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

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EXECUTIVE SUMMARY

This report for the fourth quarter, 2001, contains results from the Environmental Surveillance, Education, and Research (ESER) Program's monitoring of the Department of Energy's Idaho National Engineering and Environmental Laboratory's (INEEL) offsite environment, October 1 through December 31, 2001. All sample types (media) and the sampling schedule followed during 2001 are listed in Appendix A. Specifically, this report contains the results for the following:

- Air sampling, including air filters and charcoal cartridges, atmospheric moisture and, 10-micron particulate matter (PM_{10});
- Water sampling, including precipitation, drinking water, and surface water;
- Food stuff sampling, including milk, potatoes, large game, ducks, and doves; and,
- Environmental radiation.

At no time during the fourth quarter were weekly average gross alpha or gross beta concentrations from Boundary locations statistically higher than corresponding averages for Distant locations, as one would expect if the INEEL was a significant source of radionuclide contamination. During the fourth quarter, analysis of one ten-cartridge batch detected ^{131}I greater than the associated 2s and minimum detectable concentration (MDC) values. Immediate reanalysis of each individual cartridge yielded results below both the MDC and 2s values. Because initial counting is done as a batch sample it appears that the cumulative activity for these ten cartridges was above the 2s/MDC value, but was not attributable to any single location (cartridge). Selected quarterly composite filter samples were analyzed for gamma emitting radionuclides, strontium-90 (^{90}Sr), plutonium-238 (^{238}Pu), plutonium-239/240 ($^{239/240}Pu$), and americium-241 (^{241}Am). Five samples showed at least one human-made radionuclide greater than its related 2s value. All results were far less than their respective Derived Concentration Guide (DCG). In addition, ^{241}Am was detected in one blank sample. Because blank samples should have no detectable radioactivity and the result was close to 2s, the result is questionable and most likely not valid. Details of the low-volume air sampling appear in section 3.1.

Eleven atmospheric moisture samples were obtained during the fourth quarter of 2001; one from Blackfoot, two from Rexburg, and four each from Idaho Falls and Atomic City. All sample results but one, collected from Rexburg in October, exceeded their respective 2s values. All were well below the DCG value of 1×10^{-7} µCi/mL (3.7×10^{-3} Bq/mL) for tritium in air. Details of atmospheric moisture sampling appear in section 3.2.

The ESER Program operates three PM_{10} samplers, one each at Rexburg, Blackfoot, and Atomic City. Sampling of PM_{10} is informational as no analyses are conducted for contaminants. PM_{10} concentrations were well below all health standard levels for all samples. The maximum 24-hour concentration was 77.8 µg/m^3 on November 11, 2001, in Blackfoot. Details of PM_{10} sampling appear in section 3.3.

Sufficient precipitation occurred to allow collection of three monthly composite samples each from Idaho Falls and from the Central Facilities Area (CFA) on the INEEL, and six weekly samples from the Experimental Field Station (EFS) on the INEEL. Tritium was detected in nine samples: two from Idaho Falls, three from CFA, and four from EFS. There is no DCG for tritium

in precipitation, but in drinking water it is 80,000 pCi/L (2,960 Bq/L). The Safe Drinking Water Act sets a limit of 20,000 pCi/L (740 Bq/L) for tritium. The levels of tritium measured in fourth quarter precipitation samples were well below the DCG value and the Safe Drinking Water Act Limit. Details of precipitation sampling appear in section 4.1.

Drinking water samples were collected from tap water from 14 locations throughout southeast Idaho. All were analyzed for gross alpha, gross beta, and tritium. Three drinking water samples had a gross alpha results greater than their associated 2s values. Eleven of the 14 drinking water samples had gross beta results greater than their associated 2s values. The DCG values for gross alpha and gross beta in water are 30 pCi/L and 100pCi/L, respectively. The EPA has set the limits for gross alpha and gross beta in water at 15 pCi/L and 50 pCi/L, respectively. The maximum gross alpha result, in the sample from Monteview, was many times lower than the DCG value and the Safe Drinking Water Act limit. Gross beta concentrations in all fourth quarter drinking water samples were also at least nine times lower than the DCG value and four times lower than the Safe Drinking Water Act limit. Gross alpha and beta concentrations were not higher at locations “down stream” from the INEEL. Tritium analyses showed seven drinking water samples with a result greater than their 2s value. The maximum result from the Idaho Falls sample result was much lower than the DCG value and the Safe Drinking Water Act Limit. Details of drinking water sampling appear in section 4.2.

