S.M. Stoller Corporation
Environmental Surveillance, Education and Research Program
ISSN NUMBER 1089-5469

Idaho National Engineering and Environmental Laboratory Offsite Environmental Surveillance Program Report: First Quarter 2001

May 2002

List of Contributors:
Ronald Warren, Paula Weyen, Chris Martin, Douglas K. Halford, Jade Dye, Richard Marty, Larry Ingram

Program Conducted for the U.S. Department of Energy, Idaho Operations Office
Under Contract DE-RP07-99ID13658

S.M. Stoller Corporation
Environmental Surveillance, Education and Research Program
Douglas K. Halford, Program Director
1780 First Street, Idaho Falls, Idaho 83401
www.stoller-eser.com

EXECUTIVE SUMMARY

This report for the first quarter, 2001, consists of results from the Environmental Surveillance, Education, and Research (ESER) Program's monitoring of the Department of Energy's (DOE) Idaho National Engineering and Environmental Laboratory's (INEEL) offsite environment. All sample types (media) and the sampling schedule followed during 2001 are listed in Appendix A. Specifically, this report contains results for the following:

- Air sampling, including: particulate filters, charcoal cartridges, PM_{10}, and atmospheric moisture;
- Precipitation, and;
- Foodstuff sampling (milk).

Air monitors were operated continuously at 15 locations, plus 2 replicate samplers, with particulate filters and charcoal cartridges sampled weekly. No ^{131}I was detected in any of the weekly charcoal cartridges during the first quarter, 2001. The average gross alpha concentration at INEEL locations was higher than at Boundary locations in two of the thirteen weeks (weeks of January 31 and March 28). However, also during the week of January 31, the average gross alpha concentration at Distant locations was significantly higher than Boundary locations, which is the opposite of what would be expected if the INEEL were the source of contamination. No other significant differences in gross alpha concentrations were observed.

Average gross beta concentrations at INEEL locations were significantly higher than the average at either Boundary or Distant locations during the weeks of February 21, February 28, March 14, and March 21 (31% of the weeks in the first quarter). The average gross beta concentration at INEEL locations was also significantly higher than the averages at Boundary and Distant locations during the week of March 28. Examination of the average value for the week of March 28, in comparison to other weeks in the same quarter, shows that overall, the value was low and well within range of past data.

Quarterly particulate filters were composited and analyzed for gamma-emitting radionuclides with a subset analyzed for ^{90}Sr, ^{238}Pu, $^{239/240}Pu$, and ^{241}Am. No ^{90}Sr, ^{238}Pu, $^{239/240}Pu$, or ^{137}Cs were detected in any sample. The only human-made gamma emitting radionuclide detected was ^{241}Am. The ^{241}Am results for Howe, Monteview, Van Buren, FAA Tower, and Rexburg Community Monitoring Station (CMS) were all greater than their associated two standard deviation (2s) uncertainty, and all but the Van Buren sample were also above the minimum detectable concentration (MDC). However, levels of ^{241}Am in composited filter samples were within the range of values observed in the past and were well below the Derived Concentration Guide (DCG) values set by the DOE to ensure dose limits are not exceeded.

Two atmospheric moisture samples were obtained from Blackfoot CMS, two from Atomic City, one from Idaho Falls, and one from Rexburg CMS during the first quarter, 2001. All six atmospheric moisture samples had tritium results greater than their 2s uncertainty and MDC. These results are not believed to be significant due to comparable levels detected in sample blanks submitted for precipitation sampling (which are analyzed with the same instrumentation

as the atmospheric moisture samples) whose results were also greater than 2s and MDC. However, even with this potential bias, the concentrations were low. For comparison, the DCG value for tritium in air (as atmospheric moisture) is 1×10^{-7} µCi/mL (3.7×10^{-3} Bq/mL). The tritium results measured at these locations during the first quarter of 2001 were between 100,000 to nearly 800,000 times lower than this limit.

ESER Program personnel operate three PM_{10} samplers, one at Rexburg CMS, one at Blackfoot CMS, and one at Atomic City. PM_{10} concentrations for the first quarter of 2001 were well below all air quality standard levels. The maximum 24-hour concentration was 58.6 µg/m^3 on March 1 at Rexburg CMS.

For the first quarter of 2001, there was enough precipitation for a total of ten samples – three monthly composites from Idaho Falls, four weekly composites from Experimental Field Station (EFS), and three monthly composites from the Central Facilities Area (CFA). Of the samples collected from Idaho Falls, two (January and March samples) had tritium results greater than their associated 2s values. One sample (January) was below the MDC, and one sample (March) was above the MDC. Of the four weekly composite samples collected from EFS, all were above 2s, but only one (week of January 17) was above the MDC. Of the samples collected from CFA, one sample (January) was above 2s, but was below the MDC. Sample blanks (submitted as part of normal quality assurance/quality control [QA/QC] procedures) for precipitation sampling also had results greater than their associated 2s uncertainties and MDCs. Therefore, there is a high probability that one or more of these results were false positives. While there is not a DCG for precipitation, the Safe Drinking Water Act (SDWA) sets a limit for tritium in drinking water of 2×10^4 pCi/L. The levels of tritium detected in the samples that were above their associated 2s and MDC values were between 110 and 160 times lower than the level set for drinking water, and were within the range of background tritium that exists throughout the world.

A total of 39 milk samples were collected during the first quarter of 2001. Of all the milk samples collected, two (February 6 and March 6, 2001) from Dietrich had concentrations of ^{131}I greater than their 2s uncertainty. However, immediate recounts of these samples yielded results less than their 2s uncertainty levels. This is not unusual because values that are tested against the 2s level will be false positives 2.5% of the time. Cesium-137 was detected in the following samples at concentrations greater than their associated 2s uncertainty: Howe (January 9), Moreland (January 9), Carey (February 6), and Idaho Falls (March 14). However, immediate recounts of these samples gave results less than the associated 2s uncertainty.

All concentrations of radioactivity found in samples collected by the ESER program during the first quarter, 2001 were consistent with concentrations that have been found in samples taken during recent years. The ESER Program could not directly attribute measured concentrations to operations at the INEEL. Radionuclide concentrations in all of the samples collected and analyzed were below guidelines set by both the DOE and the Environmental Protection Agency (EPA) for protection of human health.

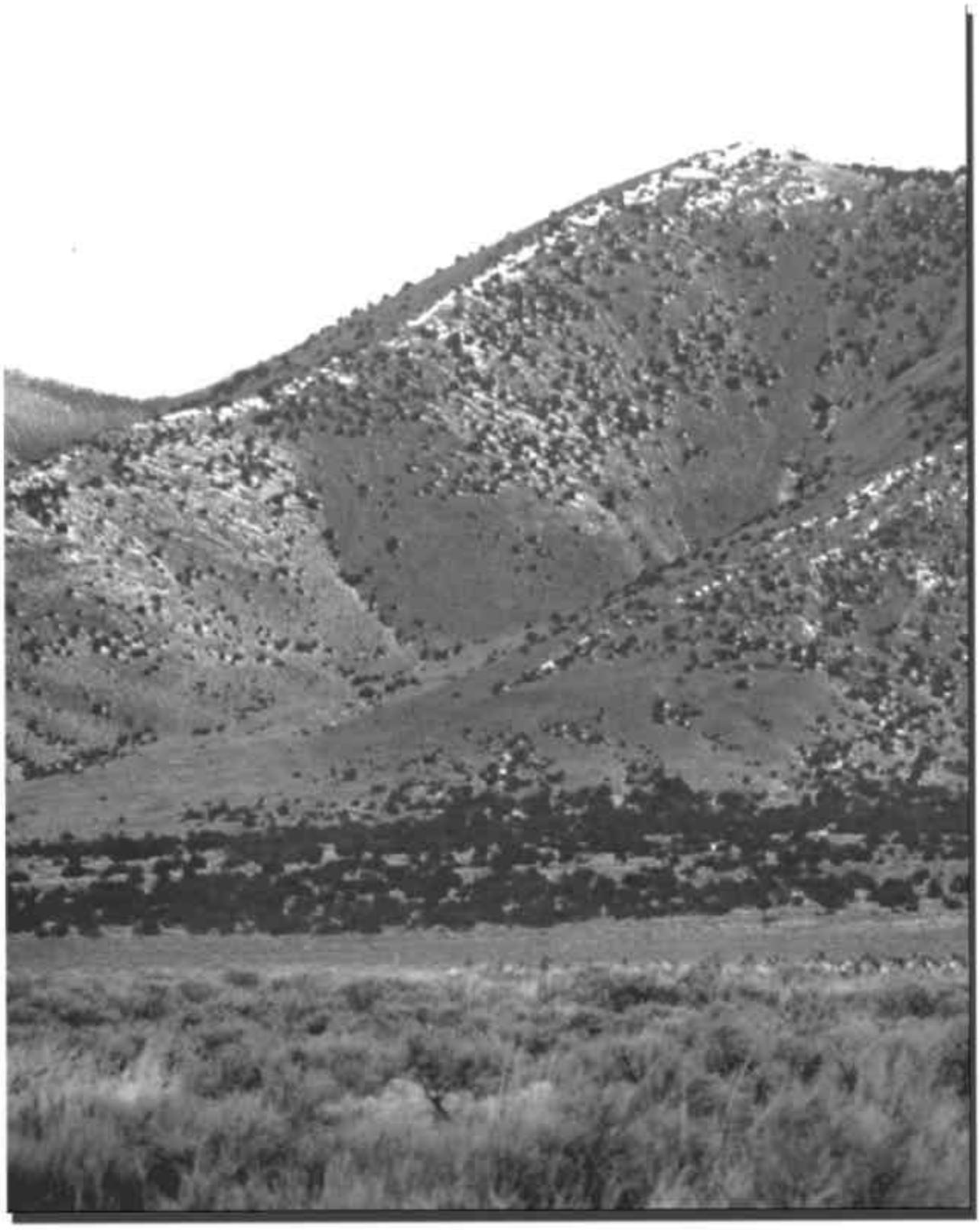
TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AEC	Atomic Energy Commission
Bq	becquerel
CFA	Central Facilities Area
CMS	community monitoring station
Ci	curie
DCG	Derived Concentration Guide
DOE	U.S. Department of Energy
DOE – ID	U.S. Department of Energy Idaho Operations Office
EAL	Environmental Assessment Laboratory
EFS	Experimental Field Station
EPA	Environmental Protection Agency
ERAMS	Environmental Radiation Ambient Monitoring System
ESER	Environmental Surveillance, Education, and Research
g	gram
INEEL	Idaho National Engineering and Environmental Laboratory
ISU	Idaho State University
L	liter
MDA	minimum detectable activity
MDC	minimum detectable concentration
M&O	Management and Operations
mi	mile
mL	milliliter
mR	milliroentgens
mrem	millirem
NRTS	National Reactor Testing Station
μCi	microcurie
pCi	picocurie
PM_{10}	particulate matter less than 10 micrometers in diameter
QA/QC	Quality Assurance/Quality Control
R	roentgen
rem	roentgen-equivalent-man
s	standard deviation
SDWA	Safe Drinking Water Act
SI	Systeme International d'Unites
Sv	seivert
UI	University of Idaho
μSv	microseiverts
WSU	Washington State University
y	year



HELPFUL INFORMATION

Elements That Make Up Our World

Atoms make up everything in our world. The basic parts of an atom are protons, neutrons, and electrons (Figure 1). Different atoms may have different numbers of each of these parts. An element is a substance that is made up of only atoms with the same number of protons. Elements with different numbers of neutrons are referred to as isotopes of that element. Elements are sometimes expressed with the one- or two-letter chemical symbol for that element. The atomic weight, shown as a superscript number, is equal to the number of protons and neutrons in its nucleus and is used to identify the isotope of that element. Some isotopes of some elements are radioactive, including many naturally occurring elements. Radioactive isotopes, when taken as a whole for more than one element, are collectively referred to as radionuclides. All human-made radionuclides detected during this quarter are listed in this report. Common, human-made radionuclides, along with their chemical symbol, are listed below.

