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INEEL Offsite Environmental Surveillance Program Report: Fourth Quarter of 1996

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Executive Summary

The Environmental Science and Research Foundation conducts the Idaho National Engineering and Environmental Laboratory (INEEL) Offsite Environmental Surveillance Program. The Foundation's environmental surveillance program is designed to monitor the effects, if any, of Department of Energy (DOE) activities on the offsite environment, to collect data to confirm compliance with applicable environmental laws and regulations, and to observe any trends in environmental levels of radioactivity. This report for the fourth quarter of 1996 includes the results of analyses conducted on samples of air, water, milk, potatoes, big game, soil, and environmental radiation. A total of 565 samples were collected and analyzed. All concentrations of radioactivity found in these samples were consistent with historical levels. No evidence of radionuclides from the INEEL was found in offsite samples. Concentrations of radionuclides found in all samples were below the guidelines set by both the Department of Energy and the Environmental Protection Agency (EPA) for radiation protection of the public.

Program Description

The Foundation collected filters weekly from low-volume air samplers at 12 offsite locations. Five were at distant locations and seven at INEEL boundary locations. An additional three samplers were operated on the INEEL. Weekly measurements were made of gross alpha and gross beta concentrations in airborne particulates. Charcoal cartridges were screened weekly for the presence of Iodine-131. At the end of the quarter, weekly filters from each location were combined to form a composite sample for each location. These composites were then analyzed for gamma-emitting radionuclides. Selected composites were also submitted for Strontium-90 and transuranic analyses (Plutonium-238, Plutonium-239/240, and Americium-241).

Atmospheric moisture and precipitation samples were collected to monitor for tritium. Atmospheric moisture samples were collected for a period of approximately eight weeks. The Foundation collected two precipitation samples monthly, one onsite and one offsite, as well as a weekly onsite sample.

Drinking water samples were collected from 13 offsite locations and surface water samples were obtained from five sites. All water samples were analyzed for gross alpha, gross beta, and tritium concentrations.

The Foundation collected a weekly milk sample from a dairy in Idaho Falls and collected monthly milk samples from eight additional dairies around the INEEL. All milk samples were analyzed for Iodine-131. Selected November samples were also analyzed for either tritium or Strontium-90.

Four big game animals killed on INEEL roads or found dead on or near the INEEL were sampled. Samples were submitted for analysis of Iodine-131 and man-made gamma-emitting radionuclides.

Five potato samples were collected from Burley, Blackfoot, Arco, Monteview, and Idaho Falls. Each sample was analyzed for gamma-emitting radionuclides and Strontium-90. Thirteen ducks were collected from three INEEL facility ponds and one offsite control area. All of the ducks were analyzed for gamma-emitting radionuclides. Selected ducks were submitted for Strontium-90 and transuranic radionuclide analysis.

Eight boundary and four distant soil samples were taken. At each location, samples were taken at 0-5 cm depth and 5-10 cm depth. The 0-5 cm samples were analyzed for Strontium-90 and transuranics. Both the 0-5 and 5-10 cm depths were analyzed by gamma spectroscopy.

The Foundation collected 13 offsite TLDs (environmental radiation dosimeters) that are analyzed semiannually to determine environmental radiation levels around the INEEL.

Summary of Fourth Quarter 1996 Results

During the fourth quarter of 1996, gross alpha and gross beta concentrations in low-volume air samples were within the expected range of values for background radioactivity. Mean concentrations of both gross alpha and gross beta were similar at onsite, distant, and boundary locations. Iodine-131 was not found in any air sample. No Cesium-137, Plutonium-238, or Plutonium 239/240 was detected in samples from any location. Concentrations just above detection limits of Strontium-90 were detected in composites from Arco and Monteview. However, the uncertainty for these concentrations did not exceed 3s, making the detections questionable. Americium-241 was detected in one distant, two boundary, and one onsite location. The concentrations of Americium-241 in the distant and boundary composities were consistent with historic findings for this radionuclide. The concentration for the onsite composite was higher than found in recent years. A recount of this sample verified the original concentration. Although no specific source has been identified, above background concentrations of Americium-241 are known to be around some INEEL facilities.

Tritium was detected in one of three atmospheric moisture samples. The detected concentration, sampled from a distant location, was attributed to contributions from natural tritium-producing processes in the earth's atmosphere, nuclear power, historic nuclear weapons testing, and statistical fluctuations in the analysis.

Tritium was detected in three of 12 precipitation samples. These three samples were collected onsite at EFS. The tritium concentrations were consistent with levels detected in offsite samples of recent years and were attributed to natural atmospheric processes, historic nuclear weapons testing, nuclear power, and statististical fluctuations in the analysis.

Water samples from two distant and one boundary location showed concentrations of tritium just above detection limits. At these concentrations, natural atmospheric processes, historic nuclear weapons testing, nuclear power, and statistical fluctuations in analysis were the most likely sources. One sample showed a detectable concentration of gross alpha and all samples had measurable levels of gross beta. These levels were attributed to naturally occuring radionuclides in the earth's crust.

None of the milk samples collected during the fourth quarter contained detectable concentrations of Iodine-131. One of four samples had a detectable concentration of tritium; three of four samples analyzed for Strontium-90 had detectable concentrations. The levels found in these samples were consistent with those reported by the U.S. Environmental Protection Agency and the presence of these radionuclides was attributed to fallout from historic nuclear weapons tests.

No Iodine-131 was found in thyroid glands of big game. Two of the four mule deer sampled had measurable levels of Cesium-137 in the muscle. One of these two had measurable Cesium-137 in the liver. These deer were collected onsite; one near TRA and one near CFA. Soil contaminated with Cesium-137 is present around some INEEL facilities. Ingestion of contaminated soil and/or plants growing in contaminated soil was the most likely cause of these detections.

None of the potato samples showed detectable levels of man-made gamma-emitting radionuclides or Strontium-90.

Detectable concentrations of ten radionuclides were neasured in the edible portion of ducks collected from the TRA ponds. Four radionuclides were detected in the edible portions of ducks from ICPP and from the control location. Detectable concentrations of two radionuclides were measured in the edible portions of ducks from TAN.

Strontium-90 and Cesium-137 were detected in all soil samples. Transuranic radionuclides were detected in many of the samples. The concentrations reported here are consistent with past results due to worldwide fallout from historical above-ground nuclear weapons testing.

The environmental radiation results were consistent with previously reported data and indicated no increase in detectable levels of environmental radiation due to INEEL activities.

Helpful Information for Readers

Radionuclide Nomenclature

Radionuclides are sometimes expressed with the one- or two-letter chemical symbol for the element. A radionuclide is an unstable, or radioactive, form of an element. A given element may have many different radionuclides. Each is designated by a superscript number to the left of the chemical symbol. This number is the atomic weight of the radionuclide, equal to the number of protons and neutrons in its nucleus. Radionuclides which may be used in this report are shown in the following table:

Symbol	Radionuclide	Symbol	Radionuclide
^{3}H	Tritium	^{131}I	Iodine-131
^{7}Be	Beryllium-7	^{134}Cs	Cesium-134
^{51}Cr	Chromium-51	^{137}Cs	Cesium-137
^{54}Mn	Manganese-54	^{144}Ce	Cerium-144
^{58}Co	Cobalt-58	^{181}Hf	Hafnium-181
^{60}Co	Cobalt-60	^{238}Pu	Plutonium-238
^{65}Zn	Zinc-65	$^{239/240}Pu$	Plutonium-239/240
^{90}Sr	Strontium-90	^{241}Am	Americium-241
^{95}Nb	Niobium-95		

Scientific Notation

Scientific notation is used to express numbers which are very small and very large. A very small number will be expressed with a negative exponent, e.g., 1.3×10^{-6}. To convert this number to the more commonly used form, the decimal point must be moved left by a number of places equal to the exponent (in this case, six). The number thus becomes 0.0000013.

For large numbers, those with a positive exponent, the decimal point is moved to the right by the number of places equal to the exponent. The number 1,000,000 (or one million) can be written as 1.0×10^{6}.

Unit Prefixes

Units for very small and very large numbers are commonly expressed with a prefix. One example is the prefix *kilo,* abbreviated k, which means 1,000 of a given unit. A kilometer is therefore equal to 1,000 meters. Prefixes that may be used in this report are:

Prefix	Abbreviation	Meaning
milli-	m	1/1,000 (=1 x 10^{-3})
micro-	µ	1/1,000,000 (=1 x 10^{-6})
pico-	p	1/1,000,000,000,000 (=1 x 10^{-12})

Units of Radioactivity and Radiation Exposure and Dose

The basic unit of radioactivity used in this report is the curie, abbreviated Ci. The curie is defined as the amount of radioactivity equivalent to 37 billion nuclear transformations per second. Historically, this was based upon the radioactivity from one gram of the radionuclide Radium-226. For any other radionuclide, one curie is the amount of that radionuclide that decays at this same rate.

Radiation exposure is expressed in terms of the Roentgen (R), the amount of ionization produced by gamma radiation in air. Dose is given in units of “Roentgen equivalent man,” or “rem,” which takes into account the effect of radiation on tissues. For the types of environmental radiation generally encountered, the unit of Roentgen is approximately equal to the unit of rem.

Units of Environmental Concentrations

Concentration of radioactivity in air and milk samples is expressed in units of microcuries per milliliter (µCi/mL). Concentrations in water samples are expressed as picocuries per liter (pCi/l); federal standards are expressed in these units. Radioactivity in foodstuffs are given in microcuries per gram (µCi/g), dry weight. Radioactivity in soil samples is expressed as picocuries per gram (pCi/g), dry weight. Annual human radiation exposure, measured by environmental dosimeters, is expressed in units of milliRoentgens (mR). This is sometimes expressed in terms of dose as millirem (mrem). Not all of the above sample types may appear in this particular report.

