A COMPILATION OF AMBIENT AIR MONITORING PARAMETERS AT DOE FACILITIES

By

Alice R. Baumann
ESH-17 Air Quality Group
University of California, Los Alamos National Laboratory
Los Alamos, New Mexico 87545

Abstract

This report details specific operating parameters of ambient air sampling and analysis for radioactive contaminants and tritium at Department of Energy (DOE) facilities. It also identifies contacts familiar with the ambient air program at each DOE site. Thirty-two sites were contacted to determine if particulate matter was collected and analyzed for a variety of radioactive materials and if water vapor was collected and analyzed for tritium. Eighteen of the sites perform radioactive particulate monitoring and twelve perform tritium monitoring. Of the facilities collecting particulate matter, 83% collect total suspended particulate; 27% collect particles with aerodynamic diameters <10 μm. The majority (67%) of facilities use glass fiber filters. Generally, facilities choosing to use other types of media did so because uranium levels were too high and variable in the glass fiber of the blank filters. Eleven of the eighteen facilities use high-volume flow rates of 35–45 cfm; seventeen facilities collect particulate for one or two weeks continuously. Fourteen facilities count the weekly or biweekly samples for gross alpha and gross beta, for which the detection limits are generally within an order of magnitude of 10^{-3} pCi/m^3. Fourteen sites prepare composites for the analyses of nuclides specific to the facility. The most common nuclides include ^{238}Pu, $^{239+240}$Pu, ^{234}U, ^{235}U, ^{238}U, and ^{241}Am. Eight of the twelve facilities collecting ambient water for tritium analysis use a collection period of one or two weeks. Silica gel is used by 75% of the sites. Detection limits for tritium at most facilities range from 0.4 to 50 pCi/m^3.

Introduction

Department of Energy (DOE) Order 5400.1 requires facilities to monitor ambient air for radioactive emissions and the DOE guidance on environmental surveillance DOE/EH-0173T provides instruction on how to perform the required monitoring. In this document I summarize specific operating parameters for monitoring radioactive particulates and tritium in ambient air at DOE sites. For the purpose of this paper, "monitoring" refers to sampling and analysis. This compilation of data on the two types of ambient air monitoring is in response to a recommendation by an independent audit of the Los Alamos National Laboratory (LANL) air monitoring program.

I contacted thirty-two DOE sites for information about their ambient air monitoring programs. Eighteen of the thirty-two sites perform ambient air radioactive-particulate monitoring, and twelve of those perform ambient air tritium monitoring. Several facilities have more than one type of collection system for particulate collection, and one facility has two systems for water vapor collection.

The parameters I summarize include radioisotopes of interest, particle sizes collected, airflow rates, filter media and size, length of sampling periods, number of air monitoring stations used, composite data, detection limits, and types and volumes of adsorbent used for tritium collection. The term "individual sample" shown in the summary table refers to a single particulate sample collected over one sample period. "Composite" refers to a group of the individual samples submitted simultaneously for analyses as a single sample.

The DOE facilities or sites conducting ambient air monitoring for radionuclides include Los Alamos National Laboratory (LANL), Savannah River Site (SRS), Hanford Site, Brookhaven National Laboratory (BNL), Idaho National Engineering & Environmental Lab (INEEL), Nevada Test Site (NTS), Oak Ridge National Laboratory (ORNL), E.O. Lawrence Berkeley National Laboratory (Berkeley), Sandia National Laboratory (Sandia), Argonne National Laboratory (ANL), Pantex, Lawrence Livermore National Laboratory (LLNL), Waste Isolation Pilot Plant (WIPP), Rocky Flats, Mound Plant, Fernald Environmental Management Project, Knolls Atomic Power Laboratory, and Bettis Atomic Power Laboratory.

We are aware that state agencies monitor ambient air at DOE sites. We are not including those agencies in this compilation because they do not necessarily have similar monitoring requirements.

All respondents were contacted in November 1999 to review this document. Changes to ambient air monitoring programs made since then are not reflected here. Due to the variations in facility-specific air monitoring programs, the comparisons found in this paper are not intended to be used for cost analyses. In addition, it is not sufficiently comprehensive to allow us to assess quality across programs.

Ambient Air Radioactive Particulate Monitoring — Summary of Findings

Of the 18 DOE laboratories that perform ambient air monitoring, 15 collect total suspended particulate (TSP) matter and do not differentiate among particle sizes. Sandia and ANL collect only particles ≤10 μm using PM-10s (PM-10s are instruments that collect only particles whose aerodynamic diameters are ≤10 μm), and INEEL and Rocky Flats collect both TSP and particles ≤10 μm.

The filter media used include glass fiber (12 facilities) and, less commonly, polypropylene, acrylic copolymer, Teflon, quartz, cellulose, and polyester. Generally, those facilities that do not use glass fiber filters switched to other filter media because uranium levels were too high and variable in the glass fiber of the blank filters.

Airflow rates for particulate sampling ranged from 0.5 to 45 cfm. Eight facilities use flow rates of 2.0–4.0 cfm and eleven facilities use high-volume flow rates of 35–45 cfm. Four facilities (INEEL, NTS, LLNL, and ORNL) used a combination of high-volume and low-volume flows.

Sizes of particulate filters varied. The majority of facilities (10) use circular filters 47 mm–50.8 mm (2 inches) in diameter; seven facilities use 8- _ 10- inch rectangular filters and the remaining facilities use assorted sizes. Typically the 8- _ 10- inch filters are used for the high-volume sampler and the 47-mm filters for the low-to medium-flow rates.

The number of ambient air particulate monitoring stations at the individual facilities range from 2 (Bettis and Knolls) to 125 (Hanford).

The length of the sampling period for particulate monitoring in 17 of 18 facilities is one or two weeks of continuous collecting. Two facilities collect one sample over a 24-hour period every sixth day. One facility collects continuously over a one-month period.

Most of the facilities (14) count the weekly or biweekly samples for gross alpha and gross beta. Detection limits for gross alpha and gross beta are generally within an order of magnitude of 10^{-3} pCi/m^3. Five facilities also perform isotopic gamma counts (see Appendix A, Table A-1).

Fourteen facilities prepare composites (six do so monthly, eight quarterly, one semi-annually, and one annually). ORNL prepares composites for some stations quarterly and for some annually; Hanford prepares them for some stations semi-annually and for others quarterly; and PNNL sometimes uses a group of stations as one composite see Appendix A, Table A-2). The detailed data on detection limits for composites provided by each facility are compiled in Table A-3 of Appendix A.