Symbol		**Radionuclide**
^{3}H	-	Tritium
^{90}Sr	-	Strontium-90
^{131}I	-	Iodine-131
^{137}Cs	-	Cesium-137
^{238}Pu	-	Plutonium-238
$^{239/240}Pu$	-	Plutonium-239/240
^{241}Am	-	Americium-241

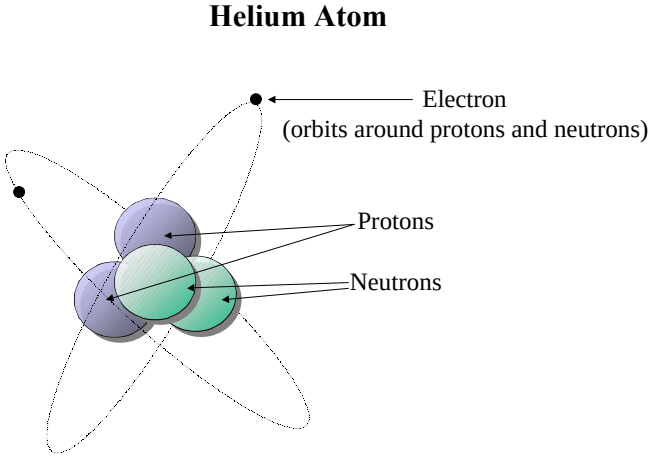


FIGURE 1. An atom of the element Helium. An element is a substance that is made up of only atoms with the same number of protons.

Radiation

Radioactive atoms are unstable and, in an effort to become stable, release energy. This release of energy comes from the release of particles or electromagnetic waves as the radioactive atom "decays," or "disintegrates." The three main types of radiation are alpha, beta, and gamma radiation (Figure 2). Alpha and beta radiation are particles emitted from an atom. Alpha particles consist of two protons and two neutrons (equal to the nucleus of a helium atom). Alpha particles do not travel very far (only centimeters in air) and are easily stopped. They will not penetrate paper or the outer layer of your skin so they are not an external hazard to the body. Internally, however, they are of more concern. Beta particles are electrons emitted from the nucleus of an atom. Beta particles can have enough energy to penetrate paper or skin but not materials like wood or plastic. Gamma rays are short-wavelength electromagnetic waves (photons) emitted from the nucleus of an atom following radioactive decay. Gamma-ray radiation has a penetration ability greater than alpha or beta radiation. X-rays are the same as gamma radiation except they are produced from the orbital electrons of atoms rather than the nucleus. All three types of radiation can come from either natural or human-made sources. The rate at which a given amount of a particular radioactive isotope decays is measured by its half-life. The half-life is the time required for half of the amount present to decay.

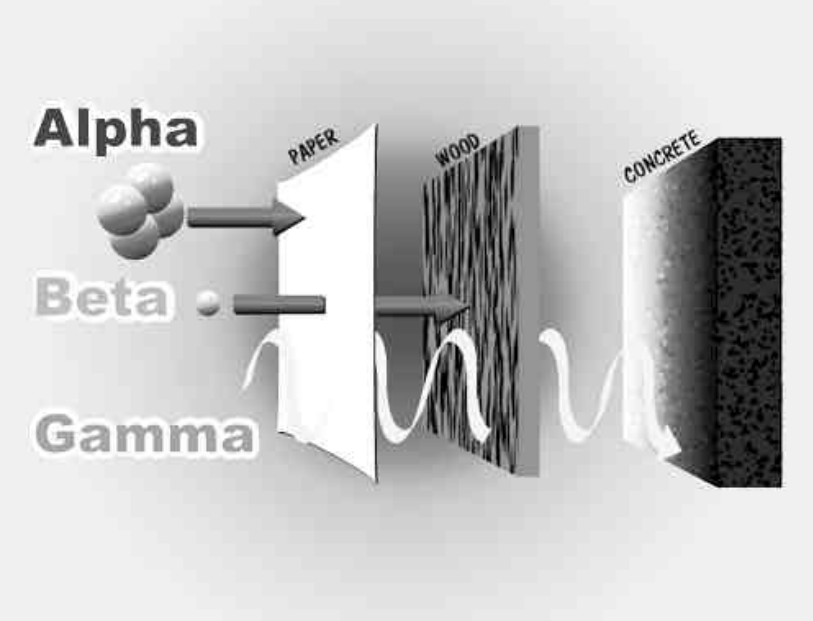


FIGURE 2. Three main types of radiation are alpha, beta, & gamma. Alpha and beta are particles emitted from an atom. Gamma radiation is short-wavelength electromagnetic waves (photons) emitted from atoms.

Units Used to Express the Amount of Radioactivity

Radioactivity is measured by the number of atoms that disintegrate per unit time. One common unit for activity is the curie (Ci). A curie is defined as the activity in one gram of naturally occurring Radium-226 and equals 37,000,000,000 disintegrations per second (Figure 3). The Systeme International d'Unites (SI) is the recognized international standard for describing measurable quantities and their units. The standard SI unit for radioactivity is the becquerel (Bq). A becquerel is equal to one disintegration per second (Figure 3).

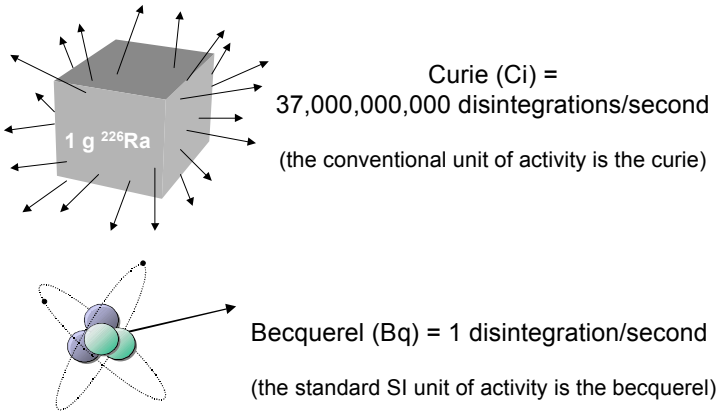


FIGURE 3. Units used to express the amount of radioactivity.

Radiation Exposure and Dose

The primary concern regarding radioactivity is the amount of energy deposited by particles or gamma radiation to the surrounding environment. It is possible that the energy from radiation may damage living tissue. When radiation interacts with the atoms of a given substance, it can alter the number of electrons associated with those atoms (usually removing orbital electrons). This is called ionization.

The term "exposure" is used to express the amount of ionization produced in air by electromagnetic (gamma and X-ray) radiation. The unit of exposure from gamma or X-ray radiation is the roentgen (R). The average exposure rate from natural radioactivity in southeast Idaho is about 0.130 R per year.

Radiation absorbed dose describes the amount of energy from ionizing radiation absorbed by any kind of matter. When absorbed dose is adjusted to account for the amount of biological damage a particular type of radiation causes, it is known as dose equivalent. The unit for dose equivalence is called the rem ("roentgen-equivalent-man"). The SI unit for dose equivalent is called the seivert (Sv). One seivert is equivalent to 100 rem.

Unit Prefixes

The range of numbers experienced in many scientific fields, like that of environmental monitoring for radioactivity, is huge and scientists commonly express units for very small and very large numbers as a prefix that modifies the unit of measure. 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 used in this report include:

Prefix	Abbreviation	Meaning
Mega	M	1,000,000 (= 1 x 10^{6})
milli	m	0.001 (= 1 x 10^{-3})
micro	µ	0.000001 (1 x 10^{-6})
pico	p	0.000000000001 (= 1 x 10^{-12})

Scientific Notation

Scientific notation is used to express numbers that are very small or very large. A very small number will be expressed with a negative exponent, e.g., 1.2×10^{-6}. To convert this number to the more commonly used form, the decimal point must be moved left by the number of places equal to the exponent (in this case, six). Thus the number 1.2×10^{-6} is equal to 0.0000012. A large number will be expressed with a positive exponent, e.g. 1.2×10^{6}. To convert this number, the decimal point must be moved right by the number of places equal to the exponent. For example, the number 1.2×10^{6} is equal to 1,200,000.

Concentrations of Radioactivity

The amount of radioactivity in a substance of interest is described by its concentration. The concentration is the amount of radioactivity per unit volume or weight of that substance. Air, milk, and atmospheric moisture samples are expressed as activity per milliliter (mL). Concentrations in surface water, drinking water, and precipitation samples are expressed as activity per liter (L). Radioactivity in foodstuff and soil are expressed as activity per gram (g). Exposure, as measured by environmental dosimeters, is expressed in units of milliroentgens (mR). This is sometimes expressed in terms of dose as millirem (mrem) or microseiverts (μSv).

Gross versus Specific Analyses

Some analyses are designed to detect specific radionuclides (specific analyses) while other analyses are designed to measure radiation of a particular type that can be from a large number of sources (gross analyses). Gamma-emitting radionuclides are determined by a specific analytical technique called gamma spectroscopy, for example. This specific analysis can show whether the radiation was produced from a natural source, or from a human made source. Analyses for specific alpha and beta emitting radionuclides, on the other hand, require more difficult and expensive radiochemical analyses. Low cost, but very sensitive, gross measurements are often substituted for the more expensive specific analyses as a screening procedure. The gross analyses are generally made first to determine the total amount of radioactivity that is present. The more expensive specific analyses of beta and alpha-emitting radionuclides are only made if the gross measurements are above background levels. When gross beta or gross alpha measurements are made, they measure all beta-activity or all alpha activity from all sources, including those that occur naturally and those that are manmade. There is no distinction between which beta-emitting or alpha-emitting radionuclides are present, just how much beta or alpha activity is present. Gross measurements are used as a method to screen samples for relative levels of radioactivity.

Detecting Radioactivity

All measurements have uncertainties. Uncertainty associated with measurements of radioactivity arises from many sources including: variations in detection equipment and the number of particles/energy that actually strike the detector, analysis procedures, natural background radiation, the random nature of radioactive decay and variances in the distribution of the targeted compound in the media being analyzed. The level of uncertainty from many of these sources is reported with each radioactive analysis presented here. If the number of radioactive disintegrations from one sample is counted multiple times, each for the same duration, that number will vary around an average value. Background radiation makes this true even for a sample that has no radioactivity. If a sample containing no radioactivity was analyzed multiple times, the net result should vary around an average of zero after correction for background radiation (Figure 4). Therefore, samples with radioactivity levels very close to zero will have negative values approximately 50% of the time. In order to avoid censoring data, these negative values, rather than “not detectable” or “zero,” are reported for radionuclides of

interest. This provides more information than merely truncating to the detection limits for results near background activities and allows for statistical analyses and measures of trends in the data.