Uncertainty of Measurements

Due to many variables, there is always an uncertainty associated with the measurement of environmental contaminants. For radioactivity, the predominant source of uncertainty is due to the inherent statistical nature of radioactive decay events, particularly at the low activity levels encountered in environmental samples. The uncertainty of a measurement is denoted by following the result with a "±" (uncertainty) term. This report follows convention in reporting the uncertainty as a 95% confidence limit (or interval), designated in the tables as “±2s." That means there is approximately a 95% level of confidence that the real concentration in the sample lies somewhere between the measured (reported) concentration minus the uncertainty term and the measured (reported) concentration plus the uncertainty term.

Negative Numbers as Results

Negative values can occur when a measured result is less than a pre-established average background level for the instrument used. These values, rather than "not detectable" or "zero," are reported to better enable statistical analyses and to observe trends in the data.

Gross versus Specific Analyses

Many of the radiological analyses of environmental samples yield information only about the overall, or gross, amount of a particular type of radiation (e.g., gross beta), rather than identifying and quantifying specific radionuclides. For example, rather than performing an analysis for particular gamma-emitting radionuclides, called gamma spectroscopy, one can do a gross gamma or, more commonly, a gross beta analysis, since gamma-emitting radionuclides also emit beta particles. This type of analysis is an effective screening tool and is much quicker and less costly than specific radionuclide analyses.

Table of Contents

Tables

Figures

1. Introduction

Consistent with requirements of applicable U.S. Department of Energy (DOE) Orders, the Foundation's environmental surveillance program is designed to monitor the effects, if any, of DOE activities on the offsite environment, to collect data which verifies compliance with applicable environmental laws and regulations, and to observe trends in environmental levels of radioactivity. This work is performed under DOE Contract DE-AC07-ID13268.

This quarterly report summarizes the data collected by the Foundation's INEEL Offsite Environmental Surveillance Program during the period October 1 through December 31, 1996. The scope of the Foundation's sampling program is outlined in Table 1. Most analyses for the surveillance program were performed by Idaho State University's Environmental Assessment Laboratory. Other analyses were performed by Quanterra Laboratory, a commercial laboratory located in Richland, Washington.

Nearly all of the reported environmental results are near background levels of radioactivity; many results are near the detection limits of the laboratory procedures. Table 2 summarizes the approximate minimum detectable concentrations (MDC) of radioactivity that the laboratories can detect and quantify for a given sample type and analysis. All results are reported with an associated 2s ("two sigma") uncertainty term. The Foundation has adopted the following method for interpreting analytical results near the minimum detectable concentration. Results less than or equal to the 2s uncertainty term, which includes some results that are negative, are considered as "not detected." For results greater than 2s (the 95% confidence level), but not exceeding 3s (the 99% confidence interval), detection of the radioactivity is questionable. Results may exceed the 2s level simply due to the inherent random nature of radioactive decay events. This is expected to occur approximately 2.5% of the time. Results exceeding 3s are interpreted as indicating that radioactivity was detected.

Where appropriate, the results in this report are compared to the following:

- For air, concentrations are compared to the DOE Derived Concentration Guides. This is the concentration of a radionuclide that, under conditions of continuous exposure, would result in an effective dose equivalent of 100 mrem (the DOE standard for members of the public);

- For drinking water, concentrations are compared to the Environmental Protection Agency's Maximum Contaminant Level. This is the maximum permissible level of a contaminant in water that is delivered to any user of a community water system.

Table 1
Summary of the Foundation's Environmental Surveillance Program

Sample Type Analysis	**Collection Frequency**	**Locations** Distant	Boundary	INEEL
Air				
Gross Alpha	weekly	Blackfoot, Craters of the Moon, Idaho Falls, Mountain View Middle School, Rexburg	Arco, Atomic City, FAA Tower, Howe, Monteview, Mud Lake, Reno Ranch	Main Gate, EFS, Van Buren
Gross Beta ^{131}I	weekly	Blackfoot, Craters of the Moon, Idaho Falls, Mountain View Middle School, Rexburg	Arco, Atomic City, FAA Tower, Howe, Monteview, Mud Lake, Reno Ranch	Main Gate, EFS, Van Buren
Gamma Spec Particulate Mass	quarterly	Blackfoot, Craters of the Moon, Idaho Falls, Mountain View Middle School, Rexburg	Arco, Atomic City, FAA Tower, Howe, Monteview, Mud Lake, Reno Ranch	Main Gate, EFS, Van Buren
^{90}Sr Transuranics	quarterly	Rotating schedule	Rotating schedule	Rotating schedule
PM-10				
	every six days	Rexburg, Mountain View	None	None
Air Moisture				
Tritium	4 to 13 weeks	Idaho Falls, Rexburg	Atomic City	None
Precipitation				
Tritium	monthly	Idaho Falls	None	CFA
Tritium	weekly	None	None	EFS
Surface H_2O				
Gross Alpha, Gross Beta, ^{3}H	quarterly→ semiannually→	Twin Falls, Buhl, Hagerman Idaho Falls, Bliss	None	None
Drinking H_2O				
Gross Alpha Gross Beta, ^{3}H	semiannually	Aberdeen, Blackfoot, Carey, Idaho Falls, Fort Hall, Minidoka, Roberts, Shoshone	Arco, Atomic City, Howe, Monteview, Mud Lake, Reno Ranch	None
Milk				
^{131}I	weekly	Idaho Falls	None	None
^{131}I	monthly	Blackfoot, Carey, Dietrich, Minidoka, Roberts	Howe, Terreton, Arco	None
Tritium ^{90}Sr	annually	Blackfoot, Carey, Dietrich, Idaho Falls, Minidoka, Roberts	Howe, Terreton, Arco	None
Potatoes				
Gamma Spec ^{90}Sr	annually	Blackfoot, Idaho Falls, Rupert	Arco, Mud Lake	None
Wheat				
Gamma Spec ^{90}Sr	annually	American Falls, Blackfoot, Dietrich, Idaho Falls, Minidoka, Carey	Arco, Monteview, Mud Lake, Tabor, Terreton	None
Lettuce				
Gamma Spec ^{90}Sr	annually	Blackfoot, Carey, Idaho Falls, Pocatello	Arco, Atomic City, Howe, Mud Lake	None
Fish				
Gamma Spec	annually	None	None	Big Lost River
Sheep				
Gamma Spec	annually	Blackfoot	None	INEEL grazing areas
Waterfowl				
Gamma Spec ^{90}Sr Transuranics	annually	Fort Hall	None	Waste disposal ponds
Game				
Gamma Spec	varies	None	None	INEEL roads
Soil				
Gamma Spec ^{90}Sr Transuranics	biennially	Carey, Crystal Ice Caves, Blackfoot, St. Anthony	Butte City, Monteview, Atomic City, FAA Tower, Howe, Mud Lake (2), Reno Ranch	None
TLDs				
Gamma Radiation	semiannual	Aberdeen, Blackfoot, Craters of the Moon, Idaho Falls, Minidoka, Rexburg, Roberts	Arco, Atomic City, Howe, Monteview, Mud Lake, Reno Ranch	None

Table 2
Summary of Approximate Minimum Detectable Concentrations for Radiological Analyses (Fourth Quarter 1996)

Sample Type	Analysis	Approximate Minimum Detectable Concentration[a] (MDC)	Derived Concentration Guide[b] (DCG)	Drinking Water Detection Limits[c]
Air (particulate filter)[d]	Gross alpha	1×10^{-15} µCi/ml	2×10^{-14} µCi/ml	--
	Gross beta	4×10^{-15} µCi/ml	3×10^{-12} µCi/ml	--
	Specific gamma (^{137}Cs)	2×10^{-15} µCi/ml	4×10^{-10} µCi/ml	--
	^{238}Pu	2×10^{-18} µCi/ml	3×10^{-14} µCi/ml	--
	$^{239/240}Pu$	3×10^{-18} µCi/ml	2×10^{-14} µCi/ml	--
	^{241}Am	2×10^{-18} µCi/ml	2×10^{-14} µCi/ml	--
	^{90}Sr	3×10^{-17} µCi/ml	9×10^{-12} µCi/ml	--
Air (charcoal cartridge)[d]	^{131}I	4×10^{-15} µCi/ml	4×10^{-10} µCi/ml	--
Air (atmospheric moisture)[e]	^{3}H	4×10^{-12} µCi/ml	1×10^{-7} µCi/ml	--
Air (precipitation)	^{3}H	1×10^{-7} µCi/ml	2×10^{-3} µCi/ml	--
Water (drinking & surface)	Gross alpha	4 pCi/l	30 pCi/l	3 pCi/l
	Gross beta	2 pCi/l	100 pCi/l	4 pCi/l
	^{3}H	100 pCi/l	2×10^{6} pCi/l	1000 pCi/l
Milk	^{131}I	2×10^{-9} µCi/ml	--	--
	^{3}H	1×10^{-7} µCi/ml	--	--
	^{90}Sr	5×10^{-10} µCi/ml	--	--
Thyroid tissue	^{131}I	3×10^{-7} µCi/g	--	--
Liver tissue	^{137}Cs	5×10^{-9} µCi/g	--	--
Muscle tissue	^{137}Cs	4×10^{-9} µCi/g	--	--

a. The MDC is an estimate of the concentration of radioactivity in a given sample type that can be identified with a 95% level of confidence and a precision of plus or minus 100% under a specified set of typical laboratory measurement conditions.
b. DCGs, set by the DOE, represent reference values for radiation exposure. They are based on a radiation dose of 100 mrem/yr for exposure through a particular exposure mode such as direct exposure, inhalation, or ingestion of water.
c. These limits are required by the National Primary Drinking Water Regulations (40 CFR 141). The "detection limit" is the terminology used by the EPA and means the same as the MDC defined above.
d. The approximate MDC is based on an average filtered air volume (pressure corrected) of 570 m^3/week.
e. The approximate MDC is expressed for tritium (as tritiated water) in air, and is based on an average filtered air volume of 25 m^3, assuming an average sampling period of eight weeks.

2. Air Sampling

2.1 Sampling Methods

2.1.1 Low-Volume Air

Airborne particulate radioactivity was continuously monitored by 15 air samplers (Figure 1), designed to provide an effective network to detect INEEL releases of radioactivity. Five offsite air samplers were designated as distant, or background, stations and seven were designated as boundary stations. Three air samplers were situated on the INEEL. Distant locations were used to make comparisons of airborne concentrations of radioactivity with boundary and onsite locations. As part of the quality assurance program, two replicate samplers, located in Mud Lake and near the INEEL Main Gate, were operated adjacent to regular air samplers to provide quality assurance information.