Ambient Air Tritium Monitoring—Summary of Findings

Twelve of the 32 contacted DOE facilities routinely collect water vapor (or precipitation) for tritium analysis. Four facilities sample ambient air continuously over a two-week period, four collect over a one-week period, three collect over a one-month period, and two have variable collection periods depending on loading. Pantex has two systems for ambient tritium collection.

The number of ambient air tritium-monitoring stations at the individual facilities range from 3 (Rocky Flats) to 52 (LANL).

Adsorbents used or methods of collection include silica gel (nine facilities), molecular sieve (two facilities), collection of precipitation (Rocky Flats), and ethylene glycol bubblers (Mound). The masses of the adsorbents used range from 135 to 1,000 g.

Airflow rates through the adsorbents are typically in the range of 100–1,000 cm^3/min.

Detection limits for tritium at the facilities range from 0.4 to 50 pCi/m^3. ORNL and Pantex have much higher detection limits. Detailed data provided by each facility are compiled in Appendix B.

DOE Laboratories and Facilities That Do Not Conduct Ambient Air Radioactive Particulate or Tritium Monitoring

Ames Laboratory
Fermi National Accelerator Laboratory
Princeton Plasma Physics Laboratory
Stanford Linear Accelerator Center
Thomas Jefferson National Accelerator Facility
Oak Ridge Operations Environmental Management Program
Oak Ridge Institute for Science and Education
Y-12 Plant (air monitoring conducted by ORNL)
Grand Junction Projects Office
Kansas City Plant
National Renewable Energy Laboratory
New Brunswick Laboratory
Environmental Measurements Laboratory

Acknowledgments

This work was supported by the US Department of Energy through a contract with the University of California. The data reported in this paper are the combined effort of many dedicated people. I would specifically like to mention some of those current staff members at LANL, including Jean Dewart, Craig Eberhart, Ernie Gladney, Joan "Pony" Lujan, and Mike McNaughton. I also thank my contacts from the various DOE facilities: Barb Gillespie, Paris Althouse, Paula Tate, Connie Carpenter, Norbert Golchert, Doug Marx, Robert Nininger, Pete Fledderman, Craig Perkins, Gary Schroeder, Robert F. (Frank) Grossman, Patrick Thorson, David Griffis, Gina Deola, Stewart Jones, Richard Fox, Maria Miles, Steve Howard, Kathy Nickel, Roy Evans, Laury Hamilton, and Joan Hughes.

Other Information

Ken Duvall, Office of Environmental Policy and Assistance, DOE headquarters, has compiled a list of DOE sites and their Clean Air Act compliance doses. This list includes the computer code (e.g., CAP-88) that the site uses to demonstrate compliance with 40 CFR 61 Subpart H.

References

1) US DOE Order 5400.1, "General Environmental Protection Program," November 9, 1988.
2) US DOE Guidance DOE/EH-0173T, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance," January 1991.

Appendix A

Compilation of Ambient Air Monitoring Program Parameters at DOE Facilities:

Radioactive Particulate Matter

Table A-1. Compilation of Ambient Air Monitoring Program Parameters at DOE Facilities: Radioactive Particulate Matter

	Particle sizes of interest	Filter media	Filter size	Airflow rate	Length of sampling period	Number of stations	Analyses of individual samples	Detection limits of individual samples in units given by facility	Detection limits for individual samples in pCi/m^3	Comments	Contact
Los Alamos National Laboratory	All (TSP)	Polypropylene	47 mm	4.0 cfm	2 weeks, continuous	52	Gross alpha, Gross beta, Gamma spec	Gross alpha: 0.5 pCi/sample Gross beta: 1.0 pCi/sample	Gross alpha: 2 _ 10^{-4} pCi/m^3* Gross beta: 4_ 10^{-4} pCi/m^3*		Jean Dewart (505) 665-0239
Savannah River Site	All (TSP)	Glass fiber	47 mm	2.6 cfm	1 week, continuous	17	Gross alpha, Gross beta, Gamma spec	Gross alpha: 1 x 10^{-3} pCi/m^3 Gross beta: 1.5 x 10^{-2} pCi/m^3	Gross alpha: 1 x 10^{-3} pCi/m^3 Gross beta: 2 x 10^{-2} pCi/m^3		Pete Fledderman (803) 725-1736
Hanford Site-WMNW	All (TSP)	Glass fiber	47 mm	2.0 cfm	2 weeks, continuous	81	Gross alpha, Gross beta	Gross alpha: 2 x 10^{-15} µCi/mL Gross beta: 1.9 x 10^{-14} µCi/mL	Gross alpha: 2 x 10^{-3} pCi/m^3* Gross beta: 2 x 10^{-2} pCi/m^3*	WMNW – Waste Management Northwest. Near Facility Environmental Monitoring	Craig Perkins (509) 372-8042
Hanford Site-PNNL	All (TSP)	Glass fiber	47 mm	2.6 m^3/hour (1.53cfm)*	2 weeks, continuous ^{129}I monthly, continuous	44 (6 are gross beta only)	Gross alpha Gross beta	Gross alpha: 1 x 10^{-3} pCi/m^3 Gross beta: 3 x 10^{-3} pCi/m^3	Gross alpha: 1_ 10^{-3} pCi/m^3 Gross beta: 3 x 10^{-3} pCi/m^3	Pacific Northwest National Laboratory conducts far field monitoring for Hanford. ^{129}I is on charcoal substrate at 4 locations only.	Barb Gillespie (509) 376-5802
Brookhaven	All (TSP)	Glass fiber, charcoal	5 cm	15–20 L/min (0.52cfm)*	1 week, continuous	5	Gross alpha, Gross beta	Gross alpha: 1–2 x 10^{-3} pCi/m^3 Gross beta: 5 x 10^{-3} pCi/m^3	Gross alpha: 1–2 x 10^{-3} pCi/m^3 Gross beta: 5 x 10^{-3} pCi/m^3		Gary Schroeder (516) 344-7045
INEEL – BBWI	PM-10 TSP	PM-10 and low-vol: acrylic copolymer	PM-10 4" Low-vol 2"	PM-10 40 cfm Low-vol 2 cfm	PM-10 2 weeks, continuous Low-vol 1 week, continuous	PM-10 27 Low-vol 18	Gross alpha Gross beta	Gross alpha: 7 x 10^{-10} pCi/cc Gross beta: 2 x 10^{-9} pCi/cc	Gross alpha: 7 x 10^{-4} pCi/m^3 Gross beta: 2 x 10^{-3} pCi/m^3	Bechtel, Babcock & Wilcox Idaho (BBWI) performs near field monitoring.	Maria Miles (208) 526-7924
INEEL – ESRF	All (TSP)	Acrylic copolymer	47 mm	2 cfm	1 week, continuous	17	Gross alpha Gross beta Gamma scan	Gross alpha: 1 x 10^{-15} µCi/ml Gross beta: 3 x 10^{-15} µCi/ml Gamma: (^{137}Cs) 3 x 10^{-16} µCi/ml	Gross alpha: 1 x 10^{-3} pCi/m^3 Gross beta: 3 x 10^{-3} pCi/m^3 Gamma: (^{137}Cs) 3 x 10^{-4} pCi/m^3	Environmental Science & Research Foundation (ESRF) conducts far field monitoring for INEEL.	Roy Evans (208) 525-7102
Nevada Test Site	All (TSP)	Glass fiber	9 cm 8" x 10"	3.0 cfm 40 cfm	1 week, continuous for both	27 6	Gross alpha Gross beta Gamma spec	Gross alpha: 1.8 x 10^{-15} µCi/mL Gross beta: 4.1 x 10^{-15} µCi/mL 3 x 10^{-16} µCi/mL	Gross alpha: 2 x 10^{-3} pCi/m^3* Gross beta: 4 x 10^{-3} pCi/m^3*		Robert F. (Frank) Grossman (702) 295-5742