Surface water samples were collected from five locations along the Snake River in the area where the Snake River Plain Aquifer discharges and from one upstream location in Idaho Falls. Samples were analyzed for the same constituents as drinking water. No sample had detectable concentrations of gross alpha activity. All samples had detectable levels of gross beta activity, which did not exceed the DCG and SDWA limit and were well within the range of past measurements. One sample, collected at Hagerman, had a detectable concentration of tritium, well within results measured in the past. The tritium result was far less than the DCG and SDWA limit for tritium in drinking water. Details of surface water sampling appear in section 4.3.

Milk samples were collected weekly in Idaho Falls and monthly at eight other locations around the INEEL. All samples were analyzed for gamma emitting radionuclides with samples from four locations (Arco, Dietrich, Howe, and Roberts) being analyzed for ^{90}Sr. Iodine-131 was detected in two samples, one from Roberts and one from Idaho Falls. However, reanalysis of these samples indicated no detectable levels of ^{131}I. Three samples had ^{137}Cs concentrations greater than their 2s uncertainty. Of the four samples analyzed for ^{90}Sr only the Arco sample did not yield concentrations greater than their associated 2s value. There are no established limits for ^{137}Cs or ^{90}Sr in milk but, for comparison, the EPA has set the limit for ^{137}Cs in drinking water at 12 pCi/L and at 8pCi/L for ^{90}Sr. The Safe Drinking Water limit is based on a 4 mrem per year maximum allowable dose and the assumption that two liters per day are consumed. The maximum ^{137}Cs concentration measured in milk during the fourth quarter, 2001 was many times lower than the 12 pCi/L limit and the maximum ^{90}Sr concentration was below the 8 pCi/L limit. Details of milk sampling appear in section 5.1.

Three large game animals were sampled during the fourth quarter of 2001. All were killed as a result of vehicular collisions. These accidents all involved mule deer (*Odocoileus hemionus*). Thyroid, liver, and muscle tissue were collected from each animal. None of the samples contained measurable radionuclides above the 2s uncertainty or the MDC. Details of large game animal sampling appear in section 5.2.

Potatoes were collected from various growers in southeast Idaho as well as from locations around the United States. All samples were analyzed for gamma emitting radionuclides and ^{90}Sr. No sample collected during the fourth quarter contained levels of ^{90}Sr or ^{137}Cs above the 2s level. Details of potato sampling appear in section 5.3.

Fourteen waterfowl were collected during 2001: three each from the Idaho Nuclear Technology and Engineering Center (INTEC) percolation ponds and Market Lake and four each from the Argonne National Laboratory-West (ANL-W) and Test Reactor Area (TRA) ponds. All were analyzed for gamma emitting radionuclides with a subset analyzed for ^{90}Sr, plutonium-238 (^{238}Pu), plutonium-239/240 ($^{239/240}$Pu), and americium-241 (^{241}Am). Seven ducks had detectable levels of at least one radionuclide in edible tissue. The highest concentrations were in the TRA samples. Duck hunting is not allowed on the INEEL but a maximum potential exposure scenario to humans would be someone collecting a duck directly from the TRA radioactive waste ponds and immediately consuming all muscle, liver, heart, and gizzard tissue. The estimated dose, 0.08 mrem, is far less than the dose limit of 100 mrem. Details of duck sampling appear in section 5.4.