Each air sampler averaged a flow of approximately 50 l/min (2 ft^3/min) through a filter head consisting of two types of filters—a 1.2-micrometer pore size particulate filter and a charcoal cartridge for the monitoring of radioactive iodine. These filters were changed weekly. In order to be considered a valid sample, each filter must sample a pressure-corrected air volume of at least 200 m^3, or about 7000 ft^3. Filters sample an average air volume of about 570 m^3 (20,000 ft^3).

Charcoal cartridges were screened in batches weekly for ^{131}I activity. If activity was detected in any batch that was greater than a preset action level, cartridges were then analyzed individually. Particulate filters were counted each week for gross (nonspecific) beta activity in a low-background beta counter after waiting a minimum of four days for the naturally occurring decay products of radon and thoron to decay. The particulate filters were also counted for gross alpha activity.

At the end of the quarter, weekly filters from each location were combined to form a composite. All composites were then analyzed by gamma spectrometry for specific radionuclides. Selected composites were also analyzed for ^{90}Sr or transuranic radionuclides (^{238}Pu, $^{239/240}Pu$, and ^{241}Am).

2.1.2 Atmospheric Moisture

Three air samplers, located in Atomic City, Idaho Falls, and Rexburg, collected atmospheric moisture for tritium analysis. Air was passed through a column of silica gel, which absorbs the water vapor in the air. Tritium concentrations were determined by extracting water from the silica gel and counting the water sample by liquid scintillation.

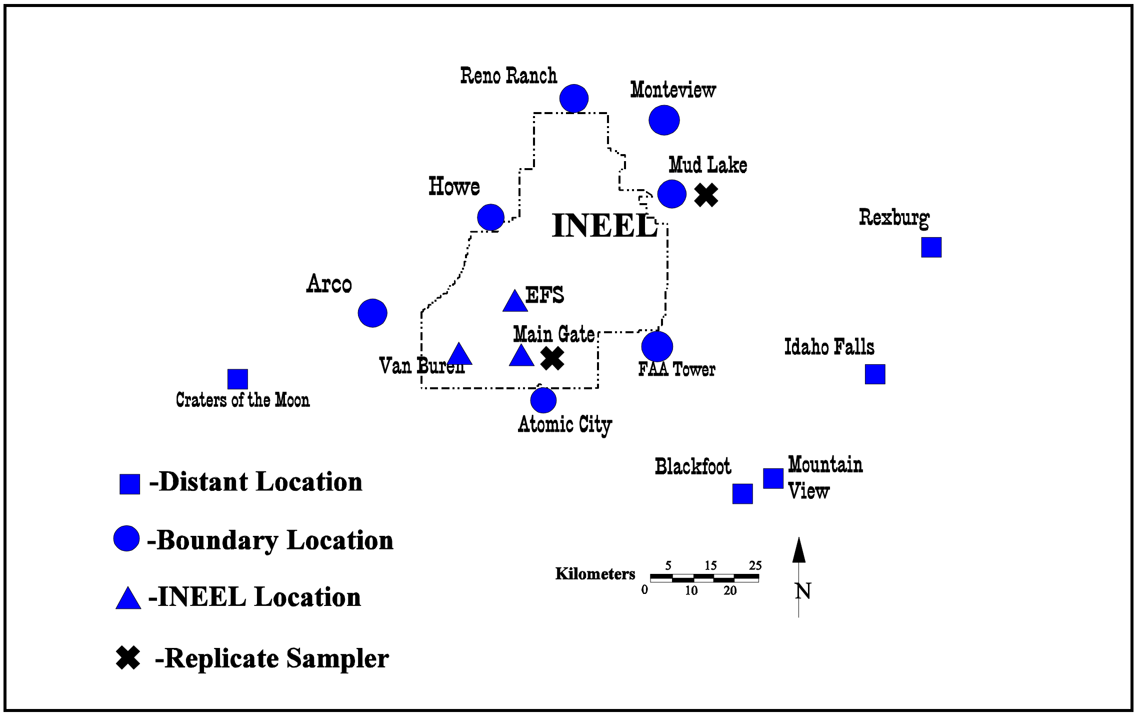

Figure 1. Air Sampling Location Map

2.1.3 Precipitation

When available, weekly precipitation samples were collected at the Experimental Field Station (EFS) on the INEEL. Monthly samples were collected from both Idaho Falls and Central Facilities Area on the INEEL. All precipitation samples were analyzed for tritium by liquid scintillation.

2.1.4 PM-10

Filters were collected weekly from PM-10 samplers in Rexburg and Blackfoot. Each filter was weighed and compared to its original weight to determine total concentration of airborne particulate matter below 10 microns in size. Filters collected from PM-10 samplers are not analyzed for radionuclides. These samplers specifically quantify the airborne particulate smaller than 10 microns in size, a size that can readily bypass the body's natural air filtering system and enter the lungs.

2.2 Results

2.2.1 Low-Volume Air

No ^{131}I was detected in any of the weekly charcoal cartridge batches analyzed during the fourth quarter, thus no analyses of individual cartridges were required. The minimum detectable concentration was approximately 1 x 10^{-15} µCi/ml.

All gross alpha concentrations were within the expected range of background levels. Mean gross alpha concentrations of boundary and INEEL stations were not statistically different from distant (background) stations (Figure 2, Table 3, and Table A-1).

All gross beta concentrations were consistent with expected background ranges. The quarterly mean gross beta concentrations for INEEL and boundary stations were not statistically different from the distant stations (Figure 3, Table 4, Table A-2).

Quarterly average gross alpha and gross beta concentrations from the replicate samplers at the INEEL Main Gate and Mud Lake stations showed no statistical difference in comparison to their respective test samplers (Tables 3, 4).

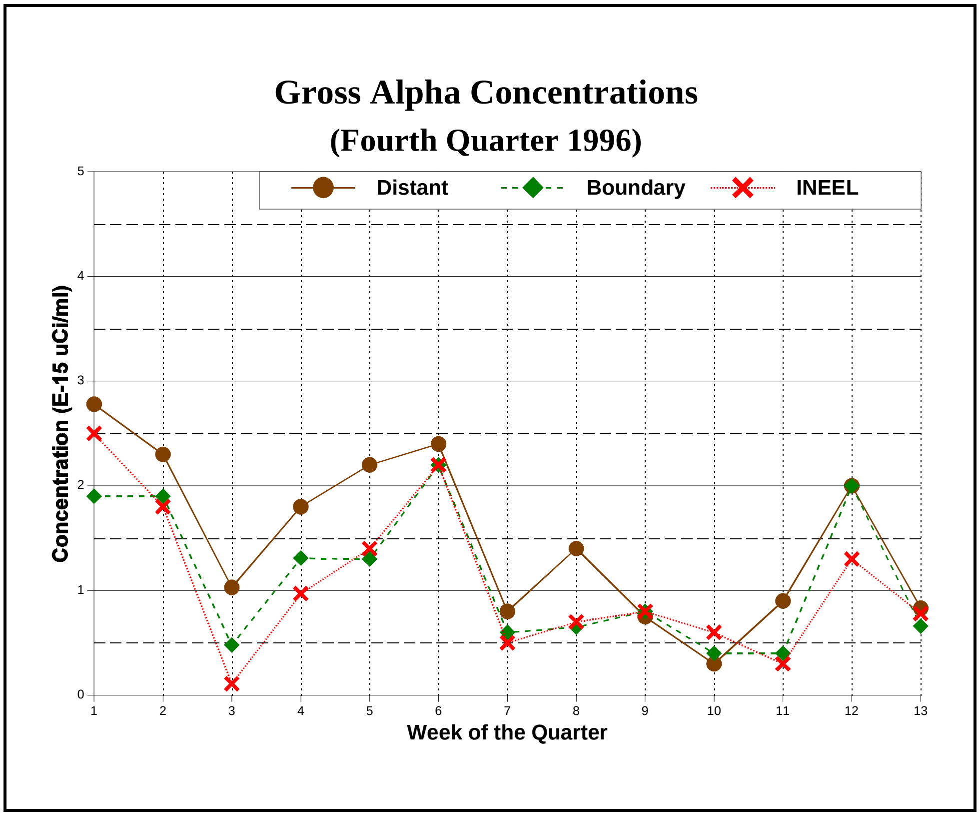

Figure 2 Weekly Gross Alpha Concentrations

Table 3
Gross Alpha Concentrations in Air
(Fourth Quarter 1996)

Group	Location	Number of Samples	Gross Alpha Concentration ($x\ 10^{-15}$ µCi/ml) Range of Samples	Mean with 95% Confidence Interval
Distant	Blackfoot	13	0.2 - 3.2	1.6 ± 0.6
	Craters of the Moon	13	0.0 - 2.3	0.9 ± 0.4
	Idaho Falls	12	- 0.3 - 2.2	1.4 ± 0.5
	Rexburg	13	0.0 - 2.9	1.5 ± 0.6
	Mtn.View Mdl. School	13	0.2 - 4.4	2.1 ± 0.7
			Group Mean	**1.5 ± 0.3**
Boundary	Arco	13	0.2 - 2.5	1.2 ± 0.5
	Atomic City	13	0.1 - 2.2	1.1 ± 0.4
	FAA Tower	13	0.0 - 2.4	1.0 ± 0.5
	Howe	13	0.3 - 2.3	1.2 ± 0.4
	Monteview	13	0.1 - 2.1	1.0 ± 0.4
	Mud Lake (Replicate)	13 (12)	0.0 - 2.4 (0.2 - 2.8)	1.1 ± 0.5 (1.4 ± 0.6)
	Reno Ranch	11	0.4 - 2.3	1.3 ± 4.8
			Group Mean	**1.1 ± 0.2**
INEEL	EFS	12	0.2 - 3.1	1.1 ± 0.6
	Main Gate (Replicate)	13 (13)	-0.1 - 2.2 (0.0 - 2.4)	1.0 ± 0.5 (1.4 ± 0.5)
	Van Buren	13	0.0 - 3.2	1.1 ± 0.4
			Group Mean	**1.1 ± 0.3**
			DOE Derived Concentration Guide	20

Quarterly composite samples from all sampling stations were analyzed for gamma-emitting radionuclides. Beryllium-7, a naturally-occurring gamma-emitting radionuclide produced by cosmic rays in the atmosphere, was detected in all of the composites. Cesium-137, sometimes detected on composite samples and whose presence is generally attributed to fallout from nuclear weapons, was not detected in any of the samples.