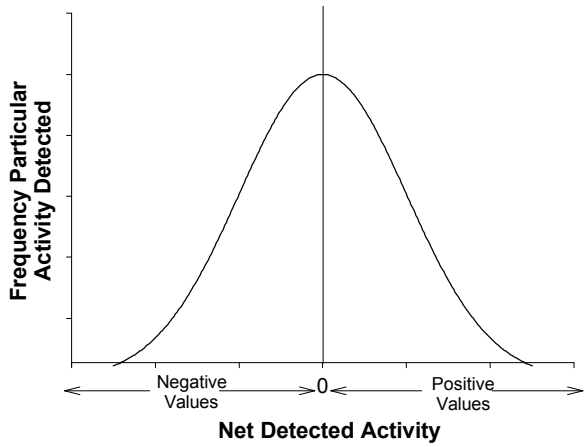


FIGURE 4. Expected frequency distribution for a sample with no radioactivity. If a sample containing no radioactivity was analyzed multiple times, a distribution of net values with an average of zero would result. Samples with radioactivity levels very close to zero are expected to have net results that are negative values approximately 50% of the time after background is subtracted.

Confidence in Detections

There are two main types of errors that may be made when reporting levels of contaminants:

- Reporting something as not present when it actually is, and;
- Reporting something as present when it actually is not.

It is the goal of the ESER program to minimize the error of saying something is not present when it actually is. To do this, a two standard deviation (2s) reporting level is used. The standard deviation is a measurement of the variation from the mean. In a distribution of results for one sample, the average result, plus or minus (±) two standard deviations (2s) of that average, approximates the 95% confidence interval for that average. When a net sample result is greater than 2s from zero, we have about 95% confidence[1] the value came from a distribution with an average greater than zero (Figure 5). The uncertainty of measurements in this report are denoted by following the result with a "±" 2s uncertainty term and all results that are greater than 2s from zero are reported in the text (all data are reported in Appendix C).

By using a 2s value as a reporting level (i.e. reporting net results that are greater than two times their uncertainty), we are controlling the error rate for saying something is not there when it is, to less than 5% (we have 95% confidence the value is greater than zero). However, there is a relatively high error rate for false detections (reporting something as present when it actually is not) for results near their 2s uncertainty. This is because there is variability around a net activity of zero for samples with no radioactivity, which may substantially overlap the variability

[1] 95% confidence interval is equal to 1.96s.

around the sample result (Figure 5). Variability associated with current analysis techniques were used to calculate the level at which we are 95% certain the sample result is greater than the *distribution* of values for a sample with no radioactivity. This level is known as the minimum detectable activity (MDA). When sample net results are greater than the MDA, (Figure 6) we have 95% confidence the results are not false detections. The MDA per sample weight or volume is called the minimum detectable concentration (MDC). All results with measured levels greater than the MDC will be specifically highlighted in this report.

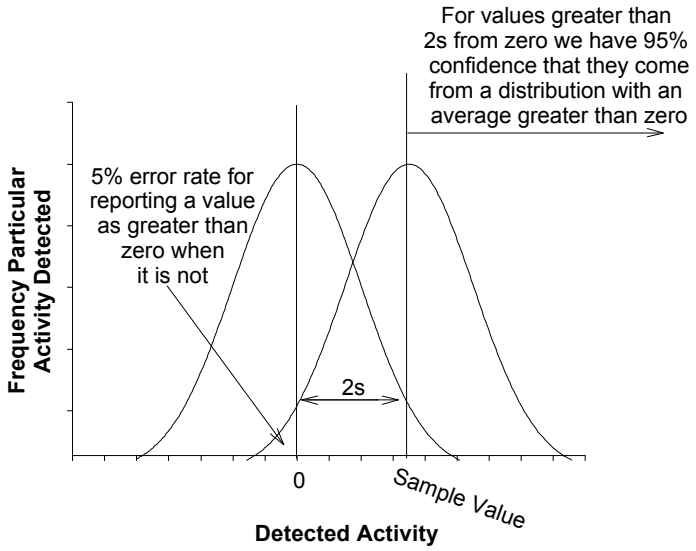


FIGURE 5. Radioactivity is reported when the result is greater than 2s from a net activity of zero. However, because there is variability around a net activity of zero for a sample with no radioactivity and variability around some value for a sample with radioactivity, there is a high rate for false detections for results near 2s.

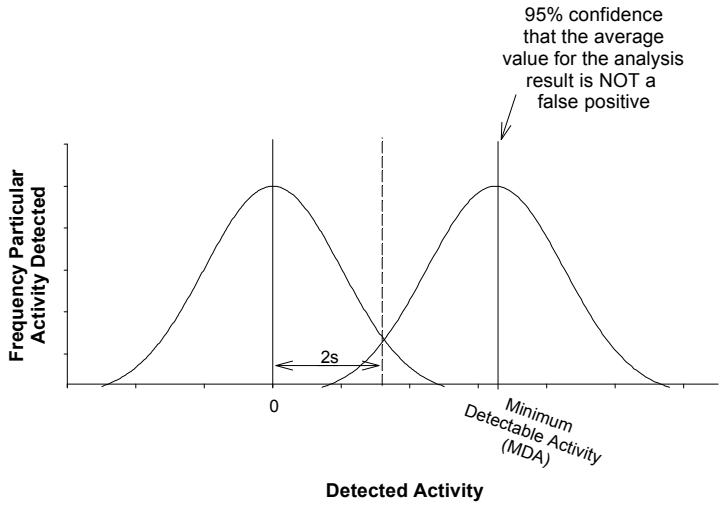


FIGURE 6. 95% confidence level that a sample result is not a false positive (95% confidence the sample result is greater than 2s from zero) is obtained when the sample result is greater than the MDA.

Determining Statistical Differences

When radiological measurements are made, it is often of interest to determine whether concentrations are different between locations or periods of time. For example, if the INEEL were a significant source of offsite contamination, concentrations of contaminants would be higher at INEEL locations compared to Boundary locations which, in turn, would be higher than at Distant locations, this, due to dispersal. To investigate this, statistical tests are used. Specifically, an independent samples t-test is used to test if there are significant differences between the average gross alpha and gross beta concentrations at INEEL, Boundary, and Distant locations. Groups are considered significantly different if the 95% confidence interval for their averages overlaps (t-test with $\alpha = 0.05$).

Radioactivity In Our World

Radiation has always been a part of the natural environment in the form of cosmic radiation, cosmogenic radionuclides [carbon-14 (^{14}C), Beryllium-7 (^{7}Be), and tritium (^{3}H)], and naturally occurring radionuclides, such as potassium-40 (^{40}K), and the thorium, uranium, and actinium series radionuclides which have very long half lives. Additionally, human-made radionuclides were distributed throughout the world beginning in the early 1940s. Atmospheric testing of nuclear weapons from 1945 through 1980 and nuclear power plant accidents, such as the Chernobyl accident in the former Soviet Union during 1986, have resulted in fallout of detectable radionuclides around the world. This naturally occurring and manmade, global, fallout radioactivity is referred to as background radiation and would be found in Idaho whether or not the INEEL was here.

The radionuclides present in our environment can give both internal and external doses (Table 1). Internal dose is received as a result of the intake of radionuclides. The major routes of intake of radionuclides for members of the public are ingestion and inhalation. Ingestion includes the intake of the radionuclides from drinking milk and water and consuming food products. Inhalation includes the intake of radionuclides through breathing dust particles containing radioactive materials.

Regulatory Limits

During the last 100 years, research has been conducted in an attempt to understand the effects of radiation on humans and the environment. Much of this research was done using standard epidemiological and toxicological approaches to characterize the response of populations and individuals to high radiation doses. A good understanding of risks associated with high radiation doses was achieved. At low exposures to radiation, however, cells may heal, so the risks from these levels are less known. This problem is compounded because scientists are searching for effects from exposure to low levels of radiation in the midst of exposure to much larger amounts of background radiation. The only measurable increased cancer incidence has occurred following high radiation doses. Mathematical models have been used to predict risks from low radiation doses.

Regulatory dose limits are set well below levels where measurable health effects have been observed. The total radiation dose limit for individual members of the public as defined by the Code of Federal Regulations (10 CFR 20.1301) is 1 mSv/y (100 mrem/y), not including the dose contribution from background radiation. Limits on emissions of radionuclides to the air from DOE facilities are set such that they will not result in a dose greater than 0.1 mSv/y (10 mrem/y) to any member of the public (40 CFR 61.92). DOE drinking water criterion have set limits of 0.04 mSv/y (4 mrem/y) for the ingestion of drinking water (DOE Order 5400.5), and EPA limits on drinking water supplies specify low allowable limits for radioactive constituents (40

CFR Parts 9, 141, and 142). DOE Order 5400.5 lists DCG values which are the concentrations in air and water that a person exposed to continuously (ingested and inhaled given certain assumptions) will result in the dose limit. DCG values are used as a reference to ensure observed concentrations are lower than concentrations that would result in a dose near the limit. ESER Program laboratories analyze for radionuclides at levels ranging from 10 to over one million times lower than those that would result in a dose near the limits (Table B-1, Appendix B).

TABLE 1. Annual estimated average dose received by a member of the population of the United States from natural radiation sources. (Data source NCRP 1987)[a].

	Average Annual Effective Dose Equivalent	
SOURCE	**(mSv)[b]**	**(mrem)[c]**
Inhaled (Radon and Decay Products)	2	200
Other Internally Deposited Radionuclides	0.39	39
Terrestrial Radiation	0.28	28
Cosmic Radiation	0.27	27
Cosmogenic Radioactivity	0.01	1
Rounded Total From Natural Sources	3	300

[a] Natural radiation doses vary based on local geology and elevation.
[b] milliseiverts
[c] millirem

1. ESER PROGRAM DESCRIPTION

Operations at the INEEL are conducted under requirements imposed by the DOE under authority of the Atomic Energy Act, and the EPA under a number of acts (e.g. the Clean Air Act and Clean Water Act). The requirements imposed by the DOE are specified in the DOE Orders. These requirements include those to monitor the effects of DOE activities onsite and offsite of the INEEL (DOE Order 5400.1). During calendar year 2001, environmental monitoring within the INEEL boundaries was primarily the responsibility of the INEEL Management and Operations (M&O) contractor, while monitoring outside the INEEL boundaries was conducted under the ESER Program. The ESER Program is led by the S.M. Stoller Corporation in cooperation with its team members including the University of Idaho (UI) and Washington State University (WSU) for research, Montgomery Watson Harza and North Wind Environmental for technical support. This report contains the monitoring results from the ESER Program for the first quarter of 2001 (January 1 – March 30).

The surveillance portion of the ESER Program is designed to satisfy the following program objectives:

- Verify compliance with applicable environmental laws, regulations, and DOE Orders;
- Characterize and define trends in the physical, chemical, and biological condition of environmental media on and around the INEEL;
- Assess the potential radiation dose to members of the public from INEEL effluents, and;
- Present program results clearly and concisely through the use of reports**,** presentations, newsletter articles, and press releases.

The goal of the surveillance program is to monitor several different media points within these potential pathways, including air, water, foodstuff, and soil, that could potentially contribute to the dose received by the public.

Air samples are taken at 15 locations on and around the INEEL; surface water at five locations on the Snake River; drinking water at 14 locations around the INEEL; foodstuff which includes milk at nine dairies around the INEEL, potatoes from at least 5 local producers, wheat from approximately 10 local producers, lettuce from approximately nine home-owned gardens around the INEEL, sheep from 2 operators which graze their sheep on the INEEL, and various types of wildlife including big game (pronghorn, mule deer, and elk), waterfowl, and fish sampled on and near the INEEL. Table A-1 in Appendix A lists samples, sampling locations and collection frequency for the ESER Program.

