb-125	2.6E-04	pCi/m^3		1.5E-03	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	Pu-238	1.6E-07	pCi/m^3		1.1E-06	U		Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	Pu-238	2.6E-06	pCi/m^3		1.7E-05	U		Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	Pu-238	-5.7E-06	pCi/m^3		5.2E-06	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	Pu-238	-1.5E-06	pCi/m^3		5.3E-06	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	Pu-239/240	-1.2E-07	pCi/m^3		9.4E-07	U		Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	Pu-239/240	2.6E-06	pCi/m^3		1.3E-05	U		Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	Pu-239/240	-1.3E-06	pCi/m^3		4.9E-06	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	Pu-239/240	0.0E+00	pCi/m^3		0.0E+00	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	Sr-90	3.0E-05	pCi/m^3		4.8E-05	U		Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	Sr-90	-1.0E-04	pCi/m^3		1.7E-04	U		Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	Sr-90	-2.8E-05	pCi/m^3		1.0E-04	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	Sr-90	-8.4E-05	pCi/m^3		1.8E-04	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	U-234	7.2E-05	pCi/m^3		3.5E-05			Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	U-234	5.9E-05	pCi/m^3		3.2E-05			Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	U-234	8.8E-06	pCi/m^3		3.2E-05	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	U-234	1.1E-05	pCi/m^3		2.0E-05	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	U-235	3.0E-05	pCi/m^3		1.8E-05			Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	U-235	1.1E-05	pCi/m^3		1.7E-05	U		Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	U-235	4.0E-06	pCi/m^3		2.3E-05	U		Y
YAKIMA	FILTER1		3-Oct-12	27-Dec-12	U-235	2.1E-06	pCi/m^3		9.2E-06	U		Y
YAKIMA	FILTER1		28-Dec-11	4-Apr-12	U-238	6.0E-05	pCi/m^3		2.5E-05			Y
YAKIMA	FILTER1		4-Apr-12	27-Jun-12	U-238	3.9E-05	pCi/m^3		2.2E-05			Y
YAKIMA	FILTER1		27-Jun-12	3-Oct-12	U-238	2.2E-05	pCi/m^3		2.9E-05	U		Y
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