Several composite samples were also analyzed for ^{90}Sr and transuranics of interest (^{241}Am, ^{238}Pu, and $^{239/240}$Pu). Concentrations of Strontium-90 slightly above detection limits were measured in the composites from Arco and Monteview. Their concentrations did not exceed 3s uncertainty, thus making their detection questionable (Table 5).

Americium-241 was detected in composites from one distant, one INEEL and two boundary locations. The concentrations found in the distant and

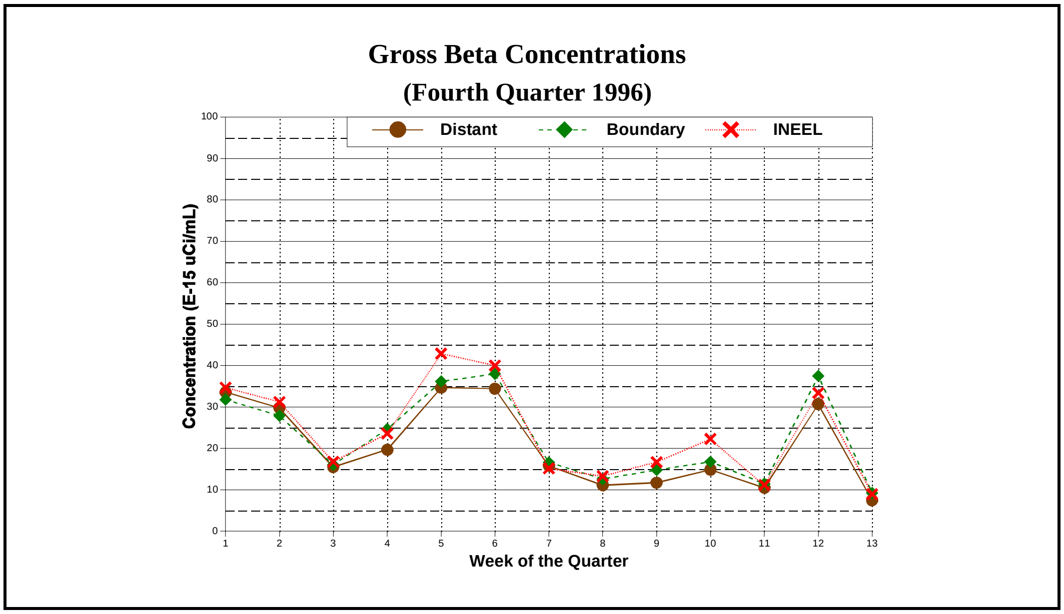

Figure 3. Weekly Gross Beta Concentrations

boundary samples were consistent with levels found in past composite samples. The measured concentration of (0.04 ± 0.01) x 10^{-15} µCi/ml in the onsite (EFS) composite was higher than found in recent years (Table 5). This sample was recounted and the original measured concentration was verified. Although no specific source has been identified, above background concentrations of ^{241}Am are found around some INEEL facilities.

2.2.2 Atmospheric Moisture

Atmospheric moisture samples were collected from Idaho Falls, Atomic City, and Rexburg in December 1996, representing moisture collected between October and December. The sample from Rexburg contained detectable tritium at (9.4 ± 5.9) x 10^{-14} µCi/ml, a concentration consistent with tritium levels attributed to natural atmospheric processes, historic nuclear weapons testing, nuclear power, and statistical variations in the analysis.

2.2.3 Precipitation

Twelve precipitation samples were collected during the fourth quarter. Each sample was analyzed for tritium. Tritium was detected in three samples, all from the Experimental Field Station (EFS). The range of concentrations detected in these EFS samples were (1.7 ± 1.2) x 10^{-7} to (2.4 ± 1.2) x 10^{-7} µCi/ml.

Table 4
Gross Beta Concentrations in Air
(Fourth Quarter 1996)

Group	Location	Number of Samples	Gross Beta Concentration ($x 10^{-15}$ µCi/ml) Range of Samples	Mean with 95% Confidence Interval
Distant	Blackfoot	13	9 - 39	23 ± 7
	Craters of the Moon	13	4 - 39	20 ± 6
	Idaho Falls	12	9 - 35	20 ± 6
	Rexburg	13	9 - 38	22 ± 6
	Mountain View Middle School	13	8 - 33	19 ± 6
			Group Mean	**21 ± 3**
Boundary	Arco	13	6 - 37	22 ± 6
	Atomic City	13	5 - 41	22 ± 8
	FAA Tower	13	9 - 36	20 ± 6
	Howe	13	11 - 40	24 ± 6
	Monteview	13	12 - 43	24 ± 6
	Mud Lake (Replicate)	13 (12)	3 - 45 (8 - 42)	23 ± 9 (22 ± 8)
	Reno Ranch	11	10 - 41	23 ± 7
			Group Mean	**23 ± 2**
INEEL	EFS	12	9 - 48	26 ± 8
	Main Gate (Replicate)	13 (13)	9 - 37 (8 - 41)	22 ± 6 (22 ± 8)
	Van Buren	13	9 - 47	24 ± 7
			Group Mean	**25 ± 4**
		DOE Derived Concentration Guide		3000

Historically, in certain cases, tritium found in onsite precipitation samples could be attributed to airborne effluents from the ICPP. However, the concentrations reported here for EFS are consistent with those found in offsite samples from recent years, and are most likely due to contributions from cosmic ray interactions in the earth's atmosphere,historic nuclear weapons testing, nuclear power, and statistical variations in the analysis.

2.2.4 PM-10

During the fourth quarter, eight PM-10 samples from Blackfoot and 13 PM-10 samples from Rexburg were collected. The mean concentration of airborne particulate smaller than 10 microns was measured at 14.3 µg/m^3 in Blackfoot and 16.6 µg/m^3 in Rexburg. The maximum concentration measured for Blackfoot was 41.2 µg/m^3, compared to 52.9 µg/m^3 measured in Rexburg.

Table 5
Manmade Radionuclides in Particulate Filter Quarterly Composites
(Fourth Quarter 1996)

Strontium-90

Location	Strontium-90 (10^{-15} µCi/ml ± 2s)
Distant Locations	
Not Detected: Blackfoot, Rexburg	
Boundary Locations	
Arco	0.05 ± 0.04
Monteview	0.04 ± 0.04
INEEL Locations	
Not Detected: Main Gate and Replicate	
DOE Derived Concentration Guide	9000

Transuranic Radionuclides

Location	Americium-241 (10^{-15} µCi/ml ± 2s)	Plutonium-238 (10^{-15} µCi/ml ± 2s)	Plutonium-239/240 (10^{-15} µCi/ml ± 2s)
Distant Locations			
Craters of the Moon	Not Detected	Not Detected	Not Detected
Idaho Falls	Not Detected	Not Detected	Not Detected
Mtn. View Middle School	0.004 ± 0.003	Not Detected	Not Detected
Boundary Locations			
Atomic City	Not Detected	Not Detected	Not Detected
Mud Lake	0.006 ± 0.003	Not Detected	Not Detected
Replicate	0.004 ± 0.003	Not Detected	Not Detected
INEEL Location			
EFS	0.04 ± 0.01	Not Detected	Not Detected
DOE Derived Concentration Guide	20	30	20

3.0 Foodstuff Sampling

3.1 Sampling Methods

3.1.1 Milk

Milk samples were collected weekly in Idaho Falls and monthly at eight other locations around the INEEL (Figure 5). Two types of locations were sampled: single family dairies and large commercial dairies. Each milk sample was analyzed for ^{131}I using gamma spectrometry. Selected milk samples collected in November were also analyzed for ^{3}H and ^{90}Sr.

3.1.2 Potatoes

Five potato samples were collected from warehouses in Burley, Blackfoot, Arco, Monteview, and Idaho Falls. Samples were analyzed for gamma-emitting radionuclides and Strontium-90.

3.1.3 Big Game

Thyroid, muscle tissue, and liver were sampled from big game animals killed on roadways or found dead on and near the INEEL. Thyroid glands were submitted for ^{131}I analysis. Muscle and liver samples were submitted for analysis of manmade gamma-emitting radionuclides.

3.1.4 Waterfowl

In cooperation with the Foundation's research program, waterfowl were collected from three INEEL facility waste disposal ponds. All of the samples were analyzed for gamma-emitting radionuclides, and some were submitted for Strontium-90 and transuranic radionuclide analysis.