Table A-1. Compilation of Ambient Air Monitoring Program Parameters at DOE Facilities: Radioactive Particulate Matter (Cont.)

	Particle sizes of interest	Filter media	Filter size	Airflow rate	Length of sampling period	Number of stations	Analyses of individual samples	Detection limits of individual samples in units given by facility	Detection limits for individual samples in pCi/m^3	Comments	Contact
Oak Ridge National Laboratory	All (TSP)	Glass fiber, charcoal	9— 8" x 10" 4—2.5"	9–35 cfm 4–2 cfm	9—1 week continuous 4—2 weeks continuous	8 Reservation, 1 Background; 4 Local	N/A	N/A	N/A	Other than I and Os (adsorbable gases collected on charcoal), analyses are done only on composites.	Laury Hamilton (423) 576-4526 Joan Hughes (423) 574-6649
E.O. Lawrence Berkeley National Lab	All (TSP)	Borosilicate glass microfiber	4"	2.1 cfm	1 Month, continuous	4	Gross alpha Gross beta	Gross alpha: 10 pCi/ sample Gross beta: 8 pCi/sample	Gross alpha: 4×10^{-3} pCi/m^3* Gross beta: 3×10^{-3} pCi/m^3*		Patrick Thorson (510)486-5852
Sandia National Laboratories	≤10µm	Glass fiber	8" x 10"	40 cfm	24 Hours every 6th day	4	None	N/A	N/A	No analyses are performed on individual samples. Only composites are analyzed.	Gina Deola (505)845-7688
Argonne National Laboratory	≤10µm	Glass fiber	8" x 10"	60–70 m^3/hr (35–41 cfm)*	1 week, continuous	18	Gross alpha Gross beta Gamma spec	Gross alpha: ~0.3 fCi/m^3 Gross beta and gamma: ~1fCi/m^3	Gross alpha: 3×10^{-4} pCi/m^3* Gross beta: 1×10^{-3} pCi/m^3*		Norbert Golchert (630) 252-3912
Pantex	All (TSP)	47 mm – Teflon or cellulose	47 mm	180 cm^3/min or 1.5 cfm	4 weeks or 1 week	27	Gross alpha Gross beta (screening)	Gross alpha: ~0.01 dpm Gross beta: ~0.01 dpm	N/A	Two systems of collection are used. 47 mm filters are in line with the tritium collection and are collected at the same frequency as that system.	David W. Griffis (806) 477-4426
Lawrence Livermore	All (TSP)	Hi-vol Glass fiber Low-vol Millipore	Hi-vol 8" x 10" Low-vol 47 mm	Hi-vol 35 cfm Low-vol 30 L/min (1cfm)*	1 week, continuous for both	28 Hi-vol 3 LowVol	Gross alpha Gross beta	Gross alpha: 12 pCi/filter Gross beta: 20 pCi/filter	Gross alpha: 35 cfm 1×10^{-3}* 30 L/min 4×10^{-2}* Gross beta: 35 cfm 2×10^{-3}* 30 L/min 7×10^{-2}*	Monitoring performed by Terrestrial Atmospheric Monitoring and Modeling Group.	Paris Althouse (925) 422-3001
Waste Isolation Pilot Plant	All (TSP)	Glass fiber	47 mm	2.0 cfm	1 week, continuous	7	Gross alpha Gross beta	Gross alpha: 2×10^{-10}µCi/m^3 Gross beta: 1.9×10^{-10} µCi/m^3	Gross alpha: 2×10^{-4} * Gross beta: 2×10^{-4} *	Environmental Evaluation Group headed by Jim Kenney (505) 885-9675 evaluates in a similar manner except at 5 cfm and 102 mm filters	Stewart Jones (505) 234-8293 Benny Hooda (505) 234-8932
Rocky Flats-APCD	PM-10 and TSP	TSP–Glass fiber, PM10 – Quartz	8" x 10"	40 cfm	24 hours every 6th day	6 PM-10 6 TSP	Mass Loading	N/A	N/A	APCD—Air Pollution Control Division	Richard Fox (303) 692-3251

Table A-1. Compilation of Ambient Air Monitoring Program Parameters at DOE Facilities: Radioactive Particulate Matter (Cont.)