The ESER and its predecessors have placed an array of thermoluminescent dosimeters (TLDs) throughout the Eastern Snake River Plain to measure the amount of radiation in the environment. The results of the November sampling (the period of measurement being May 2001 through November 2001) show the average exposure rate for locations in the Boundary group to range from a low of 0.32 mR/day at Birch Creek to a high of 0.40 mR/day at Mud Lake. The overall average was 0.35 mR/day. The Distant set had a high of 0.43 mR/day at Rexburg and a low of 0.33 mR/day at the new station in Jackson Wyoming. The overall average Distant value was 0.36 mR/day. There was no statistical difference between Boundary and Distant locations. Details of environmental radiation measurements appear in section 6.

Overall, the only radionuclides measured that could be attributed to the INEEL were ^{60}Co and ^{137}Cs in some of the ducks and doves collected directly from contaminated waste ponds on the INEEL. No radionuclides in any other samples taken during the fourth quarter, 2001, could be directly linked with INEEL activities. Levels of detected radionuclides were below regulatory limits and not different from values measured at other locations across the United States. Concentrations of ^{60}Co and ^{137}Cs in ducks from TRA were higher than in samples taken from offsite locations, still, all concentrations were much lower than regulatory dose limits. Concentrations in all of the samples collected and analyzed during the fourth quarter, 2001 were below guidelines set by both the DOE and the U.S. Environmental Protection Agency (EPA) for protection of the public.

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LIST OF ABBREVIATIONS

AEC	Atomic Energy Commission
ANL-W	Argonne National Laboratory-West
CFA	Central Facilities Area
CMS	community monitoring station
DCG	Derived Concentration Guide
DOE	Department of Energy
DOE – ID	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
INEL	Idaho National Engineering Laboratory
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
ISU	Idaho State University
MDC	minimum detectable concentration
M&O	Management and Operating
NRTS	National Reactor Testing Station
PM	particulate matter
PM_{10}	particulate matter less than 10 micrometers in diameter
SI	Systeme International d'Unites
TLDs	thermoluminescent dosimeters
TRA	Test Reactor Area
UI	University of Idaho
WSU	Washington State University

LIST OF UNITS

Bq	becquerel
Ci	curie
g	gram
L	liter
µCi	microcurie
mL	milliliter
mR	milliroentgens
mrem	millirem (rem = unit of dose equivalent [roentgen-equivalent-man])
mSv	millisieverts
pCi	picocurie
R	Roentgen
µSv	microseiverts

1. ESER PROGRAM DESCRIPTION

Operations at the Idaho National Engineering and Environmental Laboratory (INEEL) are conducted under requirements imposed by the U.S. Department of Energy (DOE) under authority of the Atomic Energy Act, and the U.S. Environmental Protection Agency (EPA) under a number of acts (e.g. the Clean Air Act and Clean Water Act). The requirements imposed by DOE are specified in 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 Operating (M&O) contractor, while monitoring outside the INEEL boundaries was conducted under the Environmental Surveillance, Education, and Research (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 monitoring results from the ESER Program for samples collected during the fourth quarter of 2001 (October1 – December 31, 2001).

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 potential pathways, including air, water, agricultural products and wildlife, and soil, that could potentially contribute to the dose received by the public.

Air samples are taken at 16 locations on and around the INEEL; surface water at 5 locations on the Snake River; drinking water at 14 locations around the INEEL; agricultural and wildlife products, which includes milk at 10 dairies around the INEEL, potatoes from at least 5 local producers, wheat from approximately 10 local producers, lettuce from approximately 9 home-owned gardens around the INEEL, soil from 13 locations biennially, sheep from 2 operators which graze their sheep on the INEEL, environmental dosimeters from 15 locations semi-annually, and various numbers of wildlife including big game (pronghorn, mule deer, and elk), waterfowl, doves, and marmots sampled on and near the INEEL. Fish are also sampled as available (i.e., when there is flow in the Big Lost River). 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. Analyses requiring radiochemistry, including ^{90}Sr, ^{238}Pu, $^{239/240}Pu$, and ^{241}Am were performed by Severn-Trent, Inc. 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. It is owned and administered by the U.S. Department of Energy, Idaho Operations Office (DOE-ID) and 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 warships. 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 develop nuclear power, the Atomic Energy Commission (AEC), predecessor to the DOE, became interested in the Naval Proving Ground and made 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 (INEL) in 1974 and the INEEL in January 1997. Activities at the INEEL center on environmental cleanup and research and development.