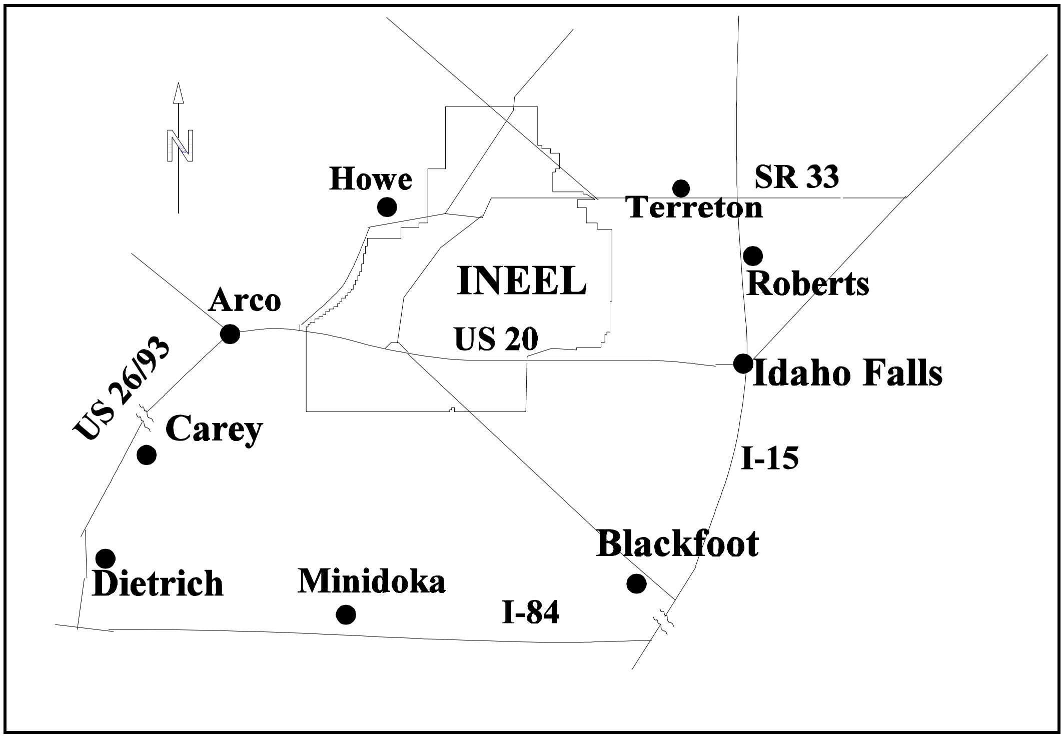

Figure 4. Milk Sampling Locations

3.2 Results

A total of 35 milk samples were collected during the fourth quarter. Iodine-131 was not detected in any of the samples, at a minimum detectable concentration of about 2 x 10^{-9} µCi/ml.

Milk samples from Carey, Minidoka, Blackfoot, Mud Lake, and Idaho Falls were analyzed for tritium. One distant sample (Blackfoot) had a detectable concentration at (1.3 ± 0.9) x 10^{-7} µC/ml. Four milk samples were analyzed for Strontium-90. Samples from two boundary locations and one distant location had detectable concentrations (Table 6). All Strontium-90 concentrations were consistent with those reported nationwide by the Environmental Protection Agency, and are likely due to worldwide fallout from historic above-ground nuclear weapons tests.

Four mule deer were sampled during the fourth quarter of 1996. No ^{131}I was found in thyroid glands. One mule deer collected near the Test Reactor Area contained ^{137}Cs in the muscle at (13 ± 4) x 10^{-9} µC/g and in the liver at (20 ± 6) x 10^{-9} µC/g. Soil contaminated with ^{137}Cs is present around some INEEL facilities, such as the Test Reactor Area, making it possible this deer may have ingested contaminated soil or plants growing in the contaminated soil. Another deer, collected at the Central Facilities Area, contained ^{137}Cs in the muscle tissue at a concentration of (4 ± 3) x 10^{-9} µC/g. This result is similar to the concentrations detected in offsite sheep from recent years, where ^{137}Cs is present in soils due to worldwide fallout.

No man-made gamma-emitting radionuclides or Strontium-90 were detected in the potato samples.

Thirteen ducks were collected from the following areas: three control ducks from Fort Hall and Heise, four from the radioactive waste ponds at the Test Reactor Area (TRA), and three each from historic radioactive waste ponds at Test Area North (TAN) and the Idaho Chemical Processing Plant (ICPP). Detectable concentrations of ten radionuclides were measured in the edible portions of ducks collected from the TRA ponds. Detectable concentrations of four radionuclides were measured in the edible portions of ducks collected from the ICPP. Control ducks had measurable concentrations of four radionuclides and ducks collected from TAN had measurable concentrations of two radionuclides (Table 7). Calculations were made to quantify the radiation dose a human would receive by consuming 225 grams (8 ounces) of muscle tissue from the most contaminated duck collected from the TRA ponds. This dose was 0.17 mrem. For perspective, a person would need to eat 2,117 eight oz. servings at this dose rate to equal the 360 mrem average dose a person living in southeast Idaho receives per year from sources such as cosmic rays, radon, medical procedures, and worldwide fallout.

Table 6
^{90}Sr Concentrations in Milk
(Fourth Quarter 1996)

	Location	Result (µCi/ml ± 2s) x 10^{-9}
Distant		
	Dietrich	2.2 ± 1.1
	Roberts	0.8 ± 1.2
Boundary		
	Arco	0.9 ± 0.6
	Howe	1.5 ± 0.9

Table 7-1
Manmade Gamma-emitting Radionuclides in Edible Portions of Waterfowl (1996)

Radionuclide	Location	# Ducks Analyzed	Minimum[a]	Maximum[a]	Mean[b]
			Concentration (x 10^{-6} µCi/g)		
^{51}Cr	Control	3	ND[c]	ND	-----[d]
	ICPP	4	ND	ND	-----
	TAN	3	ND	ND	-----
	TRA	3	ND	ND	-----
^{54}Mn	Control	3	ND	0.03 ± 0.03	0.03 ± 0.03
	ICPP	4	ND	ND	-----
	TAN	3	ND	ND	-----
	TRA	3	ND	0.26 ± 0.13	0.06 ± 0.14
^{58}Co	Control	3	ND	ND	-----
	ICPP	4	ND	ND	-----
	TAN	3	ND	0.13 ± 0.11	0.02 ± 0.11
	TRA	3	ND	0.26 ± 0.17	0.12 ± 0.11
^{60}Co	Control	3	ND	ND	-----
	ICPP	4	ND	ND	-----
	TAN	3	ND	ND	-----
	TRA	3	ND	8.97 ± 0.96	4.56 ± 4.84
^{65}Zn	Control	3	ND	ND	-----
	ICPP	4	ND	ND	-----
	TAN	3	ND	ND	-----
	TRA	3	ND	4.71 ± 0.69	1.48 ± 2.15
^{95}Nb	Control	3	ND	ND	-----
	ICPP	4	ND	0.23 ± 0.20	0.02 ± 0.25
	TAN	3	ND	ND	-----
	TRA	3	ND	ND	-----
^{95}Zr	Control	3	ND	ND	-----
	ICPP	4	ND	ND	-----
	TAN	3	ND	ND	-----
	TRA	3	ND	0.49 ± 0.24	0.17 ± 0.21
^{134}Cs	Control	3	ND	ND	-----
	ICPP	4	ND	ND	-----
	TAN	3	ND	0.03 ± 003	0.02 ± 0.02
	TRA	3	ND	0.09 ± 0.08	0.03 ± 0.04
^{137}Cs	Control	3	ND	0.03 ± 0.03	0.01 ± 0.02
	ICPP	4	ND	0.05 ± 0.04	0.03 ± 0.03
	TAN	3	ND	ND	-----
	TRA	3	ND	7.27 ± 0.78	2.10 ± 3.39
^{140}Ba	Control	3	ND	ND	-----
	ICPP	4	ND	17.80 ± 12.77	3.52 ± 15.64
	TAN	3	ND	ND	-----
	TRA	3	ND	4.67 ± 3.55	3.74 ± 2.60
^{181}Hf	Control	3	ND	0.10 ± 0.08	-0.04 ± 0.20
	ICPP	4	ND	ND	-----
	TAN	3	ND	ND	-----
	TRA	3	ND	ND	-----

a Concentration ± 2 standard deviations.
b Mean with 95% confidence interval.
c Not detectable
d There were no detectable concentrations for this radionuclide at this location.

Table 7-2
Strontium-90 and Transuranics in Edible Portions of Waterfowl (1996)

			Concentration (x 10^{-6} µCi/g)		
Radionuclide	Location	# Ducks Analyzed	Minimum[a]	Maximum[a]	Mean[b]
^{90}Sr	Control	2	ND	0.02 ± 0.01	0.02 ± 0.01
	ICPP	1	ND	ND	-----
	TAN	1	ND	ND	-----
	TRA	3	0.03 ± 0.01	0.65 ± 0.13	0.19 ± 0.31
^{238}Pu	Control	2	ND	ND	-----
	ICPP	1	ND	0.011 ± 0.003	0.01[e]
	TAN	1	ND	ND	-----
	TRA	3	ND	ND	-----
$^{239/240}Pu$	Control	2	ND	0.0007 ± 0.0009	0.0004 ± 0.0007
	ICPP	1	ND	ND	-----
	TAN	1	ND	ND	-----
	TRA	3	ND	ND	-----
^{241}Am	Control	2	ND	ND	-----
	ICPP	1	ND	ND	-----
	TAN	1	ND	ND	-----
	TRA	3	ND	0.006 ± 0.003	0.002 ± 0.004

[a] Concentration ± 2 standard deviations.
[b] Mean with 95% confidence interval.
[c] Not detectable
[d] There were no detectable concentrations for this radionuclide at this location.
[e] No Confidence interval can be calculated when sample number is 1.

4. Water Sampling

4.1 Methods

Thirteen drinking water samples were collected from local businesses. Five surface water samples were collected. Four samples collected in the Magic Valley were from the Thousand Springs area, outlets for the Snake River Plain Aquifer, which flows beneath the INEEL (Figure 5). At Idaho Falls, a sample was collected from the Snake River. Each water sample was analyzed for gross (nonspecific) alpha and gross beta activity by evaporating a portion of the sample on a stainless steel plate and counting the residue. Tritium concentrations were determined in each sample using liquid scintillation.