Once samples have been collected and analyzed, the ESER Program has the responsibility for quality control of the data and preparing quarterly reports on results from the environmental surveillance program. The quarterly reports are then combined into the *INEEL Annual Site Environmental Report* for each calendar year. Annual reports also include data collected by other INEEL contractors.

The ESER Program used two laboratories to perform analyses on environmental samples for the quarter reported here. The Idaho State University (ISU) Environmental Assessment Laboratory (EAL) performed routine gross alpha, gross beta, tritium, and gamma spectrometry

analyses. Severn-Trent, Inc performed analyses requiring radiochemistry, including analysis for ^{90}Sr, ^{238}Pu, $^{239/240}Pu$, and ^{241}Am. The Operational Dosimetry unit of the INEEL M&O contractor evaluates environmental dosimeters. Samples collected by the ESER Program on behalf of the EPA (detailed in the next paragraph) are sent to the EPA's Eastern Environmental Radiation Facility.

In the event of non-routine occurrences, such as suspected releases of radioactive material, the ESER Program may increase the frequency of sampling and/or the number of sampling locations based on the nature of the release and wind distribution patterns. In the event of any suspected worldwide nuclear incidents, like the Chernobyl accident, the EPA may request additional sampling be performed through the Environmental Radiation Ambient Monitoring System (ERAMS) network of which the ESER Program operates air and precipitation sampling equipment in Idaho Falls. The EPA established the ERAMS network in 1973 with an emphasis on identifying trends in the accumulation of long-lived radionuclides in the environment. ERAMS is comprised of a nationwide network of sampling stations that provide air, precipitation, surface water, drinking water, and milk samples. Any data found to be outside historical norms in the ESER Program are thoroughly investigated to determine if an INEEL origin is likely. Investigation may include re-sampling and/or re-analysis of prior samples.

For more information concerning the ESER Program, contact the S.M. Stoller Corporation at (208) 525-9358, or visit the Program's web page (http://www.stoller-eser.com).

2. THE INEEL

The INEEL is a nuclear energy research and environmental management facility, owned and administered by the U.S. Department of Energy, Idaho Operations Office (DOE-ID). It occupies about 2,300 km^2 (890 mi^2) of the upper Snake River Plain in Southeastern Idaho. The history of the INEEL began during World War II when the U.S. Naval Ordnance Station was located in Pocatello, Idaho. This station, one of two such installations in the U.S., retooled large guns from U.S. Navy ships. The facility tested the retooled guns on the nearby-uninhabited plain, known as the Naval Proving Ground. In the aftermath of the war, as the nation worked to tame atomic power, the Atomic Energy Commission (AEC), predecessor to the DOE, became interested in the Naval Proving Ground and developed plans for a facility to build, test, and perfect nuclear power reactors.

The Naval Proving Ground became the National Reactor Testing Station (NRTS) in 1949, under the AEC. By the end of 1951, a reactor at the NRTS became the first to produce useful electricity. The facility evolved into an assembly of 52 reactors, associated research centers, and waste handling areas. The NRTS was renamed the Idaho National Engineering Laboratory in 1974 and Idaho National Engineering and Environmental Laboratory in January 1997. Only two reactors are operable today with most activities at the INEEL centered on environmental restoration and waste management.

3. AIR SAMPLING

Groundwater is a potential migration pathway and is monitored by the United States Geological Survey, as well as the INEEL M&O contractor. Surface water does not flow off of the INEEL so the primary pathway by which radionuclides can move off-site is through the air. Consequently, air is a primary focus of ESER monitoring on and around the INEEL. Particulates and ^{131}I in air are measured weekly at 15 locations using low-volume air samplers for the duration of the quarter. Moisture in the atmosphere is sampled at four locations around the INEEL and analyzed for tritium. Concentrations of particulates in the air are obtained using PM_{10} samplers at three locations. Air sampling activities and results for the first quarter, 2001 are discussed below.

3.1 Low-Volume Air Sampling

Radioactivity associated with airborne particulates was monitored continuously by 17 ESER Program air samplers at 15 locations during the first quarter of 2001 (Figure 7). Three of these samplers were located on the INEEL, seven were located off the INEEL near the boundary, and five were at locations distant the INEEL. Replicate sampler "Q/A-1" was repaired and then relocated from the FAA Tower to Arco. One sample was taken (on January 3) from the FAA Tower location prior to the repair and relocation of sampler "QA-1", five weeks of replicate samples were missed due to repairs (from January 10 to February 7), and the rest of the samples for the first quarter were taken from the new location in Arco. The other replicate sampler, "Q/A-2", was also relocated during the first quarter from Monteview to Howe. This resulted in one sample being taken from the Monteview location (on January 3), and all other samples being taken from the Howe location. An average of 13,144 ft^3 (372 m^3) of air was sampled at each location, each week, at an average flow rate of 1.3 ft^3/min (0.04 m^3/min). Particulates in air were collected on filters (1.2 µm pore size), while gases were pulled through activated charcoal cartridges.

Filters and charcoal cartridges were changed weekly at each station. Each filter was screened for gross alpha and gross beta radioactivity using thin-window gas flow proportional counting systems after waiting about four days for naturally-occurring daughter products of radon and thoron to decay. For more information concerning gross alpha and beta radioactivity, see the *Gross versus Specific Analyses* portion of the *Helpful Information* section of this report. Charcoal cartridges were analyzed for gamma emitting radionuclides, specifically ^{131}I. Iodine-131 is of great interest because it is produced in relatively large quantities by nuclear fission and has a half-life of only eight days. This means any ^{131}I that is detected would be from a recent release of fission products. Finally, a composite of the 13 filters (one for each week) for each location was analyzed for gamma-emitting radionuclides with a subset analyzed for ^{90}Sr, ^{238}Pu, $^{239/240}Pu$, and ^{241}Am.

3.1.1 Gross Alpha and Beta Concentrations at INEEL, Boundary, and Distant locations

Weekly, average, gross alpha concentrations in air for INEEL, Boundary, and Distant locations are shown in Figure 8. If the INEEL was a significant source of offsite contamination, concentrations of contaminants would trend higher at INEEL locations compared to Boundary locations which, in turn, would be higher than Distant locations. An independent samples t-test ($\alpha = 0.05$) was used to determine if there were significant differences between the average gross alpha and gross beta concentrations at INEEL, Boundary, and Distant locations.

The average gross alpha concentration at INEEL locations was higher than at Boundary locations in two of the thirteen weeks (weeks of January 31 and March 28). However, also during the week of January 31, the average gross alpha concentration at Distant locations was significantly higher than Boundary locations, which is the opposite of what would be expected if the INEEL were the source of contamination. No other significant differences in gross alpha concentrations were observed.

Average gross beta concentrations at INEEL locations were significantly higher than the average at either Boundary or Distant locations during the weeks of February 21, February 28, March 14, and March 21 (31% of the weeks in the first quarter). The average gross beta concentration at INEEL locations was also significantly higher than the averages at Boundary and Distant locations during the week of March 28. Examination of the gross beta data for the first quarter, 2001 shows that the overall magnitude was well within the range of values observed in the past.

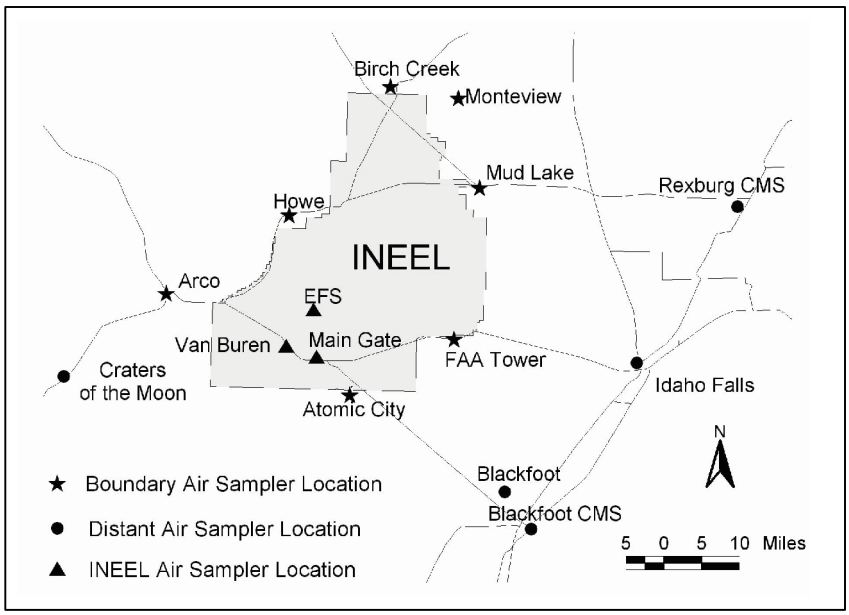


FIGURE 7. Continuous air sampling locations.

A summary of approximate MDC for radiological analyses data is provided in Appendix B, while results for individual filters are listed in Table C-1 of Appendix C. Weekly average gross alpha and beta concentrations in air are shown in Figure 9. Monthly average gross alpha and beta concentrations in air at each sampling location are shown in Figures 10 – 15.

No ^{131}I was detected in any of the weekly charcoal cartridges during the first quarter. Weekly ^{131}I results for each location are listed in Table C-2 of Appendix C.

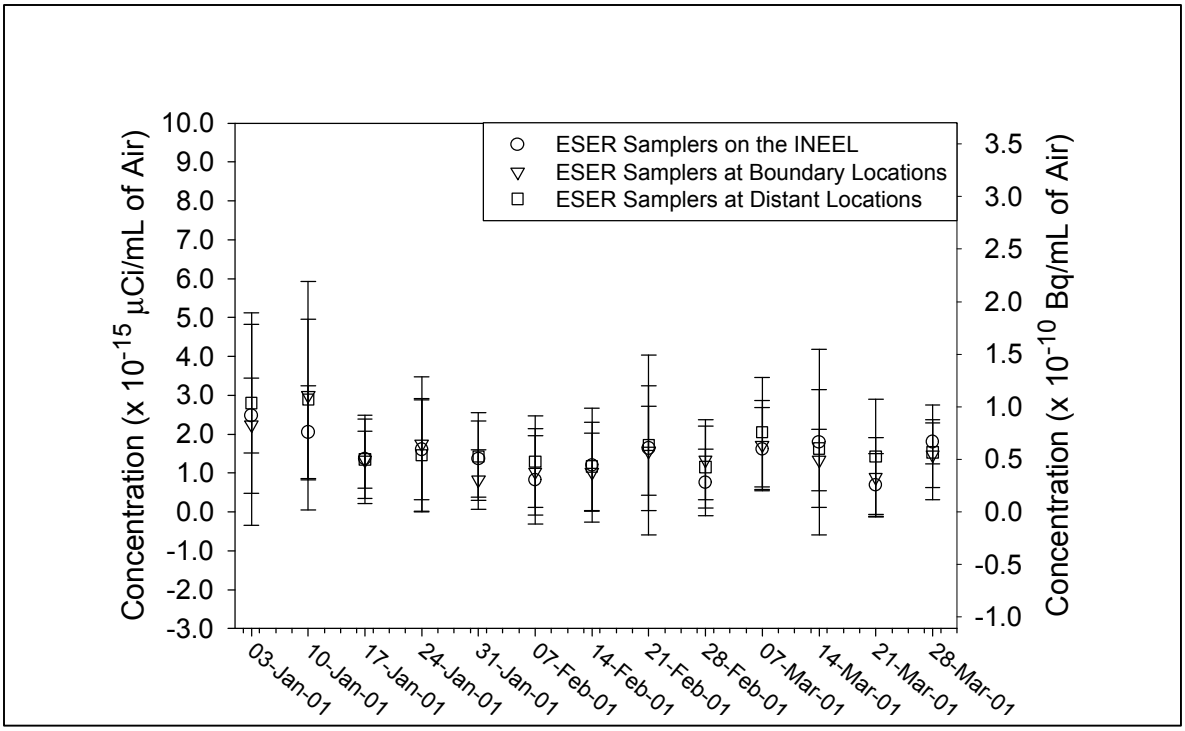


FIGURE 8. Weekly average gross alpha concentrations in air at INEEL, Boundary, and Distant locations (error bars equal ± 2 standard deviations).