	Particle sizes of interest	Filter media	Filter size	Airflow rate	Length of sampling period	Number of stations	Analyses of individual samples	Detection limits of individual samples in units given by facility	Detection limits for individual samples in pCi/m^3	Comments	Contact
Rocky Flats-LARS	PM-10 and TSP	TSP–Glass fiber, PM10 – Quartz	8" x 10"	40 cfm	1 week, continuous	3 PM-10, 12 TSP	Gross alpha Gross beta	Gross alpha: 2×10^{-3} pCi/m^3 Gross beta: 4×10^{-3} pCi/m^3	Gross alpha: 2×10^{-3} Gross beta: 4×10^{-3}	LARS—Laboratory and Radiation Services	Tony Harrison (303) 692-3046
Rocky Flats-RFETS	PM-10 and >10 μm	PM-10 – Glass fiber >10 μm – oiled paper	8" x 10" filter ~4" x 6" paper	40 cfm	1 Month, continuous	35	^{239}Pu, ^{241}Am, $^{234,238}U$	Pu & Am 2×10^{-4} pCi/m^3	Pu & Am 2×10^{-4} pCi/m^3	RFETS—Rocky Flats Environmental Technology Site 14 stations analyzed monthly, other selected stations analyzed weekly for α/β, monthly for isotopes	Bob Nininger (303) 966-4663
Mound Plant	All (TSP)	Quartz fiber	200 mm	45 cfm	1 week, continuous	20	^{238}Pu; ^{228}Th, ^{232}Th at 1 Station	^{238}Pu, ^{228}Th, ^{232}Th: 10^{-18} μCi/mL	^{238}Pu, ^{228}Th, ^{232}Th: 10^{-6} pCi/m^3*	10 stations are analyzed monthly by creating composites of weekly samples. Individual samples are halved for composites.	Steve Howard (937) 865-4188
Fernald Environmental Management Project	All (TSP)	Polyester	20 x 25 cm	45 cfm	2 weeks, continuous	20	Total U, Thorium, Particulate Weight	Th 0.4 pCi/ Filter Total U 3×10^{-5} pCi/m^3	Th 1.6×10^{-5} pCi/m^3* Total U 3×10^{-5} pCi/m^3	Monitor for 40 CFR Part 61 (NESHAP) compliance	Kathy Nickel (513) 648-3166
Knolls Atomic Power Laboratory	All (TSP)	Glass fiber	2"	1 cfm	2 weeks, continuous	2	Gross alpha Gross beta	Gross alpha: 1×10^{-15} μCi/mL Gross beta: 5×10^{-15} μCi/mL	Gross alpha: 1×10^{-3} pCi/m^3* Gross beta: 5×10^{-3} pCi/m^3*	NOT used for compliance	Doug Marx (518) 395-6169
Bettis Atomic Power Laboratory	All (TSP)	Mixed cellulose esters	47 mm	20 L/min (0.7 cfm)*	1 week, continuous	2	Gross alpha Gross beta	Gross alpha: 2×10^{-16} μCi/mL Gross beta: 4×10^{-16} μCi/mL	Gross alpha: 2×10^{-4} pCi/m^3* Gross beta: 4×10^{-4} pCi/m^3*	NOT used for compliance	Connie Carpenter (412) 476-7388

***Denotes a calculation and is not the value and/or units given by the facility.**
TSP = Total Suspended Particulate

Table A-2. Compilation of Ambient Air Monitoring Program Parameters at DOE Facilities: Composites

	Airflow rate	Length of sampling period	Composite	Composite nuclides	Detection limits for composites in units given by facility	Comments	Contact
Los Alamos National Laboratory	4.0 cfm	2 weeks, continuous	Quarterly	^{238}Pu, $^{239+240}$Pu, ^{234}U, ^{235}U, ^{238}U, ^{241}Am, Gamma scan	0.04 pCi/sample		Jean Dewart (505) 665-0239
Savannah River Site	2.6 cfm	1 week, continuous	No	N/A	N/A	A one-week sample is characterized annually for Sr, Pu, U, Am and Cm	Pete Fledderman (803) 725-1736
Hanford Site-WMNW	2.0 cfm	2 weeks, continuous	Every 6 months	^{238}Pu, $^{239+240}$Pu, ^{234}U, ^{235}U, ^{238}U, ^{241}Am, ^{90}Sr, Gamma scan	**Units in μCi/mL:** ^{90}Sr 1.9 x 10^{-14} Iso Pu: 2.0 x 10^{-15} ^{241}Am: 1.9 x 10^{-15} Iso U: 7.1 x 10^{-15}	WMNW – Waste Management Northwest. Near Facility Environmental Monitoring	Craig Perkins (509) 372-8042
Hanford Site-PNNL	2.6 m^3/hour (1.53cfm)*	2 weeks, continuous ^{129} I monthly, continuous	Quarterly (filters and ^{129}I)	^{238}Pu, $^{239+240}$Pu, ^{234}U, ^{235}U, ^{238}U, ^{90}Sr, ^{134}Cs, ^{137}Cs, ^{7}Be, ^{40}K, ^{60}Co, ^{106}Rn, ^{125}Sb, ^{154}Eu, ^{155}Eu	**In pCi/m^3:** ^{238}Pu 5 x 10^{-6} $^{239+240}$Pu 5 x 10^{-6} ^{90}Sr 1 x 10^{-4} ^{234}U 5 x 10^{-5} ^{235}U 5 x 10^{-5} ^{238}U 5 x 10^{-5} ^{137}Cs .01	29 composites are made up of the 44 stations for _ and _. ^{129} I is on charcoal substrate at 4 locations only. PNNL – Pacific Northwest National Laboratory conducts far field monitoring for Hanford.	Barb Gillespie (509) 376-5802
Brookhaven	15–20 L/min (0.52 cfm)*	1 week, continuous	Monthly	Gamma scan. No specific nuclides.	N/A		Gary Schroeder (516) 344-7045
INEEL – BBWI	PM-10 40 cfm Low-vol 2.0 cfm	PM-10 2 weeks, continuous Low-vol 1 week, continuous	Quarterly for both, PM10—Monthly γ composite	^{238}Pu, $^{239+240}$Pu, ^{234}U, ^{235}U, ^{238}U, ^{241}Am, ^{90}Sr, ^{137}Cs Gamma spec on both Low-vol and PM-10	**In μCi/cc:** ^{238}Pu 8 x 10^{-18} $^{239+240}$Pu 8 x 10^{-18} ^{241}Am 8 x 10^{-18} ^{90}Sr 1 x 10^{-16} ^{234}U 6 x 10^{-18} ^{235}U 4 x 10^{-18} ^{238}U 4 x 10^{-18}	Bechtel, Babcock & Wilcox Idaho (BBWI) performs near field monitoring.	Maria Miles (208) 526-7924
INEEL – ESRF	2.0 cfm	1 week, continuous	Quarterly	^{90}Sr ^{241}Am ^{238}Pu $^{239/240}$Pu Specific Gamma (^{137}Cs)	**In μCi/ml:** ^{90}Sr 3 x 10^{-17} ^{241}Am 2 x 10^{-18} ^{238}Pu 2 x 10^{-18} $^{239/240}$Pu 3 x 10^{-18} ^{137}Cs 3 x 10^{-16}	Environmental Science and Research Foundation (ESRF) conducts far field monitoring for INEEL.	Roy Evans (208) 525-7102

Table A-2. Compilation of Ambient Air Monitoring Program Parameters at DOE Facilities: Composites (Cont.)