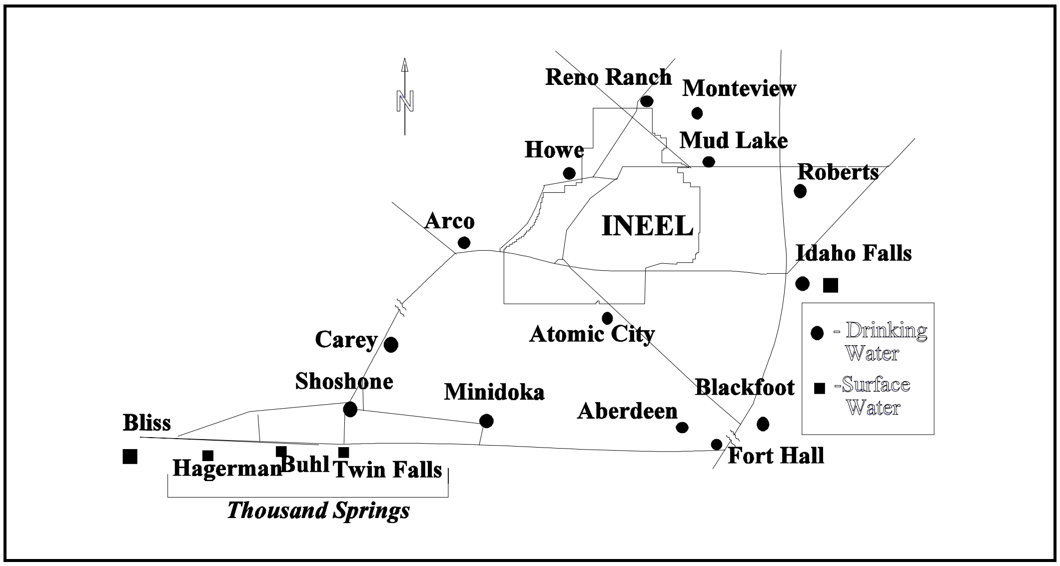

Figure 5. Water Sampling Locations

4.2 Results

Arco, Blackfoot, and Idaho Falls showed concentrations of tritium just above detection limits, none exceeding 3s uncertainty (Table 8). Environmental tritium is due primarily to contributions from natural atmospheric reactions, historic nuclear weapons testing, and the use of nuclear power. The sample from Monteview showed a detectable concentration of gross alpha. Detectable gross beta concentrations were measured in samples from all locations (Table 8). Within the range detected in these samples, radioactivity in water samples is generally attributed to naturally occurring decay products, primarily from primordial deposits of uranium and thorium, picked up by water as it travels through the earth's crust.

Table 8
Radionuclide Concentrations in Offsite Water Samples
(Fourth Quarter 1996)

Location	^{3}H (pCi/l ± 2s)	Gross Alpha (pCi/l ± 2s)	Gross Beta (pCi/l ± 2s)
Drinking Water			
Aberdeen	75 ± 94	-0 ± 1	6 ± 2
Arco	104 ± 94	0 ± 1	3 ± 2
Atomic City	84 ± 94	-0 ± 1	2 ± 2
Blackfoot	99 ± 94	-1 ± 1	2 ± 2
Blackfoot Replicate	54 ± 94	-1 ± 1	5 ± 2
Carey	75 ± 94	0 ± 1	1 ± 1
Fort Hall	-57 ± 92	0 ± 1	4 ± 2
Howe	90 ± 94	0 ± 1	2 ± 2
Idaho Falls	95 ± 94	-1 ± 1	4 ± 2
Minidoka	-78 ± 93	0 ± 1	4 ± 2
Monteview	27 ± 93	3 ± 2	5 ± 2
Mud Lake	-41 ± 92	-1 ± 1	4 ± 2
Roberts	14 ± 93	-1 ± 1	4 ± 2
Shoshone	63 ± 94	0 ± 1	3 ± 2
Surface Water			
Alpheus Spring (Twin Falls)	37 ± 93	-1 ± 1	8 ± 2
Alpheus replicate	41 ± 94	-1 ± 1	7 ± 2
Bill Jones Hatchery (Hagerman)	-16 ± 93	-1 ± 1	4 ± 2
Clear Spring (Buhl)	14 ± 93	0 ± 1	4 ± 2
Bliss	-44 ± 92	0 ± 1	5 ± 2
Idaho Falls	40 ± 94	1 ± 1	3 ± 2
EPA Maximum Contaminant Level (MCL)	20,000	15	50

5. Soil Sampling

5.1 Methods

Soil samples were taken from eight boundary locations and four locations distant from the INEEL. Samples from each location consisted of a composite of five samples from 0-5 cm depth and a composite of five samples taken at a depth of 5-10 cm. Each sample was dried and sieved prior to analysis. The 0-5 cm layers were analyzed for Strontium-90 and transuranics (Plutonium-238, Plutonium-239/240, and Americium-241). Both the 0-5 and 5-10 cm layers were analyzed by gamma spectroscopy.

5.2 Results

Consistent with historical results, Strontium-90 and Cesium-137 were detected in all soil samples. Transuranic radionuclides were detected in many of the samples (Table 9). No statistical differences in radionuclide concentrations were detected between boundary and distant locations. Due to historical above-ground nuclear weapons testing, the widespread occurrence of these radionuclides is normal.

Table 9

Radionuclide Concentrations ± 2s in pCi/g for Offsite Surface[a] Soils (1996)

Location	Cesium-137	Strontium-90	Plutonium-238	Plutonium-239/240	Americium-241
Distant Locations					
Blackfoot	1.30 ± 0.09	0.21 ± 0.05	0.002 ± 0.005	0.03 ± 0.02	0.010 ± 0.007
Carey	0.38 ± 0.02	0.13 ± 0.04	0.005 ± 0.005	0.02 ± 0.01	0.010 ± 0.007
Crystal Ice Caves	0.83 ± 0.04	0.30 ± 0.06	0.005 ± 0.008	0.03 ± 0.01	0.010 ± 0.007
St. Anthony	1.10 ± 0.05	0.43 ± 0.10	-0.0004 ± 0.0007	0.02 ± 0.01	0.006 ± 0.005
Mean[b]	0.82	0.24	0.003	0.02	0.008
95% C.I.[c]	0.47 - 1.41	0.15 - 0.41	0.002-0.005	0.02 - 0.04	0.007-0.01
Boundary Locations					
Atomic City	0.44 ± 0.02	0.22 ± 0.05	0.000 ± 0.002	0.02 ± 0.008	0.009 ± 0.006
Butte City	0.96 ± 0.07	0.31 ± 0.07	0.003 ± 0.003	0.03 ± 0.02	0.008 ± 0.007
FAA Tower	1.26 ± 0.05	0.40 ± 0.08	0.008 ± 0.008	0.05 ± 0.02	0.020 ± 0.008
Howe	0.38 ± 0.03	0.20 ± 0.04	0.001 ± 0.002	0.02 ± 0.008	0.006 ± 0.005
Monteview	0.82 ± 0.04	0.14 ± 0.03	0.001 ± 0.002	0.02 ± 0.008	0.01 ± 0.007
Mud Lake 1	0.59 ± 0.03	0.10 ± 0.03	0.001 ± 0.005	0.02 ± 0.02	0.004 ± 0.005
Mud Lake 2	0.14 ± 0.01	0.20 ± 0.05	0.002 ± 0.003	0.008 ± 0.008	0.009 ± 0.007
Reno Ranch	0.68 ± 0.03	0.40 ± 0.08	0.001 ± 0.004	0.03 ± 0.012	0.01 ± 0.007
Mean[b]	0.56	0.22	0.003	0.02	0.009
95% C.I.[c]	0.33 - 0.95	0.15 - 0.33	0.001-0.001	0.01-0.03	0.006-0.01

a. Samples represent 0-5 cm depth of soil.
b. The geometric mean.
c. The 95% confidence interval for the mean.

6. Environmental Radiation

6.1 Methods

Environmental radiation is monitored at six boundary and seven distant stations using thermoluminescent dosimeters (TLDs) made of lithium fluoride crystals (Figure 7). The TLDs are placed on posts one meter (3.3 feet) above the ground at field locations and changed every six months in May and November. The crystals detect beta and gamma radiation and store this information in the form of “excited” electrons within the crystals. The TLDs are analyzed by an instrument which heats them under precisely controlled conditions and detects the light they give off. The amount of light is a measure of the amount of environmental radiation.

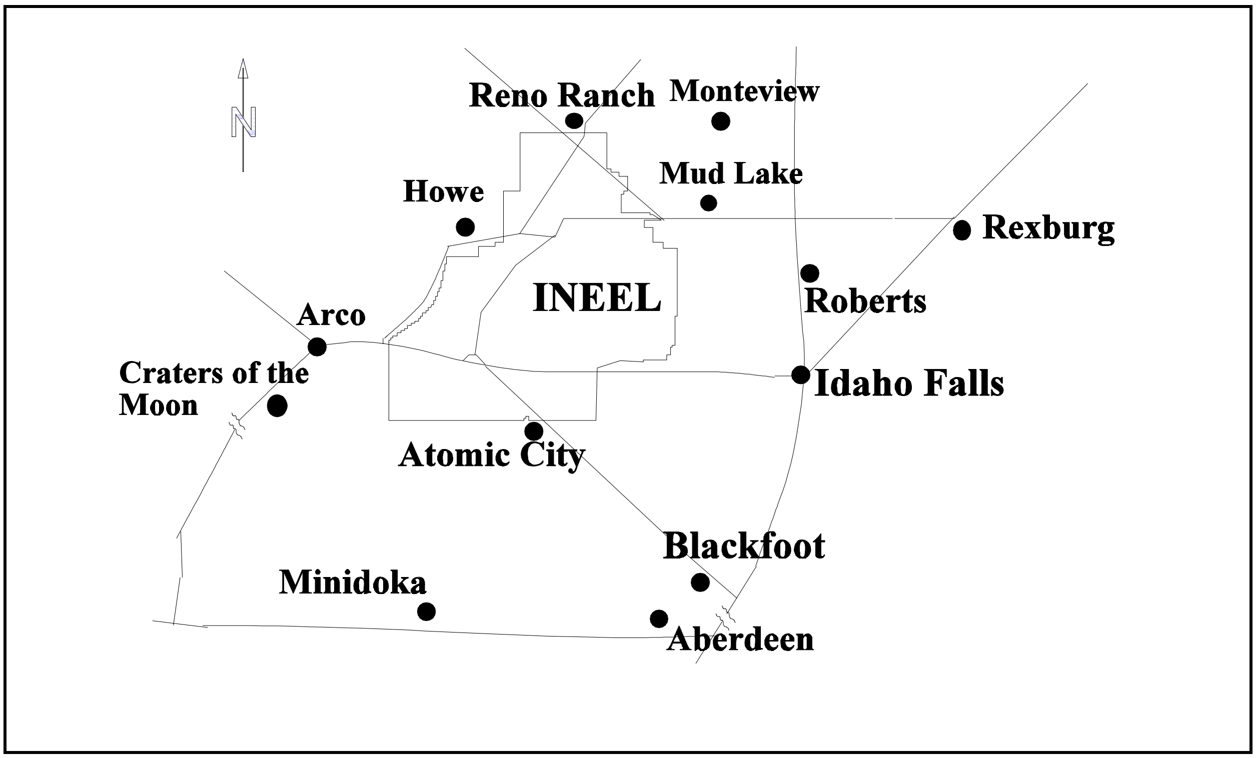

Figure 6. TLD Locations

6.2 Results

Table 10 shows the results for May through November 1996. Results from the previous two reporting periods are also shown. Exposure levels for May, 1996 through November, 1996 were higher than those for November, 1995 through May, 1996. This is due to higher exposure levels during months without snow cover. Snow shields the dosimeters from naturally occurring radionuclides in the soil. The mean exposures for distant and boundary locations were not statistically different.