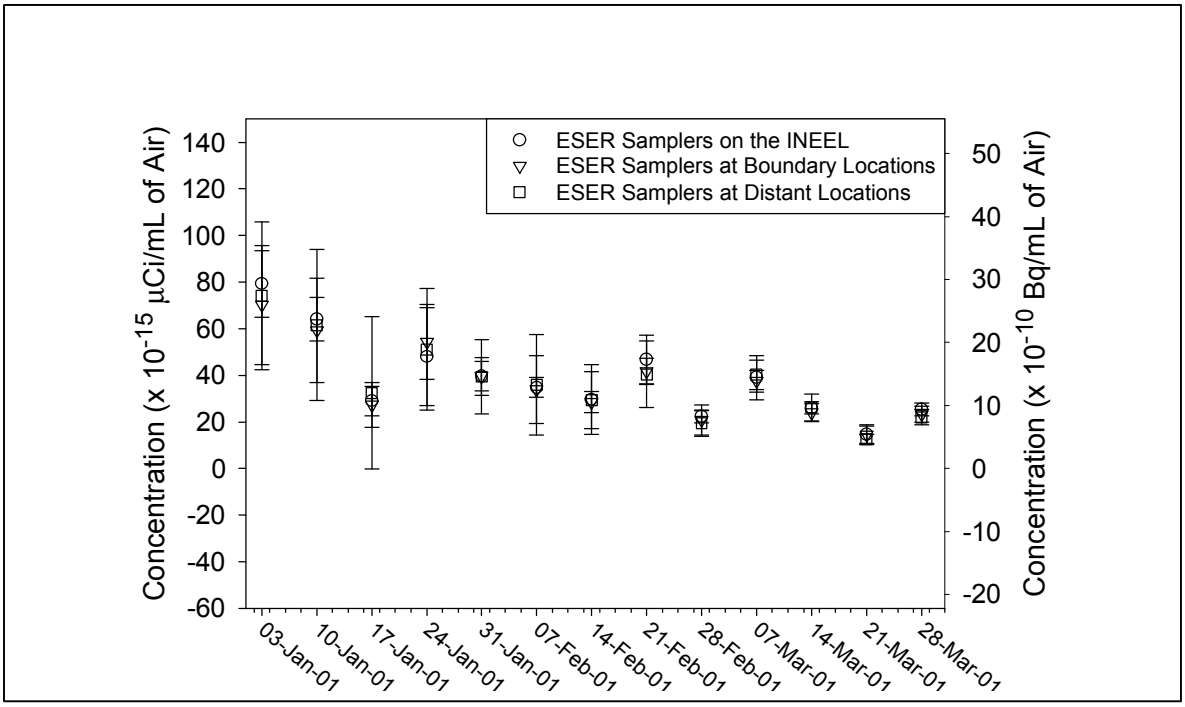


FIGURE 9. Weekly Average gross beta concentrations in air at INEEL, Boundary, and Distant locations (error bars equal ± 2 standard deviations).

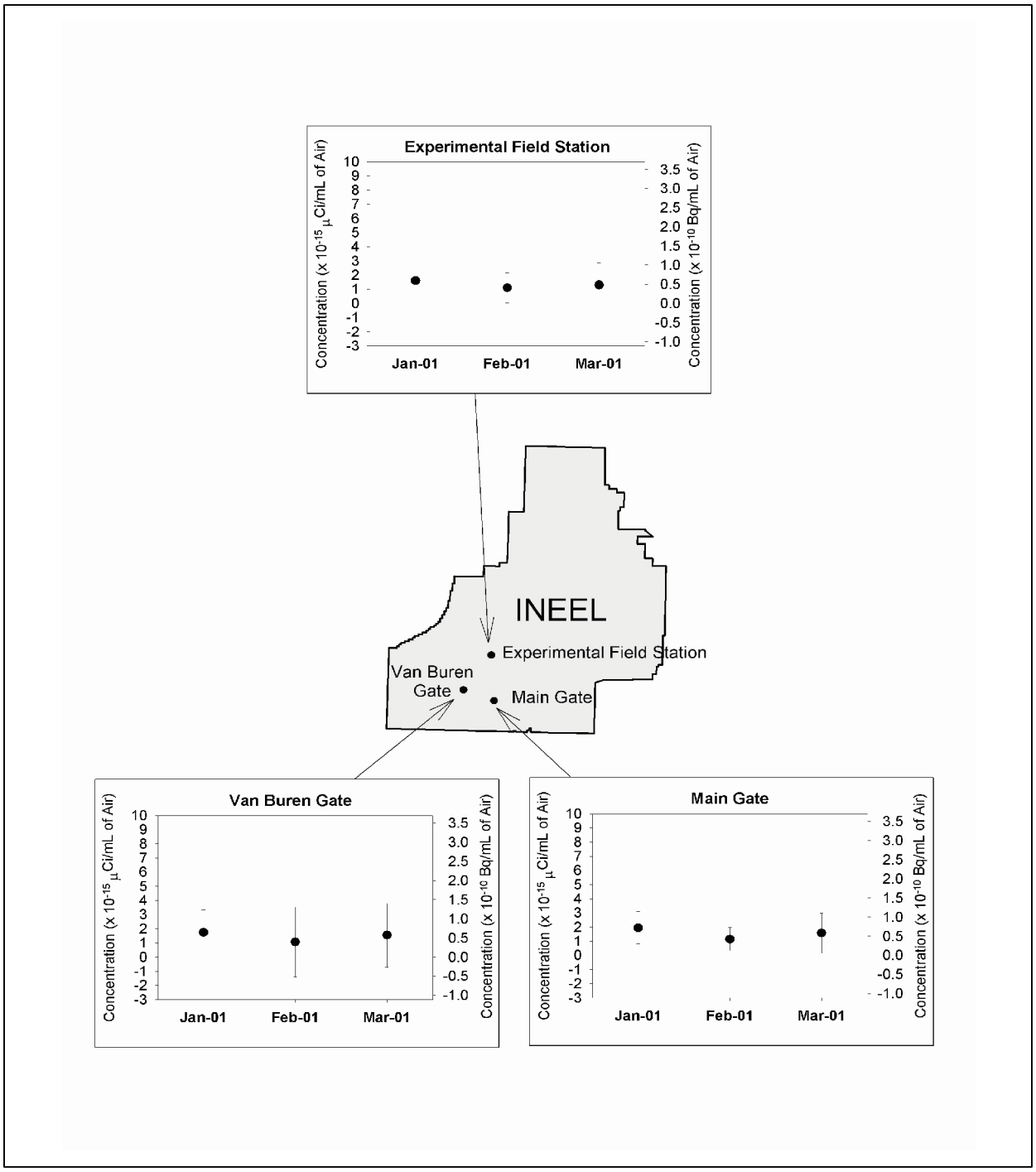


FIGURE 10. Monthly average gross alpha concentrations in air at INEEL Locations.

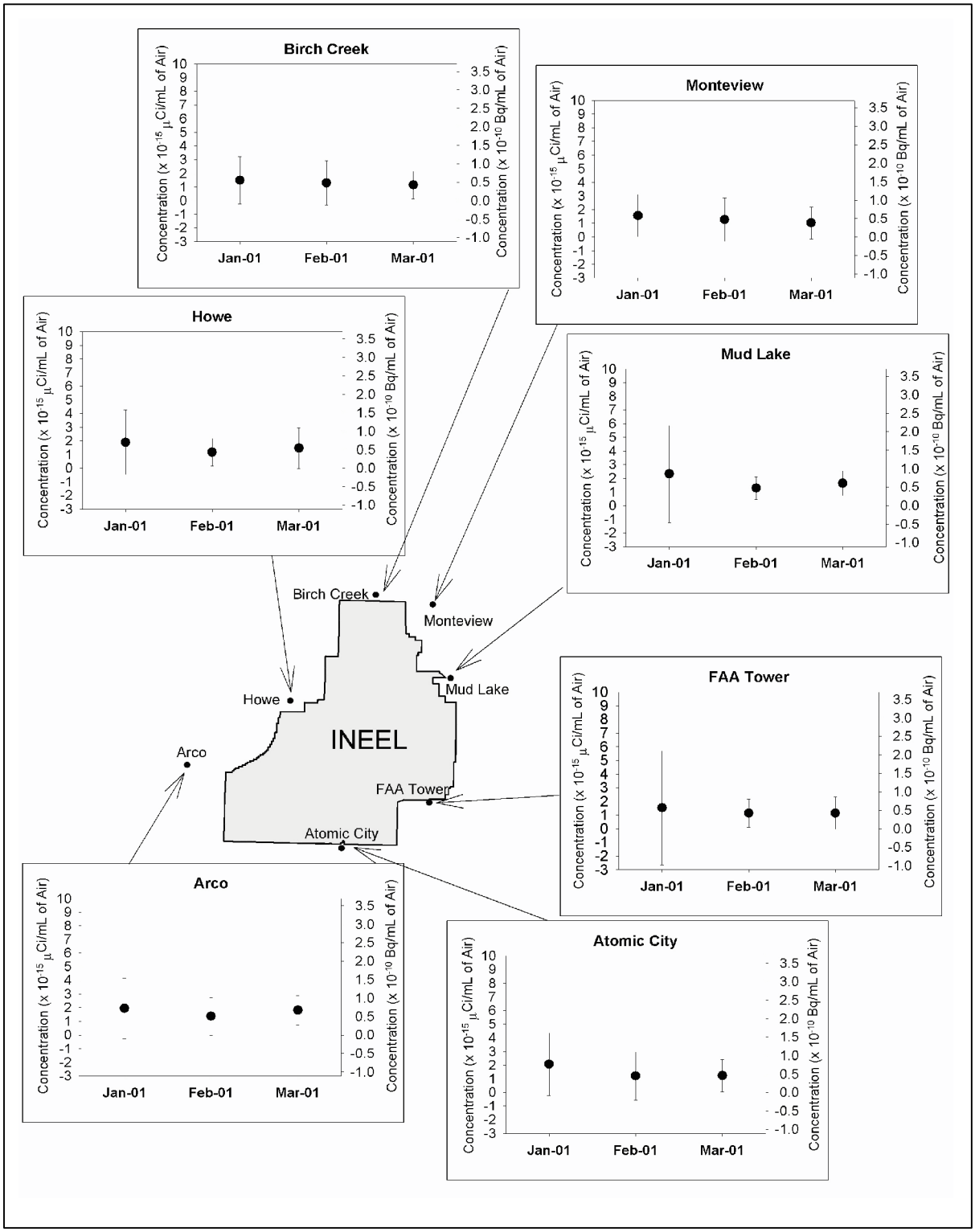


FIGURE 11. Monthly average gross alpha concentrations in air at Boundary Locations.