	Airflow rate	Length of sampling period	Composite	Composite nuclides	Detection limits for composites in units given by facility	Comments	Contact
Nevada Test Site	3.0 cfm 40 cfm	1 week, continuous for both	Monthly	^{238}Pu, $^{239+240}$ Pu, ^{7}Be, Gamma scan ^{238}Pu, $^{235+240}$ Pu	**In μCi /mL:** ^{238}Pu 9.8 x 10^{-18} $^{239+240}$Pu 10.6 x 10^{-18} ^{7}Be 2.1 ^{x} 10^{-14} ^{238}Pu 6 x 10^{-18} $^{235+240}$ Pu 6 x 10^{-18}		Robert F. (Frank) Grossman (702) 295-5742
Oak Ridge National Laboratory	9—35 cfm 4—2 cfm	9—1 week continuous 4—2 weeks continuous	9 Quarterly, 4 Annually	Gross alpha, Gross beta, Gamma scan, ^{234}U, ^{235}U, ^{238}U	**In μCi/year:** ^{234}U 3.53 x 10^{-4} ^{235}U 3.76 x 10^{-4} ^{238}U 3.92 x 10^{-4} Gross _ 2.25 x 10^{-5} Gross _ 6.54 x 10^{-4}	Other than I and Os, analyses are done only on composites.	Laury Hamilton (423) 576-4526 Joan Hughes (423) 574-6649
E.O. Lawrence Berkeley National Lab	2.1 cfm	1 Month, continuous	None	None	N/A		Patrick Thorson (510)486-5852
Sandia National Laboratories	40 cfm	24 Hours every sixth day	Monthly	Gross alpha Gross beta Gamma spec	Gross alpha: 5.4 x 10^{-4} pCi/m^3 Gross beta: 1.5 x 10^{-3} pCi/m^3	Gamma spec – Peaks are counted	Gina Deola (505)845-7688
Argonne National Laboratory	60–70 m^3/hr (35–41 cfm)*	10 days, continuous	Monthly	^{238}Pu, ^{239}Pu, ^{234}U, ^{238}U, ^{90}Sr, ^{232}Th, ^{230}Th, ^{228}Th	^{238}Pu 1 aCi/m^3 ^{239}Pu 1 aCi/m^3 ^{234}U 1 aCi/m^3 ^{238}U 1 aCi/m^3 ^{232}Th 1 aCi/m^3 ^{230}Th 1 aCi/m^3 ^{228}Th 1 aCi/m^3 ^{90}Sr: 10 aCi/m^3	Three separate stations are used for compositing. They run for 10 days and are composited monthly. Polystyrene filters are used for these composites	Norbert Golchert (630)252-3912
Pantex	8" x 10" 40 cfm	1 week, continuous	Monthly	^{234}U, ^{238}U, ^{239}Pu – all filters ^{238}Pu, ^{232}Th – some filters	.05 pCi/composite	The 8" x 10" cellulose filters are collected weekly from a total of 27 monitoring locations.	David W. Griffis (806) 477-4426

Table A-2. Compilation of Ambient Air Monitoring Program Parameters at DOE Facilities: Composites (Cont.)

	Airflow rate	Length of sampling period	Composite	Composite nuclides	Detection limits for composites in units given by facility	Comments	Contact
Lawrence Livermore	Hi-vol 35 cfm Low-vol 30 L/min (1cfm)*	1 week, continuous for both	Monthly	^{238}Pu, $^{239+240}$Pu, ^{235}U, ^{238}U, Gamma	**In pCi/filter:** ^{238}Pu 1.7 x 10^{-2} $^{239+240}$Pu 3.06 x 10^{-3} **In μg /filter:** ^{235}U 1.43 x 10^{-2} ^{238}U 2.00	**Calculations at a flow rate of 1 cfm:** ^{238}Pu 7 x 10^{-6}* $^{239+240}$Pu 1 x 10^{-5}* ^{235}U 1 x 10^{-4}* ^{238}U 2 x 10^{-3}*	Paris Althouse (925) 422-3001
Waste Isolation Pilot Plant	2.0 cfm	1 week, continuous	Quarterly	^{238}Pu, ^{239}Pu, ^{234}U, ^{235}U, ^{238}U, ^{90}Sr, ^{241}Am	**In pCi/m^3:** ^{238}Pu 6 x 10^{-5} ^{239}Pu 6 x 10^{-5} ^{234}U 3 x 10^{-5} ^{235}U 3 x 10^{-5} ^{238}U 3 x 10^{-5} ^{241}Am See Comments ^{90}Sr 8 x 10^{-4} ^{40}K 1 x 10^{-2} ^{137}Cs 1 x 10^{-3} ^{60}Co 1 x 10^{-3}	Environmental Evaluation Group headed by Jim Kenney (505) 885-9675 evaluates in a similar manner except at 5 cfm and 102 mm filters. ^{241}Am 1 x 10^{-6} Bq/m^3	Stewart Jones (505) 234-8293 Benny Hooda (505) 234-8932
Rocky Flats-APCD	40 cfm	24 hours every 6th day	Quarterly TSP and PM10	^{239}Pu, ^{240}Pu, U, ^{241}Am	U 1 x 10^{-4} pCi/m^3 ^{241}Am 5 x 10^{-6} pCi/m^3 Iso Pu 5 x 10^{-6} pCi/m^3	APCD – Air Pollution Control Division	Richard Fox (303) 692-3251
Rocky Flats-LARS	40 cfm	1week, continuous	Quarterly TSP and PM10	^{239}Pu, ^{240} Pu, ^{241}Am	^{241}Am 3 x 10^{-6} pCi/m^3 Iso Pu 3 x 10^{-6} pCi/m^3	LARS-Laboratory and Radiation Services	Tony Harrison (303) 692-3046
Mound Plant	45 cfm	1 week, continuous	Quarterly (remaining 12 stations)	^{238}Pu; ^{228}Th, ^{232}Th	^{2} ^{38}Pu; ^{228}Th, ^{232}Th: 10^{-18}μCi/mL	Individual samples are halved for composites	Steve Howard (937) 865-4188
Fernald Environmental Management Project	45 cfm	2 weeks, continuous	Quarterly	^{234}U, ^{235}U, ^{236}U, ^{238}U; ^{228}Th, ^{230}Th, ^{232}Th; ^{226}Ra	**In pCi/m^3:** Iso U 9 x 10^{-5} Iso Th 7 x 10^{-6} ^{226}Ra 2 x 10^{-4}	Monitor for 40 CFR Part 61 (NESHAP) compliance	Kathy Nickel (513) 648-3166
Knolls Atomic Power Laboratory	1 cfm	2 weeks, continuous	No	N/A	N/A	NOT used for compliance	Doug Marx (518) 395-6169
Bettis Atomic Power Laboratory	20 L/min (0.7 cfm)*	1 week, continuous	No	N/A	N/A	NOT used for compliance	Connie Carpenter (412) 476-7388

Table A-3. Compilation of Ambient Air Monitoring Program Parameters at DOE Facilities: Detection Limits for Composites