Table 10
Environmental Radiation Exposure (mR) for May-Nov. 1996

Location	5/95-11/95 Exposure (mR ± 2s)	11/95-5/96 Exposure (mR ± 2s)	5/96-11/96 Exposure (mR ± 2s)
Distant Locations			
Aberdeen	59 ± 2	56 ± 4	Missing TLD
Blackfoot	63 ± 2	57 ± 3	63 ± 7
Craters of the Moon	62 ± 3	55 ± 2	62 ± 4
Idaho Falls	63 ± 3	61 ± 3	59 ± 4
Minidoka	54 ± 2	56 ± 4	62 ± 3
Rexburg	59 ± 3	60 ± 3	62 ± 3
Roberts	59 ± 4	71 ± 5	69 ± 7
Group Mean[a]	**60 ± 3**	**59 ± 5**	**63 ± 5**
Boundary Locations			
Arco	63 ± 2	58 ± 3	73 ± 5
Atomic City	65 ± 4	70 ± 5	66 ± 3
Howe	58 ± 3	57 ± 5	60 ± 6
Monteview	62 ± 3	60 ± 2	62 ± 4
Mud Lake	58 ± 6	62 ± 2	67 ± 6
Reno Ranch	58 ± 3	57 ± 3	53 ± 3
Group Mean[a]	**61 ± 3**	**61 ± 5**	**63 ± 5**

a. Mean ± 95% confidence interval.

Appendix

Weekly Gross Alpha and Gross Beta

Concentrations in Air

Table A-1
Weekly Gross Alpha Concentrations in Air

Location	**Weekly Collection Date**	**Concentration ± 2s Uncertainty (10^{-15} µCi/ml)**
	Distant Locations	
Blackfoot	10/09	3.2 ± 1.2
	10/16	2.7 ± 1.0
	10/23	1.3 ± 0.9
	10/30	3.0 ± 1.0
	11/06	2.1 ± 0.9
	11/13	2.2 ± 0.9
	11/20	1.0 ± 0.7
	11/26	1.4 ± 0.8
	12/04	0.3 ± 0.7
	12/11	0.2 ± 0.8
	12/18	0.4 ± 0.7
	12/24	2.2 ± 1.2
	12/31	0.6 ± 0.7
Craters of the Moon	10/09	1.8 ± 0.9
	10/16	1.4 ± 0.6
	10/23	0.5 ± 0.7
	10/30	1.0 ± 0.5
	11/06	1.4 ± 0.8
	11/13	2.2 ± 0.8
	11/20	0.0 ± 0.5
	11/26	0.2 ± 0.5
	12/04	0.7 ± 0.7
	12/11	0.5 ± 0.8
	12/18	0.7 ± 0.7
	12/24	1.2 ± 1.0
	12/31	0.3 ± 0.6
Idaho Falls	10/09	2.1 ± 1.0
	10/16	2.2 ± 0.7
	10/23	1.7 ± 0.8
	10/30	1.4 ± 0.6
	11/06	1.3 ± 0.7
	11/13	2.2 ± 0.7
	11/20	1.5 ± 0.7
	11/26	1.9 ± 0.7
	12/04	0.8 ± 0.7
	12/11	-0.3 ± 1.2
	12/18	0.6 ± 0.7
	12/24	1.9 ± 1.0
	12/31	invalid sample

Table A-1 (Cont.)
Weekly Gross Alpha Concentrations in Air

Location	Weekly Collection Date	Concentration ± 2s Uncertainty (10^{-15} μCi/ml)
Mountain View	10/09	4.4 ± 1.1
	10/16	2.7 ± 0.8
	10/23	1.6 ± 0.8
	10/30	2.4 ± 0.7
	11/06	3.7 ± 1.0
	11/13	2.8 ± 0.8
	11/20	0.2 ± 0.4
	11/26	1.4 ± 0.7
	12/04	1.7 ± 0.7
	12/11	0.9 ± 0.7
	12/18	1.4 ± 0.8
	12/24	3.1 ± 1.1
	12/31	1.7 ± 0.8
Rexburg	10/09	2.4 ± 0.9
	10/16	2.6 ± 0.8
	10/23	0.0 ± 0.5
	10/30	1.2 ± 0.6
	11/06	2.3 ± 0.8
	11/13	2.9 ± 0.9
	11/20	1.2 ± 0.6
	11/26	2.3 ± 0.8
	12/04	0.3 ± 0.6
	12/11	2.0 ± 0.7
	12/18	1.4 ± 0.8
	12/24	1.5 ± 1.0
	12/31	0.7 ± 0.6
	Boundary Locations	
Arco	10/09	2.3 ± 1.0
	10/16	1.8 ± 0.8
	10/23	0.8 ± 0.7
	10/30	1.2 ± 0.6
	11/06	1.0 ± 0.7
	11/13	2.5 ± 0.8
	11/20	0.4 ± 0.6
	11/26	0.2 ± 0.5
	12/04	1.5 ± 0.8
	12/11	0.7 ± 1.0
	12/18	1.2 ± 0.9
	12/24	2.2 ± 1.1
	12/31	0.2 ± 0.5

Table A-1 (Cont.)
Weekly Gross Alpha Concentrations in Air

Location	Weekly Collection Date	Concentration ± 2s Uncertainty (10^{-15} µCi/ml)
Atomic City	10/09	2.2 ± 0.9
	10/16	1.5 ± 0.7
	10/23	0.3 ± 0.6
	10/30	1.9 ± 0.7
	11/06	1.3 ± 0.7
	11/13	1.8 ± 0.7
	11/20	0.9 ± 0.6
	11/26	0.8 ± 0.6
	12/04	0.3 ± 0.6
	12/11	0.1 ± 0.7
	12/18	0.5 ± 0.7
	12/24	1.6 ± 1.1
	12/31	1.0 ± 0.7
FAA Tower	10/09	0.9 ± 0.9
	10/16	2.1 ± 0.8
	10/23	0.0 ± 0.6
	10/30	1.6 ± 0.7
	11/06	1.6 ± 0.8
	11/13	2.4 ± 0.8
	11/20	0.1 ± 0.6
	11/26	0.2 ± 0.5
	12/04	0.7 ± 0.7
	12/11	0.7 ± 0.8
	12/18	0.2 ± 0.7
	12/24	2.3 ± 1.1
	12/31	0.5 ± 0.7
Howe	10/09	2.2 ± 0.9
	10/16	2.0 ± 0.7
	10/23	0.8 ± 0.7
	10/30	1.1 ± 0.5
	11/06	2.3 ± 0.9
	11/13	2.0 ± 0.7
	11/20	0.4 ± 0.5
	11/26	0.5 ± 0.5
	12/04	1.2 ± 0.7
	12/11	0.5 ± 0.7
	12/18	0.3 ± 0.6
	12/24	1.6 ± 0.9
	12/31	0.7 ± 0.7

Table A-1 (Cont.)
Weekly Gross Alpha Concentrations in Air

Location	Weekly Collection Date	Concentration ± 2s Uncertainty (10^{-15} µCi/ml)
Monteview	10/09	2.1 ± 0.9
	10/16	1.3 ± 0.6
	10/23	0.6 ± 0.7
	10/30	0.6 ± 0.4
	11/06	1.1 ± 0.7
	11/13	1.9 ± 0.8
	11/20	1.2 ± 0.7
	11/26	0.5 ± 0.5
	12/04	0.4 ± 0.6
	12/11	0.2 ± 0.7
	12/18	0.1 ± 0.6
	12/24	2.0 ± 1.1
	12/31	0.6 ± 0.6
Mud Lake	10/09	1.8 ± 0.8 (2.8 ± 0.9)
(Replicate)	10/16	2.1 ± 0.8 (1.6 ± 0.7)
	10/23	0.5 ± 0.6 (0.7 ± 0.7)
	10/30	1.6 ± 0.6 (invalid sample)
	11/06	0.9 ± 0.6 (1.3 ± 0.7)
	11/13	2.4 ± 0.8 (2.4 ± 0.8)
	11/20	0.6 ± 0.6 (0.2 ± 0.5)
	11/26	1.2 ± 0.6 (2.1 ± 0.8)
	12/04	0.7 ± 0.6 (0.6 ± 0.7)
	12/11	0.7 ± 0.8 (1.1 ± 0.9)
	12/18	0.1 ± 0.6 (0.4 ± 0.7)
	12/24	2.0 ± 1.1 (2.6 ± 1.1)
	12/31	0.3 ± 0.6 (0.4 ± 0.6)
Reno Ranch	10/09	invalid sample
	10/16	2.3 ± 0.9
	10/23	invalid sample
	10/30	1.2 ± 0.6
	11/06	1.3 ± 0.7
	11/13	2.3 ± 0.8
	11/20	0.6 ± 0.6
	11/26	1.1 ± 0.6
	12/04	0.6 ± 0.6
	12/11	0.5 ± 0.7
	12/18	0.7 ± 0.6
	12/24	2.3 ± 1.0
	12/31	1.4 ± 0.7