3. AIR SAMPLING

The primary pathway by which radionuclides can move off-site is through the air and is thus the primary focus of monitoring on and around the INEEL. Particulates and iodine-131 (^{131}I) in air are measured weekly at 16 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 EPA size-targeted particulates in air are measured using samplers that collect particulates less than 10 microns (PM_{10}) at three locations. Air sampling activities and results for the fourth quarter, 2001 are discussed below.

3.1 Low-Volume Air Sampling

Radioactivity associated with airborne particulates was monitored continuously by 18 ESER Program air samplers at 16 locations during the fourth quarter of 2001 (Figure 1). Three of these samplers were located on the INEEL, nine were located off the INEEL near the boundary, and six were at locations distant to the INEEL. Samplers are divided into INEEL, Boundary, and Distant groups to determine if there is a gradient of radionuclide concentrations, increasing towards the INEEL. One replicate sampler was placed at an Arco (Boundary location) and one at Howe (Boundary location) during 2001. An average of 13,168 ft^3 (373 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.

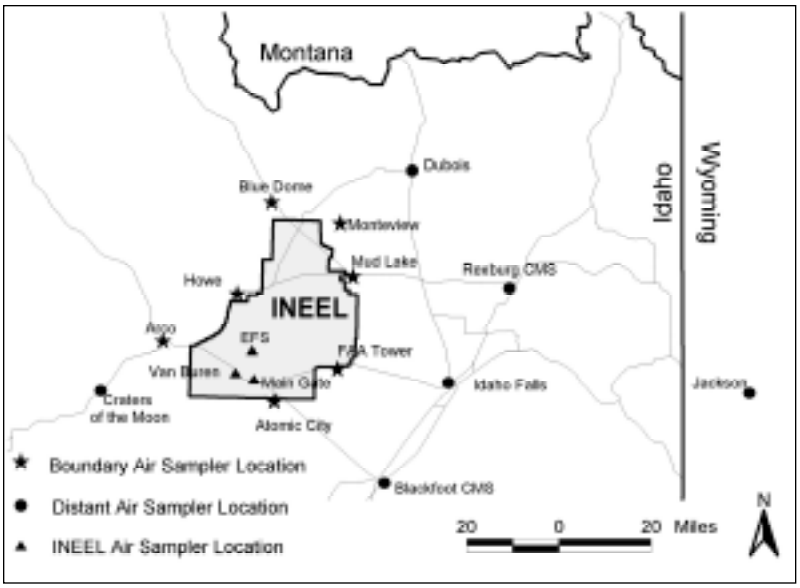


FIGURE 1. Low-volume air sampler locations.

Filters and charcoal cartridges were changed weekly at each station during the quarter. 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 thorium to decay. See the *Gross versus Specific Analyses* portion of the *Helpful Information* section of this report for more information concerning gross alpha and beta radioactivity. 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, is readily accumulated in human and animal thyroids, and has a half-life of eight days. This means any ^{131}I that is detected would be from a recent release of fission products. Finally, the 13 weekly filters for each location collected during the quarter are composited and analyzed for gamma-emitting radionuclides. Composites are also analyzed by location for strontium-90 (^{90}Sr), or plutonium-238 (^{238}Pu), plutonium-239/240 ($^{239/240}$Pu), and americium-241 (^{241}Am) as determined by a schedule that rotates quarterly.