	Detection limits for composites in pCi/m^3														
	^{238}Pu	$^{239+240}$Pu	^{234}U	^{235}U	^{238}U	^{241}Am	^{90}Sr	^{7}Be	^{137}Cs	^{228}Th	^{230}Th	^{232}Th	Gross alpha:	Gross beta:	Other
Los Alamos National Laboratory	5×10^{-6} *	5×10^{-6} *	5×10^{-6} *	5×10^{-6} *	5×10^{-6} *	5×10^{-6} *									
Hanford Site-WMNW	2×10^{-3}*	2×10^{-3}*	7×10^{-3}*	7×10^{-3}*	7×10^{3}*	2×10^{-3}*	2×10^{-2}*								
Hanford Site-PNNL	5×10^{-6}	5×10^{-6}	5×10^{-5}	5×10^{-5}	5×10^{-5}		1×10^{-4}		1×10^{-2}						
INEEL – BBWI	8×10^{-6}*	8×10^{-6}*	6×10^{-6}*	4×10^{-6}*	4×10^{-6}*	8×10^{-6}	1×10^{-4}*								
INEEL – ESRF	2×10^{-6}	3×10^{-6}				2×10^{-6}	3×10^{-5}		3×10^{-4}						
Nevada Test Site	**At 3 cfm:** 1×10^{-5}* **At 40 cfm:** 6×10^{-6}*	**At 3 cfm:** 1×10^{-5}* **At 40 cfm:** 6×10^{-6}*						2×10^{-2}*							
Oak Ridge National Laboratory			**At 2cfm:** 1×10^{-2}* **At 35cfm:** 7×10^{-4}*	**At 2cfm:** 1×10^{-2}* **At 35cfm:** 7×10^{-4}*	**At 2cfm:** 1×10^{-2}* **At 35cfm:** 8×10^{-4}*										
Sandia National Laboratories													5×10^{-4} pCi/m^3	2×10^{-3} pCi/m^3	
Argonne National Laboratory	1×10^{-6}*	1×10^{-6}*	1×10^{-6}*	1×10^{-6}*	1×10^{-6}*		1×10^{-5}*			1×10^{-6}*	1×10^{-6}*	1×10^{-6}*			
Pantex	1×10^{-5}*	1×10^{-5}*	1×10^{-5}*		1×10^{-5}*							1×10^{-5}*			
Lawrence Livermore	**At 35 cfm:** 2×10^{-7}*	**At 35 cfm:** 3×10^{-7}*		**At 35cfm:** 3×10^{-7}*	**At 35cfm:** 7×10^{-5}*										
Waste Isolation Pilot Plant	6×10^{-5}	6×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	3×10^{-5}	8×10^{-4}		1×10^{-3}						^{40}K 1×10^{-2} ^{60}Co 1×10^{-3}

Table A-3. Compilation of Ambient Air Monitoring Program Parameters at DOE Facilities
Detection Limits for Composites (Cont.)

	Detection limits for composites in pCi/m^3														
	^{238}Pu	$^{239+240}$Pu	^{234}U	^{235}U	^{238}U	^{241}Am	^{90}Sr	^{7}Be	^{137}Cs	^{228}Th	^{230}Th	^{232}Th	Gross alpha:	Gross beta:	Other
Rocky Flats-APCD		3*	6×10^{-1}*	2×10^{-4}*	3×10^{-5} *	2*									
Rocky Flats-LARS		2 *	6×10^{-1}*		3×10^{-5} *	10*									
Mound Plant	1×10^{-6} *									1×10^{-6}*		1×10^{-6}*			
Fernald Environmental Management Project			9×10^{-5}	9×10^{-5}	9×10^{-5}					7×10^{-6}	7×10^{-6}	7×10^{-6}			^{226}Ra 2×10^{-4}

*** Denotes a calculation and is not the value and/or units given by the facility.**

SRS, Brookhaven, Berkeley, Rocky Flats-RFETS, Knolls and Bettis do not analyze composites.

Table B-1. Compilation of Ambient Air Monitoring Program Parameters at DOE Facilities: Tritium

	Length of sampling period	Number of Stations	Adsorbent	Cartridge size or adsorbent mass	Flow rate	Detection limits	Comments	Contact
Los Alamos National Laboratory	2 weeks, continuous	52	Silica Gel	135g	200 cm^3/min	2 pCi/m^3		Jean Dewart (505) 665-0239
Savannah River Site	2 weeks, continuous	17	Silica Gel	400–450g	150 cm^3/min	49 pCi/m^3		Pete Fledderman (803) 725-1736
Hanford Site-WMNW	N/A	N/A	N/A	N/A	N/A	N/A	WMNW – Waste Management Northwest. Near Facility Environmental Monitoring	Craig Perkins (509) 372-8042
Hanford Site-PNNL	Monthly	20	Silica Gel	Approximately 1,000 g	0.4 ft^3/hr	3 pCi/m^3	Pacific Northwest National Laboratory conducts far field monitoring for Hanford.	Barb Gillespie (509) 376-5802
Brookhaven	1 week, continuous	22	Silica Gel	Cartridge size @12" x 2"	200 cm^3/min	1–4 pCi/m^3		Gary Schroeder (516) 344-7045
INEEL – BBWI	1–8 weeks, continuous, depending on indicator	2–3	Molecular Sieve	200g	120 cm^3/min	10 pCi/m^3	Bechtel, Babcock & Wilcox Idaho (BBWI) performs near field monitoring.	Maria Miles (208) 526-7924
INEEL – ESRF	1–13 weeks, continuous depending on indicator	4	Silica Gel	230g	300 cm^3/min	4×10^{-12} µCi/ml 4 pCi/m^3	Environmental Science and Research Foundation (ESRF) conducts far field monitoring for INEEL.	Roy Evans (208) 525-7102
Nevada Test Site	2 weeks, continuous	12	Molecular Sieve	350g	570 cm^3/min	2.9×10^{-12} µCi/mL 2.9 pCi/m^3*		Frank Grossman (702) 295-5742
Oak Ridge National Laboratory	1–2 weeks, continuous, depending on loading	9 Outside Lab 4 on Lab property	Silica Gel	250g	180 cm^3/min	1.56 µCi/year 1.7×10^4 pCi/m^3*		Laury Hamilton (423) 576-4526 Joan Hughes (423) 574-6649

Table B-1. Compilation of Ambient Air Monitoring Program Parameters at DOE Facilities: Tritium (Cont.)