Table A-1 (Cont.)
Weekly Gross Alpha Concentrations in Air

Location	Weekly Collection Date	Concentration ± 2s Uncertainty (10^{-15} µCi/ml)
		INEEL Locations
EFS	10/09	3.2 ± 1.1
	10/16	1.5 ± 0.7
	10/23	0.2 ± 0.6
	10/30	0.9 ± 0.5
	11/06	1.1 ± 0.7
	11/13	2.4 ± 0.9
	11/20	0.3 ± 0.6
	11/26	0.6 ± 0.6
	12/04	0.6 ± 0.7
	12/11	0.9 ± 0.8
	12/18	0.2 ± 0.6
	12/24	invalid sample
	12/31	0.8 ± 1.0
Main Gate	10/09	2.2 ± 1.0 (2.4 ± 1.0)
(Replicate)	10/16	2.1 ± 0.8 (1.3 ± 0.7)
	10/23	0.2 ± 0.6 (0.4 ± 0.7)
	10/30	0.9 ± 0.5 (1.0 ± 0.6)
	11/06	1.1 ± 0.7 (1.3 ± 0.8)
	11/13	1.9 ± 0.7 (2.3 ± 0.9)
	11/20	0.5 ± 0.6 (2.3 ± 0.9)
	11/26	1.2 ± 0.7 (1.3 ± 0.7)
	12/04	0.3 ± 0.6 (0.3 ± 0.7)
	12/11	0.3 ± 0.7 (0.2 ± 0.8)
	12/18	-0.1 ± 0.6 (0.0 ± 0.6)
	12/24	1.3 ± 1.0 (1.3 ± 1.1)
	12/31	1.2 ± 0.8 (0.0 ± 0.6)
Van Buren	10/09	2.0 ± 1.0
	10/16	1.9 ± 0.7
	10/23	0.0 ± 0.5
	10/30	1.1 ± 0.5
	11/06	1.9 ± 0.8
	11/13	2.3 ± 0.8
	11/20	0.8 ± 0.6
	11/26	0.4 ± 0.5
	12/04	1.5 ± 0.7
	12/11	0.7 ± 0.7
	12/18	0.9 ± 0.7
	12/24	1.3 ± 0.9
	12/31	0.3 ± 0.6

Table A-2
Weekly Gross Beta Concentrations in Air

Location	**Weekly Collection Date**	**Concentration ± 2s Uncertainty (10^{-15} µCi/ml)**
Distant Locations		
Blackfoot	10/09	37 ± 4
	10/16	32 ± 4
	10/23	18 ± 3
	10/30	22 ± 3
	11/06	36 ± 4
	11/13	38 ± 4
	11/20	16 ± 2
	11/26	11 ± 3
	12/04	11 ± 2
	12/11	16 ± 2
	12/18	11 ± 2
	12/24	39 ± 3
	12/31	9 ± 2
Craters of the Moon	10/09	31 ± 3
	10/16	27 ± 3
	10/23	17 ± 2
	10/30	19 ± 2
	11/06	39 ± 3
	11/13	34 ± 3
	11/20	11 ± 2
	11/26	11 ± 2
	12/04	12 ± 1
	12/11	20 ± 2
	12/18	11 ± 2
	12/24	24 ± 2
	12/31	37 ± 1
Idaho Falls	10/09	35 ± 3
	10/16	30 ± 3
	10/23	11 ± 2
	10/30	19 ± 2
	11/06	30 ± 3
	11/13	29 ± 3
	11/20	15 ± 2
	11/26	10 ± 2
	12/04	10 ± 1
	12/11	14 ± 3

Table A-2 (Cont.)
Weekly Gross Beta Concentrations in Air

Location	Weekly Collection Date	Concentration ± 2s Uncertainty (10^{-15} µCi/ml)
Idaho Falls (cont.)	12/18	9 ± 1
	12/24	30 ± 2
	12/31	invalid sample
Mountain View	10/09	29 ± 3
	10/16	30 ± 3
	10/23	14 ± 2
	10/30	19 ± 2
	11/06	32 ± 3
	11/13	33 ± 3
	11/20	18 ± 2
	11/26	10 ± 2
	12/04	10 ± 1
	12/11	11 ± 1
	12/18	10 ± 1
	12/24	29 ± 2
	12/31	8 ± 1
Rexburg	10/09	37 ± 3
	10/16	31 ± 3
	10/23	17 ± 2
	10/30	20 ± 2
	11/06	37 ± 3
	11/13	38 ± 3
	11/20	19 ± 2
	11/26	12 ± 2
	12/04	16 ± 2
	12/11	13 ± 2
	12/18	12 ± 2
	12/24	31 ± 3
	12/31	9 ± 1
Boundary Locations		
Arco	10/09	28 ± 3
	10/16	26 ± 3
	10/23	17 ± 2
	10/30	26 ± 3
	11/06	34 ± 3
	11/13	37 ± 3
	11/20	15 ± 2
	11/26	15 ± 2

Table A-2 (Cont.)
Weekly Gross Beta Concentrations in Air

Location	**Weekly Collection Date**	**Concentration ± 2s Uncertainty (10^{-15} µCi/ml)**
Arco (cont.)	12/04	13 ± 2
	12/11	24 ± 2
	12/18	12 ± 2
	12/24	35 ± 3
	12/31	6 ± 1
Atomic	10/09	35 ± 3
City	10/16	31 ± 3
	10/23	14 ± 2
	10/30	23 ± 3
	11/06	41 ± 3
	11/13	41 ± 3
	11/20	15 ± 2
	11/26	5 ± 2
	12/04	15 ± 2
	12/11	15 ± 2
	12/18	12 ± 2
	12/24	36 ± 3
	12/31	7 ± 1
FAA	10/09	26 ± 3
Tower	10/16	28 ± 3
	10/23	15 ± 2
	10/30	23 ± 3
	11/06	36 ± 3
	11/13	34 ± 3
	11/20	14 ± 2
	11/26	9 ± 2
	12/04	11 ± 2
	12/11	15 ± 2
	12/18	9 ± 2
	12/24	33 ± 3
	12/31	9 ± 2
Howe	10/09	32 ± 3
	10/16	28 ± 3
	10/23	17 ± 2
	10/30	29 ± 3
	11/06	39 ± 3
	11/13	40 ± 3
	11/20	16 ± 2
	11/26	15 ± 2

Table A-2 (Cont.)
Weekly Gross Beta Concentrations in Air

Location	Weekly Collection Date	Concentration ± 2s Uncertainty (10^{-15} µCi/ml)
Howe (cont.)	12/04	16 ± 2
	12/11	21 ± 2
	12/18	11 ± 2
	12/24	32 ± 2
	12/31	12 ± 2
Monteview	10/09	32 ± 3
	10/16	24 ± 3
	10/23	18 ± 2
	10/30	25 ± 3
	11/06	32 ± 3
	11/13	34 ± 3
	11/20	20 ± 2
	11/26	15 ± 2
	12/04	17 ± 2
	12/11	21 ± 2
	12/18	14 ± 2
	12/24	43 ± 3
	12/31	12 ± 2
Mud Lake	10/09	37 ± 3 (33 ± 3)
(Replicate)	10/16	29 ± 3 (25 ± 3)
	10/23	15 ± 2 (14 ± 2)
	10/30	26 ± 3 (invalid sample)
	11/06	38 ± 3 (29 ± 3)
	11/13	45 ± 3 (42 ± 3)
	11/20	17 ± 2 (17 ± 2)
	11/26	13 ± 2 (8 ± 2)
	12/04	16 ± 2 (15 ± 2)
	12/11	25 ± 2 (21 ± 2)
	12/18	12 ± 1 (12 ± 2)
	12/24	43 ± 3 (41 ± 3)
	12/31	9 ± 1 (9 ± 2)
Reno	10/09	invalid sample
Ranch	10/16	29 ± 3
	10/23	invalid sample
	10/30	23 ± 3
	11/06	35 ± 3
	11/13	35 ± 3
	11/20	20 ± 2

Table A-2 (Cont.)
Weekly Gross Beta Concentrations in Air

Location	**Weekly Collection Date**	**Concentration ± 2s Uncertainty (10^{-15} µCi/ml**
Reno Ranch (cont.)	11/26	16 ± 2
	12/04	15 ± 2
	12/11	19 ± 2
	12/18	12 ± 1
	12/24	41 ± 3
	12/31	10 ± 1
		INEEL Locations
EFS	10/09	38 ± 4
	10/16	32 ± 3
	10/23	18 ± 2
	10/30	26 ± 3
	11/06	45 ± 4
	11/13	48 ± 4
	11/20	17 ± 2
	11/26	16 ± 3
	12/04	19 ± 2
	12/11	26 ± 2
	12/18	13 ± 2
	12/24	invalid sample
	12/31	9 ± 2
Main Gate	10/09	33 ± 3 (34 ± 4)
(Replicate)	10/16	30 ± 3 (33 ± 3)
	10/23	16 ± 2 (18 ± 2)
	10/30	25 ± 3 (24 ± 3)
	11/06	37 ± 3 (34 ± 3)
	11/13	34 ± 3 (41 ± 4)
	11/20	14 ± 2 (11 ± 2)
	11/26	11 ± 2 (8 ± 2)
	12/04	15 ± 2 (15 ± 2)
	12/11	20 ± 2 (17 ± 2)
	12/18	10 ± 2 (9 ± 2)
	12/24	33 ± 3 (40 ± 3)
	12/31	9 ± 2 (8 ± 2)
Van Buren	10/09	34 ± 4
	10/16	32 ± 3
	10/23	17 ± 2
	10/30	20 ± 2
	11/06	47 ± 3

Table A-2 (Cont.)
Weekly Gross Beta Concentrations in Air

Location	Weekly Collection Date	Concentration ± 2s Uncertainty (10^{-15} µCi/ml
Van Buren (cont.)	11/13	38 ± 3
	11/20	14 ± 2
	11/26	13 ± 2
	12/04	16 ± 2
	12/11	21 ± 2
	12/18	11 ± 2
	12/24	36 ± 3
	12/31	9 ± 1

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