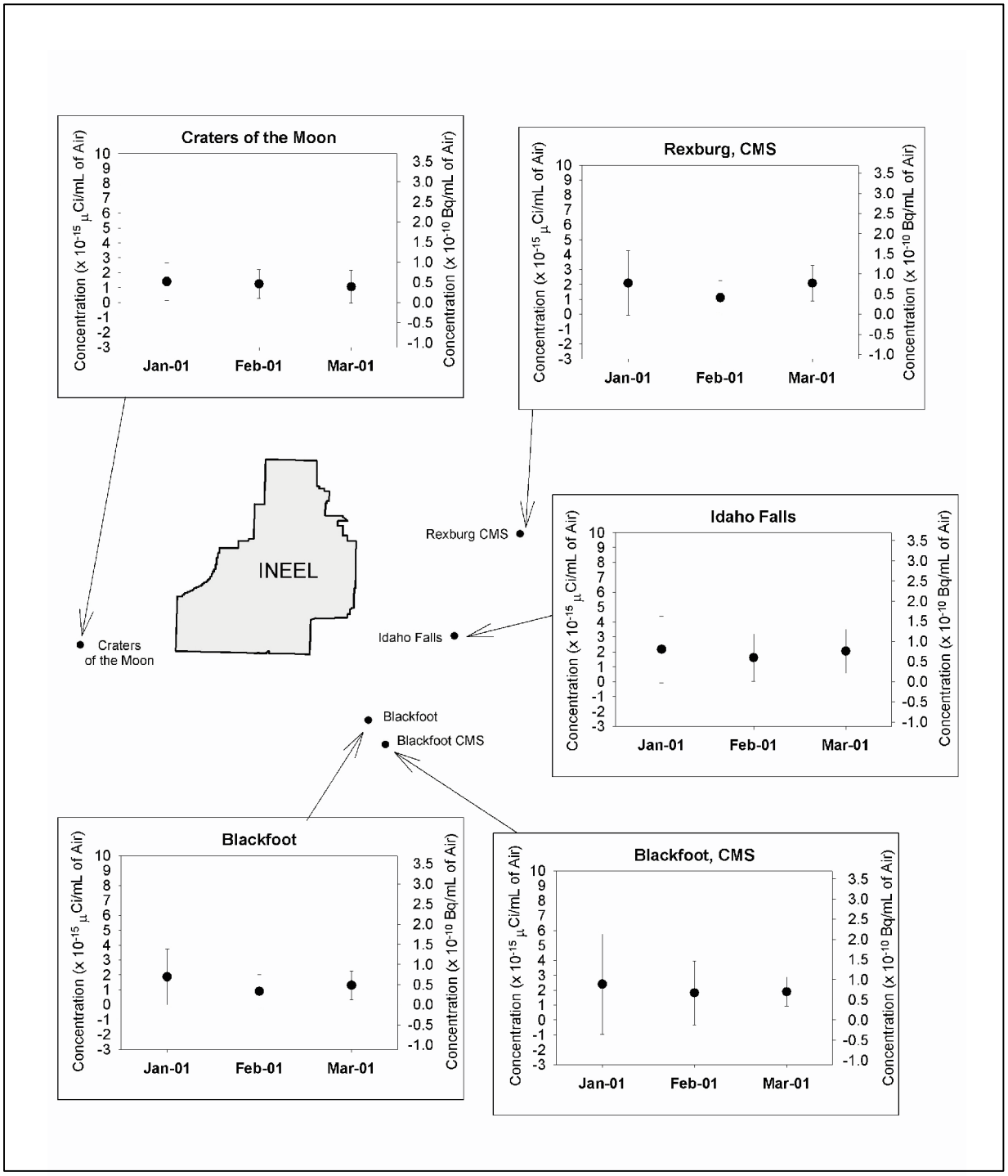


FIGURE 12. Monthly average gross alpha concentrations in air at Distant Locations.

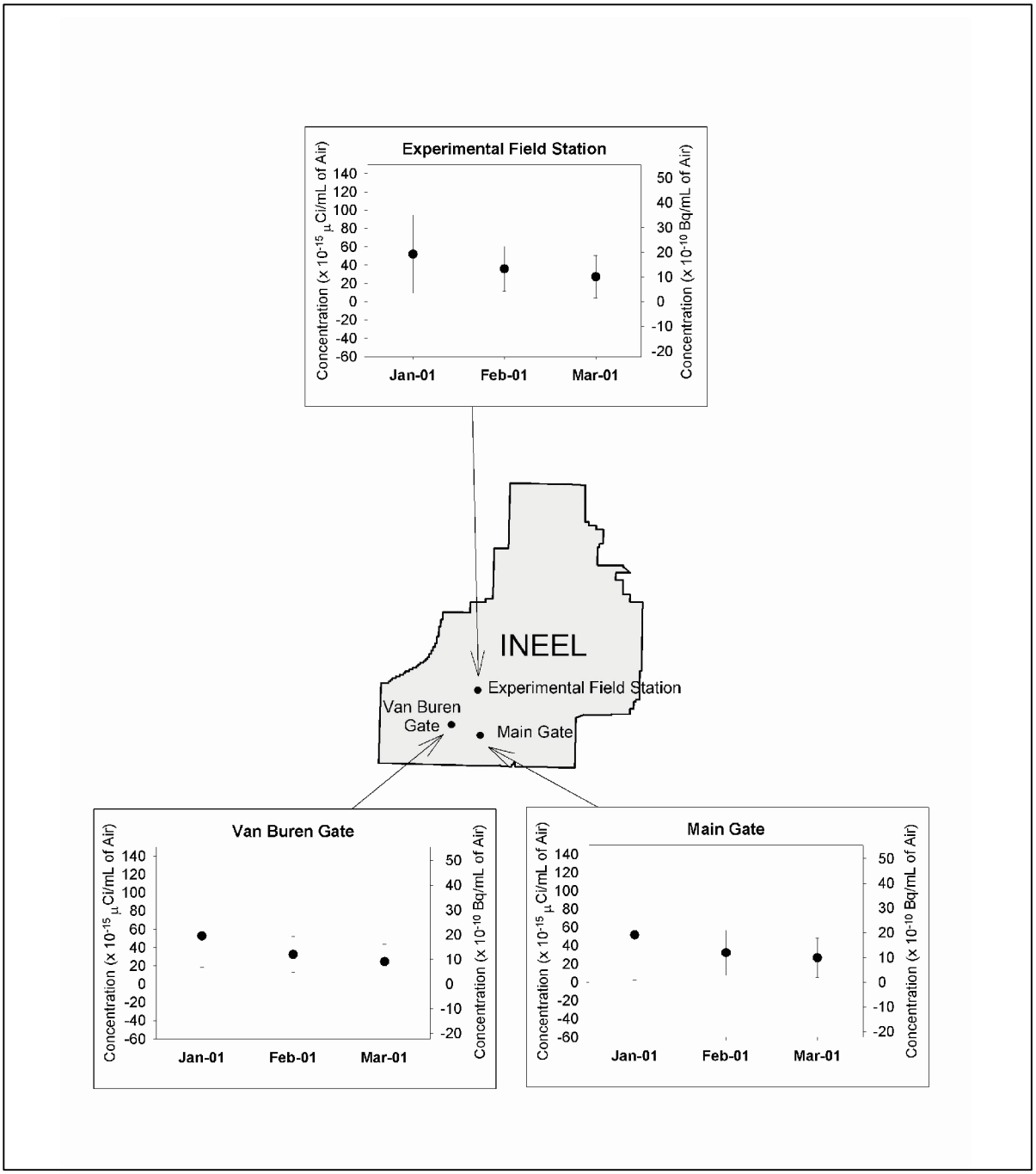


FIGURE 13. Monthly average gross beta concentrations in air at INEEL Locations.

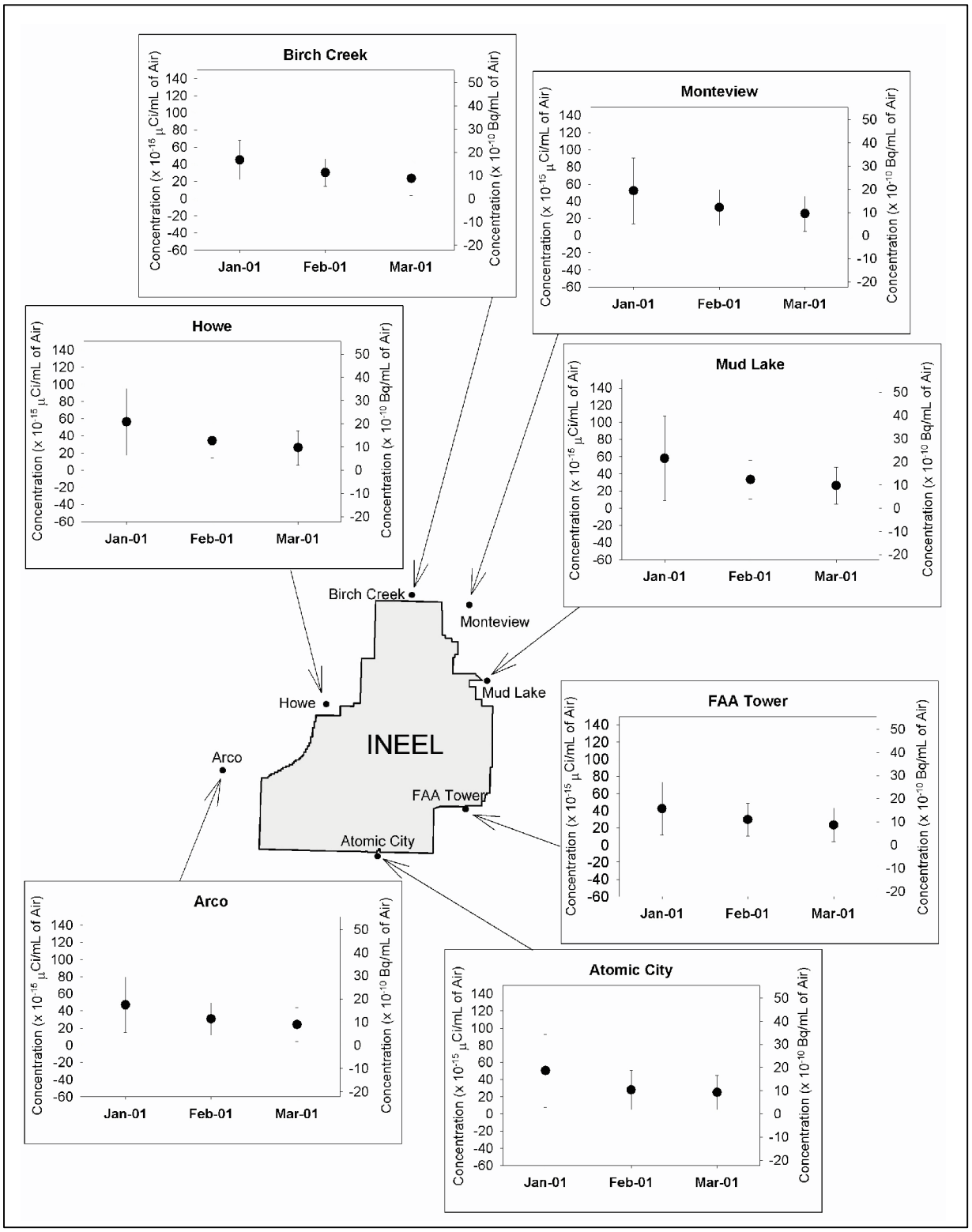


FIGURE 14. Monthly average gross beta concentrations in air at Boundary Locations.