	Length of sampling period	Number of Stations	Adsorbent	Cartridge size or adsorbent mass	Flow rate	Detection limits	Comments	Contact
E.O. Lawrence Berkeley National Lab	1 Month, continuous	6	Silica Gel	333g 480 cc	100 cm^3/min	10 pCi/m^3		Patrick Thorson (510) 486-5852
Sandia National Laboratories	N/A	N/A	N/A	N/A	N/A	N/A	No routine tritium monitoring. Tritium monitoring may be done on a project specific basis.	Gina Deola (505)845-7688
Argonne National Laboratory	N/A	N/A	N/A	N/A	N/A	N/A	No tritium monitoring	Norbert Golchert (630)252-3912
Pantex	U tube – 1 week, continuous Dual cartridge- 4 weeks, continuous	10 17 (27 total)	Silica Gel	U-tube – 200 g Dual cartridges –400 g each	U-Tube—1.5 cfm (42.5 L/min) Dual Cartridges –180 cm^3/min	0.5 dpm/mL (1.1 x 10^3 pCi/m^3*)	Two monitoring systems are used. Oxidized tritium (tritiated water vapor) is measured at 10 stations. Both oxidized and elemental tritium are measured using a monitoring system placed at 17 locations.	David W. Griffis (806) 477-4426
Lawrence Livermore	2 weeks, continuous	20	Silica Gel	~1,000 g in a glass flask	700 cm^3/min	0.4 pCi/m^3	Use freeze-dried technique	Paula Tate (925) 423-4858
Waste Isolation Pilot Plant	N/A	N/A	N/A	N/A	N/A	N/A	No tritium monitoring	Stewart Jones (505) 234-8293
Rocky Flats-APCD	N/A	N/A	N/A	N/A	N/A	N/A	No tritium monitoring	Richard Fox (303) 692-3251
Rocky Flats-LARS	Weekly; quarterly composites	3	Collect precipitation	N/A	N/A	~140 pCi/L	Precipitation only; No conversion to air	Tony Harrison (303) 692-3046
Rocky Flats-RFETS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Bob Nininger (303) 966-4663
Mound Plant	Weekly	20	Ethylene glycol, Bubbler	200 mL	1000cm^3/min	$20x10^{-12}$ µCi/mL 20 pCi/m^3*	HTO only	Steve Howard (937) 865-4188

Table B-1. Compilation of Ambient Air Monitoring Program Parameters at DOE Facilities: Tritium (Cont.)

	Length of sampling period	Number of Stations	Adsorbent	Cartridge size or adsorbent mass	Flow rate	Detection limits	Comments	Contact
Fernald Environmental Management Project	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Kathy Nickel (513) 648-3166
Knolls Atomic Power Laboratory	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Doug Marx (518) 395-6169
Bettis Atomic Power Laboratory	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Connie Carpenter (412) 476-7388

*** Denotes a calculation and is not the value and/or units given by the facility.**

Appendix C

Calculations used in the conversion of detection limits given by the facility to pCi/m^3

LANL:	Gross alpha	(0.5pCi/sample)(sample/2283m^3)
	Gross beta	(1.0pCi/sample)(sample/2283m^3)
	^{238}Pu	(0.04 pCi/sample)(1 sample/6–7 biweekly filters)(6.5 filters x 2283m^3)
	^{239}Pu	(0.04 pCi/sample)(1 sample/6–7 biweekly filters)(6.5 filters x 2283m^3)
	^{234}U	(0.04 pCi/sample)(1 sample/6–7 biweekly filters)(6.5 filters x 2283m^3)
	^{235}U	(0.04 pCi/sample)(1 sample/6–7 biweekly filters)(6.5 filters x 2283m^3)
	^{238}U	(0.04 pCi/sample)(1 sample/6–7 biweekly filters)(6.5 filters x 2283m^3)
	^{241}Am	(0.04 pCi/sample)(1 sample/6–7 biweekly filters)(6.5 filters x 2283m^3)
		(336 hr/biweekly sample)(4 ft^3/min)(60 min/hr)(0.02831m^3/ft^3)=2283 m^3
SRS:	N/A	Units given in pCi/m^3 by the facility
Hanford:	Gross alpha	(2 x 10^{-15} µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	Gross beta	(1.9 x 10^{-14}µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	^{90}Sr	(1.9 x 10^{-14} µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	Iso Pu:	(2.0 x 10^{-15} µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	^{241}Am:	(1.9 x 10^{-15} µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	Iso U:	(7.1 x 10^{-15} µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
Brookhaven:	N/A	Units given in pCi/m^3 by the facility
INEEL:	^{238}Pu	(8 x 10^{-18} µCi/cc)(1000 cc/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	$^{239+240}$Pu	(8 x 10^{-18} µCi/cc)(1000 cc/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	^{241}Am	(8 x 10^{-18} µCi/cc)(1000 cc/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	^{90}Sr	(1 x 10^{-16} µCi/cc)(1000 cc/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	^{234}U	(6 x 10^{-18} µCi/cc)(1000 cc/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	^{235}U	(4 x 10^{-18} µCi/cc)(1000 cc/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	^{238}U	(4 x 10^{-18} µCi/cc)(1000 cc/liter)(1000 liters/m^3)(10^6 pCi/µCi)
NTS:	Gross alpha	(1.8 x 10^{-15} µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	Gross beta	(4.1 x 10^{-15} µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	^{238}Pu	(9.8 *or* 6 x 10^{-18} µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	$^{239+240}$Pu	(10.6 *or* 6 x 10^{-18} µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	^{7}Be	(2.1 ^{x} 10^{-14} µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	^{3}H	(2.9 x 10^{-12} µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
ORNL:	Gross alpha	(2.25 x 10^{-5} µCi/year) (min/2 ft^3 *or* min/35 ft^3)(1 yr/365 days)
		(day/24 hr)(hr/60 min)(10^6 pCi/µCi)(35.31 ft^3/m^3)
	Gross beta	(6.54 x 10^{-4} µCi/year) (min/2 ft^3 *or* min/35 ft^3)(1 yr/365 days)
		(day/24 hr)(hr/60 min)(10^6 pCi/µCi)(35.31 ft^3/m^3)
	^{234}U	(3.53 x 10^{-4} µCi/year)(min/2 ft^3 *or* min/35 ft^3)(1 yr/365 days)
		(day/24 hr)(hr/60 min)(10^6 pCi/µCi)(35.31 ft^3/m^3)
	^{235}U	(3.76 x 10^{-4} µCi/year) (min/2 ft^3 *or* min/35 ft^3)(1 yr/365 days)
		(day/24 hr)(hr/60 min)(10^6 pCi/µCi)(35.31 ft^3/m^3)
	^{238}U	(3.92 x 10^{-4} µCi/year)(min/2 ft^3 *or* min/35 ft^3)(1 yr/365 days)
		(day/24 hr)(hr/60 min)(10^6 pCi/µCi)(35.31 ft^3/m^3)
	^{3}H	(1.56 µCi/year)(min/180 cc)(1 x 10^6 cc/m^3)(1 yr/365 days)
		(day/24 hr)(hr/60 min)(10^6 pCi/µCi)

Berkeley:	Gross alpha	(10 pCi/ sample)(1 sample/month)(month/30.5 days)(day/24 hr) (hr/60 min)(min/2.1ft^3)(1 ft^3/2.832 x 10^{-2} m^3)
	Gross beta	(8 pCi/sample)(1 sample/month)(month/30.5 days)(day/24 hr) (hr/60 min)(min/2.1ft^3)(1 ft^3/2.832 x 10^{-2} m^3)
Sandia:	N/A	Units given in pCi/m^3 by the facility
Argonne:	Gross alpha	(0.3 fCi/m^3) (10^{-3} pCi/fCi)
	Gross beta	(1fCi/m^3) (10^{-3} pCi/fCi)
	^{238}Pu	(1 aCi/m^3)(10^{-6} pCi/aCi)
	^{239}Pu	(1 aCi/m^3)(10^{-6} pCi/aCi)
	^{234}U	(1 aCi/m^3)(10^{-6} pCi/aCi)
	^{238}U	(1 aCi/m^3)(10^{-6} pCi/aCi)
	^{232}Th	(1 aCi/m^3)(10^{-6} pCi/aCi)
	^{230}Th	(1 aCi/m^3)(10^{-6} pCi/aCi)
	^{228}Th	(1 aCi/m^3)(10^{-6} pCi/aCi))
	^{90}Sr:	(10 aCi/m^3)(10^{-6} pCi/aCi)
Pantex:		
	^{238}Pu	(.05 pCi/composite)(1 composite/month)(min/40 ft^3)(month/43,200min)(35.31 ft^3/m^3)
	^{239}Pu	(.05 pCi/composite)(1 composite/month)(min/40 ft^3)(month/43,200min)(35.31 ft^3/m^3)
	^{234}U	(.05 pCi/composite)(1 composite/month)(min/40 ft^3)(month/43,200min)(35.31 ft^3/m^3)
	^{238}U	(.05 pCi/composite)(1 composite/month)(min/40 ft^3)(month/43,200min)(35.31 ft^3/m^3)
	^{232}Th	(.05 pCi/composite)(1 composite/month)(min/40 ft^3)(month/43,200min)(35.31 ft^3/m^3)
	^{3}H	(0.5 dpm/mL)(2.2pCi/dpm)(1000 mL/L)(1 L/m^3)
LLNL:	Gross alpha	(12 pCi/filter)(1 filter/wk)(1 wk/168hr)(hr/60 min)(min/35 ft^3 *or* min/1 ft^3)(35.31 ft^3/m^3)
	Gross beta	(20 pCi/filter)(1 filter/wk)(1 wk/168hr)(hr/60 min)(min/35 ft^3 *or* min/1 ft^3)(35.31 ft^3/m^3)
	^{238}Pu	(1.7 x 10^{-2} pCi/filter)(1 filter/wk)(1 wk/168hr)(hr/60 min)(min/35 ft^3 *or* min/1 ft^3)(35.31 ft^3/m^3)
	$^{239+240}$Pu	(3.06 x 10^{-3} pCi/filter)(1 filter/wk)(1 wk/168hr)(hr/60 min)(min/35 ft^3 *or* min/1 ft^3)(35.31 ft^3/m^3)
	^{235}U	(1.43 x 10^{-2} µg/filter) (2.2 x 10^{-3} mCi/g)(10^9 pCi/mCi)(g/10^6 µg) (1 filter/wk.)(1 wk./168hr)(hr/60 min)(min/35 ft^3 *or* min/1 ft^3)(35.31 ft^3/m^3)
	^{238}U	(2µg/filter)(3.3 x 10^{-4} mCi/g)(10^9 pCi/mCi)(g/10^6 µg)(1 filter/wk) (1 wk/168hr)(hr/60 min)(min/35 ft^3 *or* min/1 ft^3)(35.31 ft^3/m^3)
WIPP:	Gross alpha	(2 x 10^{-10} µCi/m^3)(10^6 pCi/µCi)
	Gross beta	(2 x 10^{-10} µCi/m^3)(10^6 pCi/µCi)
Rocky Flats:	^{234}U	(1 x 10^{-4}µg/m^3)(1.0g/10^6 µg)(6.18 mCi/g)(10^9 pCi/mCi)
	^{233}U	(1 x 10^{-4}µg/m^3)(1.0g/10^6 µg)(9.47 mCi/g)(10^9 pCi/mCi)
	^{235}U	(1 x 10^{-4}µg/m^3)(1.0g/10^6 µg)(2.2 x 10^{-3} mCi/g)(10^9 pCi/mCi)
	^{238}U	(1 x 10^{-4}µg/m^3)(1.0g/10^6 µg)(3.3 x 10^{-4} mCi/g)(10^9 pCi/mCi)
	^{241}Am	(5 x 10^{-6}µg/m^3)(1.0g/10^6 µg)(3.24 x 10^3 mCi/g)(10^9 pCi/mCi)
	^{241}Am	(3 x 10^{-6}µg/m^3)(1.0g/10^6 µg)(3.24 x 10^3 mCi/g)(10^9 pCi/mCi)
	^{239}Pu	(5 x 10^{-6}µg/m^3)(1.0g/10^6 µg)(61.3 mCi/g)(10^9 pCi/mCi)
	^{239}Pu	(3 x 10^{-6}µg/m^3)(1.0g/10^6 µg)(61.3 mCi/g)(10^9 pCi/mCi)
	^{240}Pu	(5 x 10^{-6}µg/m^3)(1.0g/10^6 µg)(2.26 x 10^2 mCi/g)(10^9 pCi/mCi)
	^{240}Pu	(3 x 10^{-6}µg/m^3)(1.0g/10^6 µg)(2.26 x 10^2 mCi/g)(10^9 pCi/mCi)
	^{3}H	Precipitation only; no conversion to air volume

Mound:	^{238}Pu	$(10^{-18}$ µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	^{228}Th	$(10^{-18}$ µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	^{232} Th	$(10^{-18}$ µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	^{3}H	(20 x 10^{-12} µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
Fernald:	Th	(0.4 pCi/ filter)(1 filter/2 weeks)(2 weeks/20,160 min)(min/45 ft^3)(35.31 ft^3/m^3)
Knolls:	Gross alpha	(1 x 10^{-15}µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	Gross beta	(5 x 10^{-15}µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
Bettis:	Gross alpha	(2 x 10^{-16}µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)
	Gross beta	(4 x 10^{-16}µCi/mL)(1000 mL/liter)(1000 liters/m^3)(10^6 pCi/µCi)