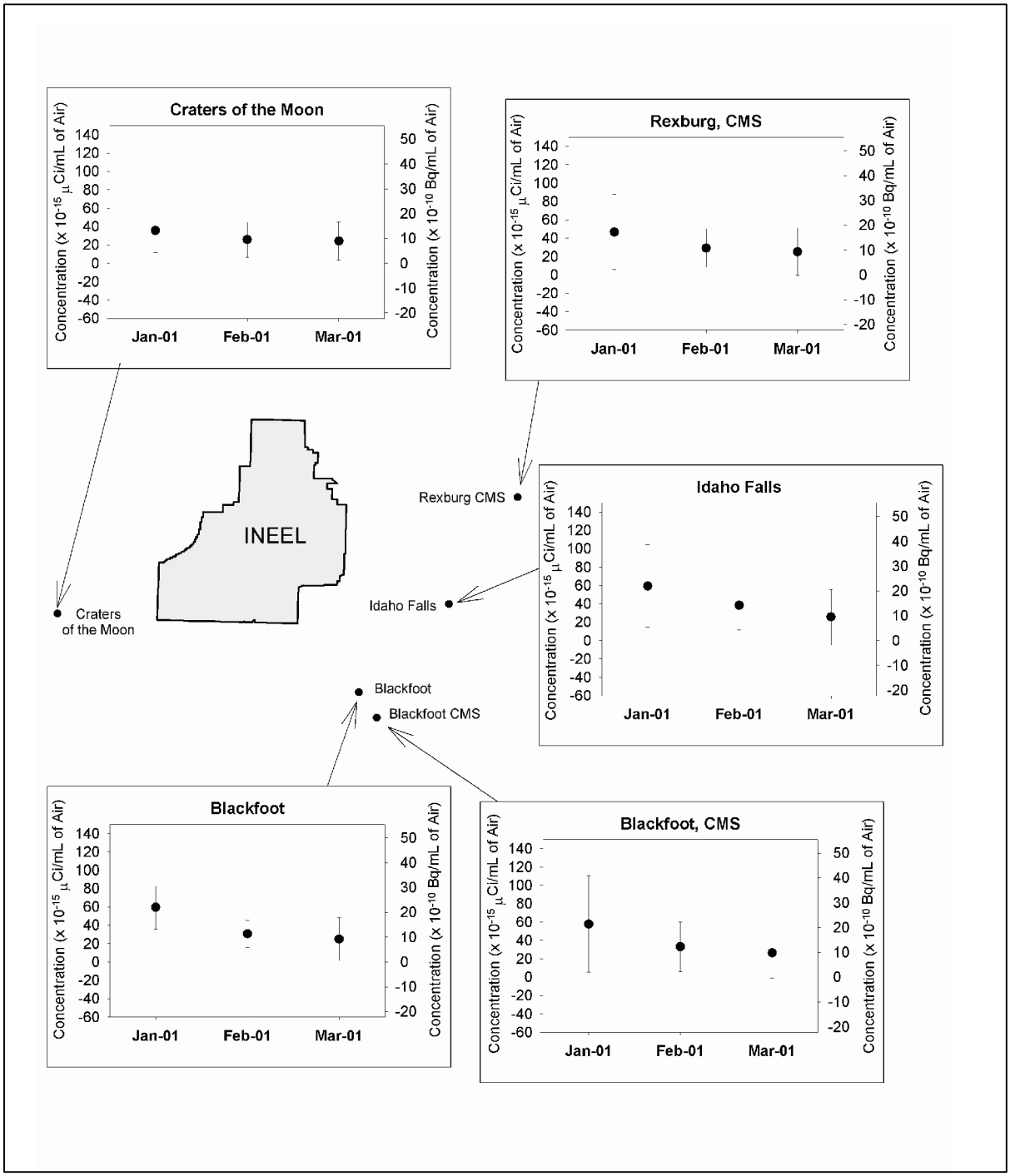


FIGURE 15. Monthly average gross beta concentrations in air at Distant Locations.

Weekly filters for the first quarter of 2001 were composited by location. All samples were analyzed for gamma-emitting radionuclides, with a subset from several locations selected on a rotating basis and analyzed for ^{90}Sr, ^{238}Pu, $^{239/240}Pu$, and ^{241}Am. No ^{90}Sr, ^{238}Pu, $^{239/240}Pu$, or ^{137}Cs were detected in any sample. The only human-made radionuclide detected was ^{241}Am. The ^{241}Am results for Howe, Monteview, Van Buren, FAA Tower, and Rexburg CMS were all greater than their associated 2s uncertainty, and all but the Van Buren sample were also above the MDC. Results that were greater than their associated 2s uncertainty and the MDC value are listed in Table 2.

Levels of ^{241}Am in composited filter samples were within the range of values reported in past quarterly reports and were between 4,200 to over 12,000 times lower than DCG values set to ensure dose limits are not exceeded (compare sample results with DCG values listed in Table B-1, Appendix B). Results for all composite filter samples are shown in Table C-3 of Appendix C.

TABLE 2. Specific radionuclides with results > 2s and results > MDC in composite air filters.

		Sample Results		MDC	
Location	**Radionuclide**	**x 10^{-16} µCi/mL ± 2s**	**x 10^{-12} Bq/mL ± 2s**	**x 10^{-16} µCi/mL**	**x 10^{-12} Bq/mL**
Howe	^{241}Am	0.036 ± 0.024	0.134 ± 0.089	0.0098	0.036
Monteview	^{241}Am	0.047 ± 0.027	0.174 ± 0.100	0.0196	0.073
FAA Tower	^{241}Am	0.022 ± 0.020	0.080 ± 0.074	0.0118	0.044
Rexburg CMS	^{241}Am	0.016 ± 0.013	0.060 ± 0.048	0.0073	0.027

3.2 Atmospheric Moisture Sampling

Two atmospheric moisture samples were obtained from the Blackfoot CMS location, two from Atomic City, one from Idaho Falls, and one from Rexburg CMS during the first quarter, 2001. Atmospheric moisture was collected by continuously drawing air through a column of silica gel that absorbed water vapor. Each sample was collected after 4-13 weeks, depending on when an adequate amount of moisture had been extracted by the silica gel from the atmosphere. The water was then extracted from the silica gel by distillation. The resulting atmospheric moisture samples were analyzed for tritium using liquid scintillation.

All six atmospheric moisture samples had tritium results greater than their 2s uncertainty and MDC. It is important to note that sample blanks (submitted as part of normal QA/QC procedures) for precipitation sampling, analyzed with the same instrumentation as the atmospheric moisture samples, also had results greater than their associated 2s uncertainties and MDCs. Therefore, there is a high probability that one or more of the atmospheric moisture sample results were false positives (see the *Confidence in Detections* section in the *Helpful Information* section of this report). However, even with this potential bias, the concentrations were very low. For comparison, the DCG value for tritium in air (as atmospheric moisture) is 1×10^{-7} µCi/mL (3.7×10^{-3} Bq/mL) (Appendix B, Table B-1). Tritium results measured at these locations during the first quarter of 2001 were between 100,000 to nearly 800,000 times lower

than this limit. Tritium results for all atmospheric moisture samples are listed in Table C-4 (Appendix C).

3.3 PM_{10} Air Sampling

In 1987, the EPA began using a standard (40 CFR 50.6) for concentrations of airborne particulate matter less than 10 micrometers in diameter (PM_{10}). Particles of this size can reach the lungs and are considered to be responsible for most of the adverse health effects associated with airborne particulate pollution.

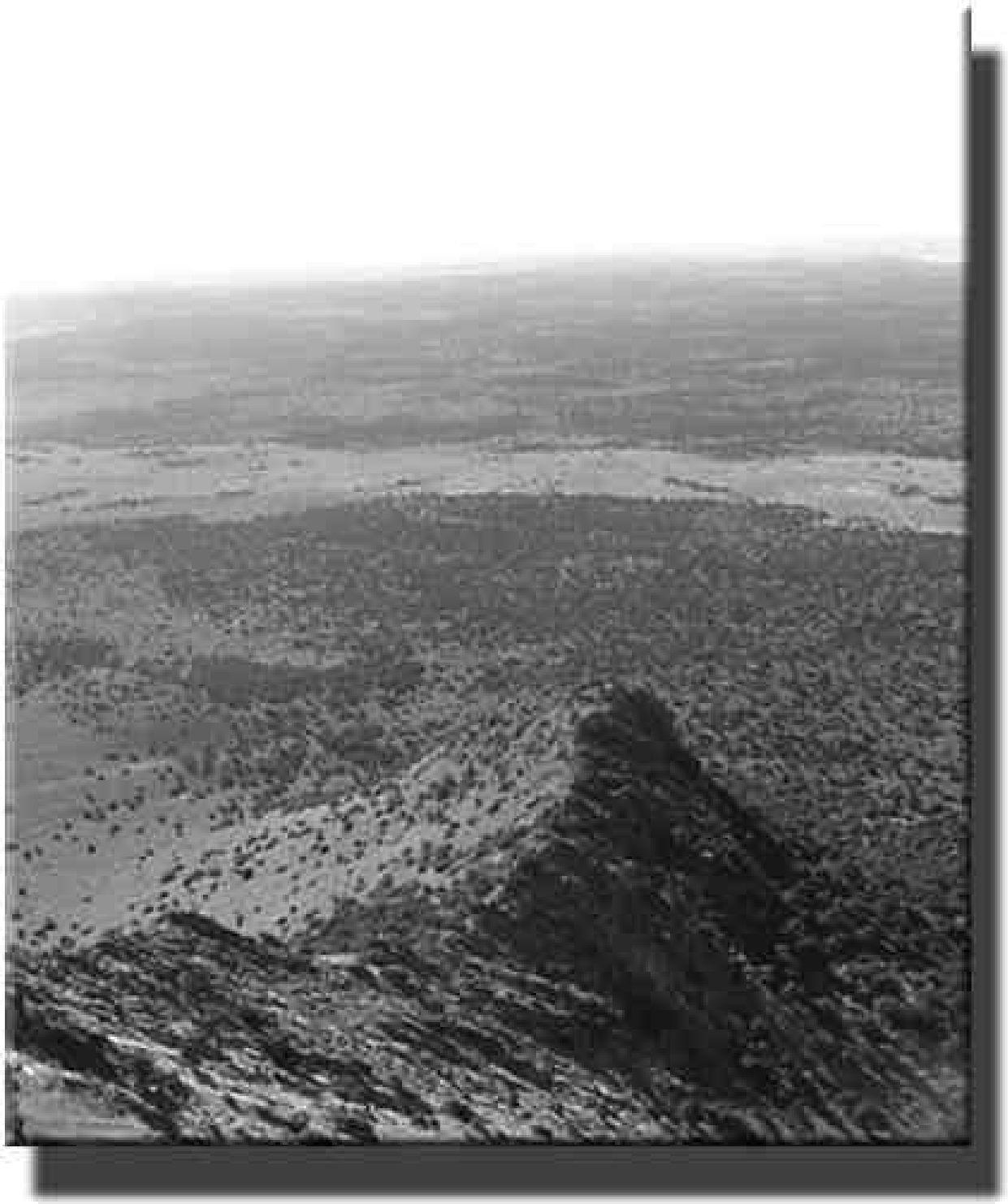
ESER Program personnel operate three PM_{10} samplers, one at Rexburg CMS, one at Blackfoot CMS, and one at Atomic City. A sample is collected for a period of 24 hours, once every six days. This interval yields 15 samples per location, per quarter. However, due to equipment failures several samples were not acceptable due to their run times not falling within the required sample interval guidelines (24 hours $\pm$1 hour). These included: three samples from the Blackfoot CMS location (January 24, February 11 and February 17), three samples from the Rexburg CMS location (January 6, January 24 and March 7) and two samples from the Atomic City location (February 11 and February 17).

The air quality standards for PM_{10}, are an annual average of 50 $\mu g/m^3$, with a maximum 24-hour concentration of 150 $\mu g/m^3$. PM_{10} concentrations for the first quarter of 2001 were well below all air quality standard levels. The maximum 24-hour concentration was 58.6 $\mu g/m^3$ on March 1, at Rexburg CMS. Results for all PM_{10} samples are listed in Table C-5, Appendix C.

TABLE 3. Summary of 24-hour PM_{10} Values ($\mu g/m^3$) for each station.

	Average	Maximum	Minimum
Atomic City	6.3	17.5	1.1
Blackfoot CMS	17.7	40.4	2.7
Rexburg CMS	18.6	58.6	6.1

Air quality PM_{10} standards permit an annual average of 50 $\mu g/m^3$, and a maximum 24-hour concentration of 150 $\mu g/m^3$.



4. WATER SAMPLING

Water that is sampled by the ESER program includes surface water, drinking water and precipitation. Surface and/or drinking water are sampled twice each year during the Second and Fourth Quarters at 19 locations around the INEEL (see Appendix A). Monthly composite precipitation samples are collected from Idaho Falls and the CFA on the INEEL. Weekly precipitation samples are collected from the EFS on the INEEL.

4.1 Precipitation Sampling

When adequate precipitation occurred, samples were taken on a monthly interval from Idaho Falls and CFA, and on a weekly interval from EFS. A minimum precipitation sample volume of approximately 20 mL is needed for a single sample. Precipitation samples are analyzed for tritium. For the first quarter of 2001, there was enough precipitation for a total of ten samples – three from Idaho Falls, three from CFA, and four from EFS. Of the three samples collected from Idaho Falls, two, (from January and March) had results greater than their associated 2s values. The February sample was below the MDC and the March sample was above the MDC (Appendix B, Table B-1). Of the four samples collected from EFS, all were above 2s, however, only one (week of January 17) was above the MDC. Of the three samples collected from CFA, the January sample was above 2s, but was below the MDC.

Sample blanks (submitted as part of normal QA/QC procedures) for precipitation sampling also had results greater than their associated 2s uncertainties and MDCs. Therefore, there is a high probability that one or more of these results were false positives (see the *Confidence in Detections* section in the *Helpful Information* section of this report). While there is not a DCG for precipitation, the SDWA sets a limit for tritium in drinking water of 2×10^4 pCi/L (Appendix B, Table B-1). The level of tritium detected in the samples that were above their associated 2s and MDC values was between 110 and 160 times lower than the level set by the SDWA, and was within the range of background tritium that exists throughout the world.

While tritium was detected (above 2s and above the MDC) in precipitation from Idaho Falls and EFS, and an INEEL source cannot be discounted for contributing to this, the measured level was within the range of background tritium that exists throughout the world. Low levels of tritium exist in the environment at all times. The major natural source of tritium is cosmic ray reactions in the upper atmosphere. From 1978 to 2001 the EPA, as part of its ERAMS, measured tritium from -2.00×10^2 to 7.38×10^6 pCi/L in precipitation samples across the United States (EPA, 2002). Data for all precipitation samples for the first quarter 2001 are listed in Table C-6 (Appendix C).

5. FOODSTUFF SAMPLING

Another potential pathway for contaminants to reach humans is through the food chain. ESER Program personnel sample multiple agricultural products, game animals, and garden lettuce around the INEEL and Southeast Idaho. Specifically, milk, wheat, potatoes, sheep, garden lettuce, big game, waterfowl and fish are sampled. Milk is sampled throughout the year. Sheep are sampled during the second quarter. Lettuce and wheat are sampled during the third quarter while potatoes and waterfowl are collected during the fourth quarter. Marmots (a.k.a. rock chucks), a food source for Native Americans, are sampled during the second quarter. Big game and fish are sampled as they come available. This report only covers milk sampled in the first quarter. See, Appendix A, Table A-1 for more details on foodstuff sampling.

5.1 Milk Sampling

Milk samples were collected weekly in Idaho Falls and monthly at eight other locations around the INEEL (Figure 16). All samples were analyzed for gamma emitting radionuclides. A total of 39 milk samples were collected during the first quarter of 2001. Of all the milk samples collected, two (February 6, and March 6, 2001) from Dietrich had concentrations of ^{131}I greater than their 2s uncertainty, however, immediate recounts of these samples gave results less than their 2s uncertainty levels. This is not unusual because 2.5% of the time, values that are tested against the 2s level will produce a false positive result. Cesium-137 was detected in the following samples at a concentration greater than the associated 2s uncertainty: Howe (January 9), Moreland (January 9), Carey (February 6), and Idaho Falls (March 14). However, immediate recounts of these samples gave results less than the associated 2s uncertainty. Data for all ESER milk samples, for first quarter 2001, are listed in Table C-7 (Appendix C).

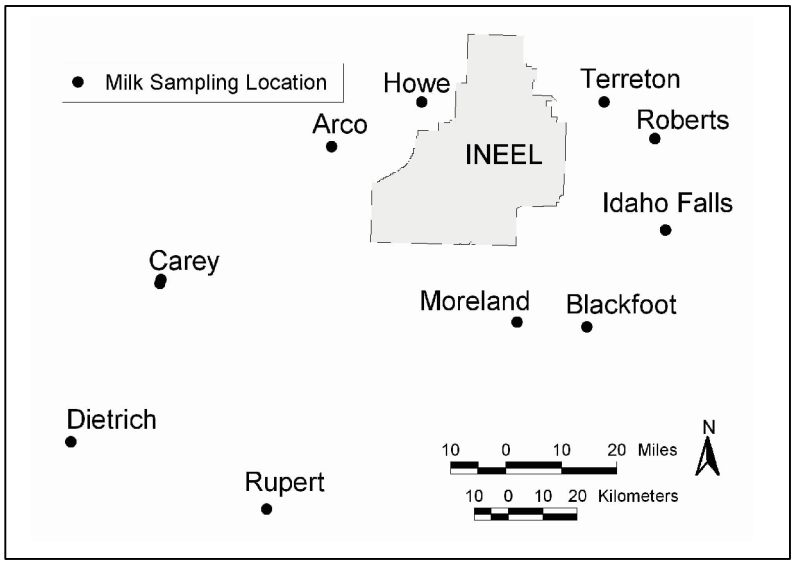
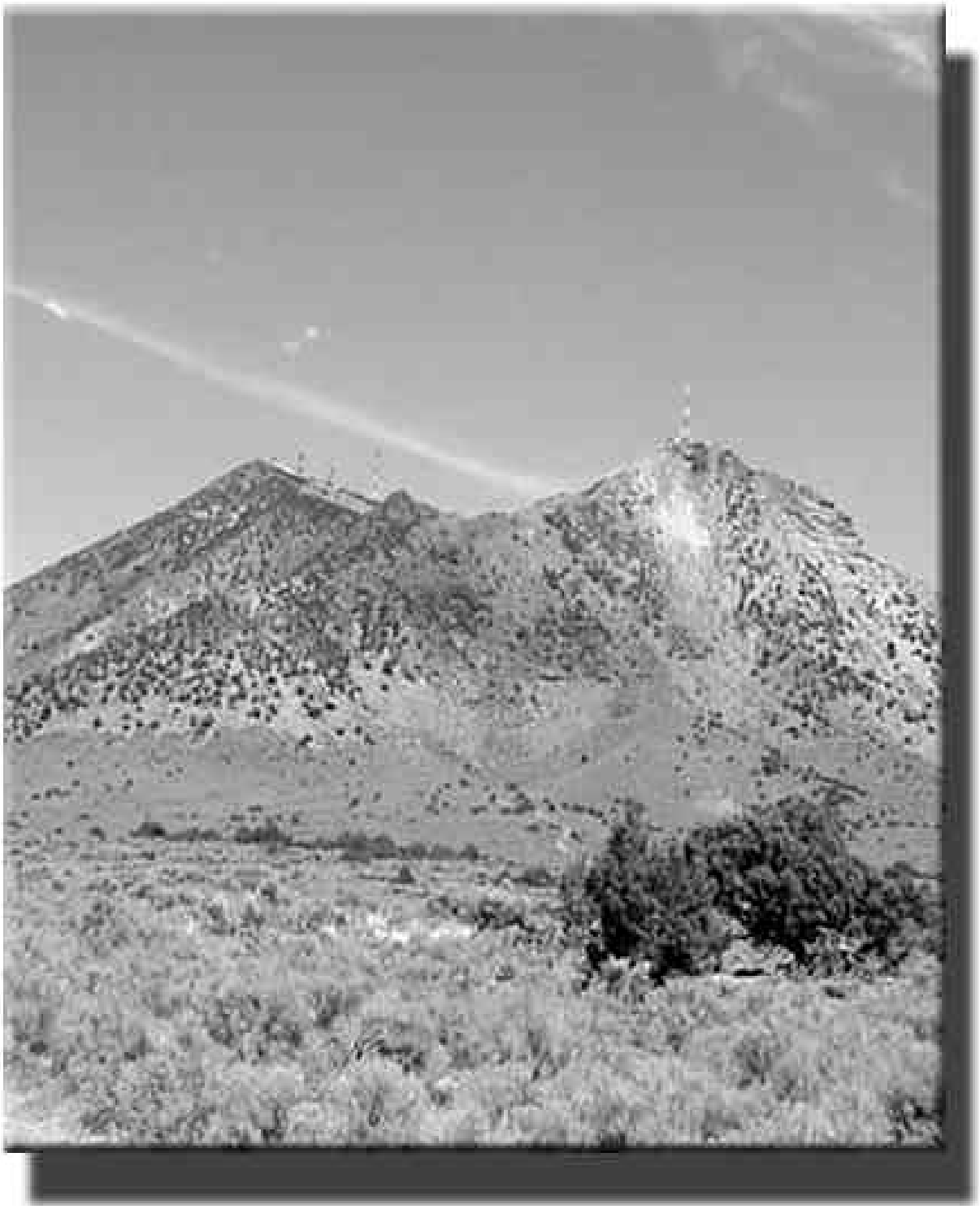


FIGURE 16. Milk sampling locations.

5.2 Large Game Animal Sampling

No large game animals were sampled during the first quarter of 2001.



6. SUMMARY AND CONCLUSIONS

There were no radionuclides measured in first quarter, 2001, ESER samples that could be directly linked with INEEL activities. There were no observed gradients of gross alpha or beta concentrations in air increasing towards the INEEL from Distant locations. Levels of detected radionuclides were below regulatory limits and were not different from values measured at other locations across the United States. Based on these results, it is the conclusion of the ESER Program that the INEEL did not measurably contribute to offsite radionuclide concentrations during the first quarter of 2001 for constituents sampled.

REFERENCES

EPA. 1997, Environmental Radiation Data. Report 91. United States Environmental Protection Agency, Office of Radiation and Indoor Air, Montgomery, AL.

EPA. 2002, Environmental Radiation Ambient Monitoring System Database, United States Environmental Protection Agency, Montgomery, AL. Data file sent via e-mail communication from Tonya Hudson to Ron Warren on 1/11/02.

NCRP. 1987, Exposure of the population in the United States and Canada from natural background. Report 94, National Council on Radiation Protection and Measurements, Bethesda, MD.