Weekly gross alpha concentrations in air for INEEL, Boundary, and Distant locations are shown in Figure 2. The data were tested for normality prior to statistical analyses and were not found to be normally or lognormally distributed. Box and whiskers plots are commonly used when there is no assumed distribution. Each data group is presented as a box and whiskers plot, with a median, a box representing 25th and 75th percentiles, and whiskers representing the minimum and maximum values. Note that outliers and extreme values are plotted separately from the box and whiskers. Outliers and extreme values are atypical, infrequent observations; data points which are far from the middle of the distribution of data. Outliers are defined mathematically as values that are equal to 1.5 times the height of the box, above or below the box. Extreme values are equal to 2 times the height of the box, above or below the box. Outliers and extreme values may reflect inherent variability, or may be due to errors associated with transcription or measurement or other anomalies. A careful review of the data indicates that the outliers and extreme values were not due to mistakes in collection, analysis, or reporting procedures, but rather reflect natural variability in the measurements. The outliers and extreme values lie within the range of measurements made within the past five years. Thus, rather than dismissing the outliers, they were included in the subsequent statistical analyses. Further discussion of box plots may be found in the *Determining Statistical Differences* portion of the *Helpful Information.*

The graphs in Figure 2 visually show that the gross alpha measurements made at INEEL, Boundary, and Distant locations are similar and tend to demonstrate comparable patterns over time (i.e., increases or decreases in one set of data are tracked by increases or decreases in the other two sets of data). There do not appear to be any differences in the data sets. This hypothesis was tested statistically.

If the INEEL were a significant source of offsite contamination, concentrations of contaminants would be statistically greater at Boundary locations than at Distant locations. Because the data were determined not to be normally or lognormally distributed, nonparametric (distribution-free) tests of significance were used to compare data collected at Boundary with data collected at Distant locations. The use of nonparametric tests gives less weight to outliers and extreme values thus allowing a more appropriate comparison of data groups. The Mann-Whitney U test was used to compare the Boundary and Distant data because it is the most powerful nonparametric alternative to the t test for independent samples. INEEL sample results were not included in this analysis because the onsite data would not aid in determining offsite impacts. The INEEL air monitoring stations were established in the past primarily to assess concentrations in the predominant wind directions downwind from the Idaho Nuclear Technology and Engineering Center (INTEC) facility. At that time the INTEC facility was the primary source of radionuclide releases at the INEEL. This is no longer the case, since radionuclide releases are now more evenly distributed between the major facilities. As such, the three onsite locations do not adequately represent the near field impact of facility releases.

The comparisons between Boundary and Distant locations were made on a weekly basis. The gross alpha concentrations measured at Boundary locations were not statistically greater

than those measured at Distant locations in any of the thirteen weeks of data evaluated using the Mann-Whitney U test. See the *Determining Statistical Differences* portion of the *Helpful Information* for more detail on the statistical tests used.

Weekly median gross beta concentrations in air for INEEL, Boundary, and Distant locations are shown in Figure 3. Box and whiskers plots were used because the data are not normally or lognormally distributed. Outliers and extreme values were retained in subsequent statistical analyses because they are within the range of measurements made in the past five years, and because these values could not be attributed to mistakes in collection, analysis, or reporting procedures. As in the case of alpha activity, the data for each group appear to be similar and to track each other over time. Comparison of weekly Boundary and Distant data sets, using the Mann Whitney U test, indicates no differences between the two location groups. The INEEL data were not included in the analysis for the reasons discussed previously.

Monthly median gross alpha and beta concentrations in air at each sampling location are shown in Figures 4 – 9. The graphs show similar results between locations and over time.

A summary of approximate minimum detectable concentrations (MDCs) for radiological analyses and DOE Derived Concentration Guide (DCG) values is provided in Appendix B, while gross alpha and beta results for individual filters are listed in Table C-1 of Appendix C.

Initial laboratory analysis of one batch containing ten charcoal cartridges collected on 12/5/01 detected ^{131}I greater than the associated 2s and MDC values. Immediate reanalysis of each individual cartridge yielded results below both the MDC and 2s values. Because initial counting is done as a batch sample it appears that the cumulative activity for these ten cartridges was above the 2s/MDC value, but was not attributable to any single location (cartridge). Weekly ^{131}I results for each location, including individual recount data, are listed in Table C-2 of Appendix C.

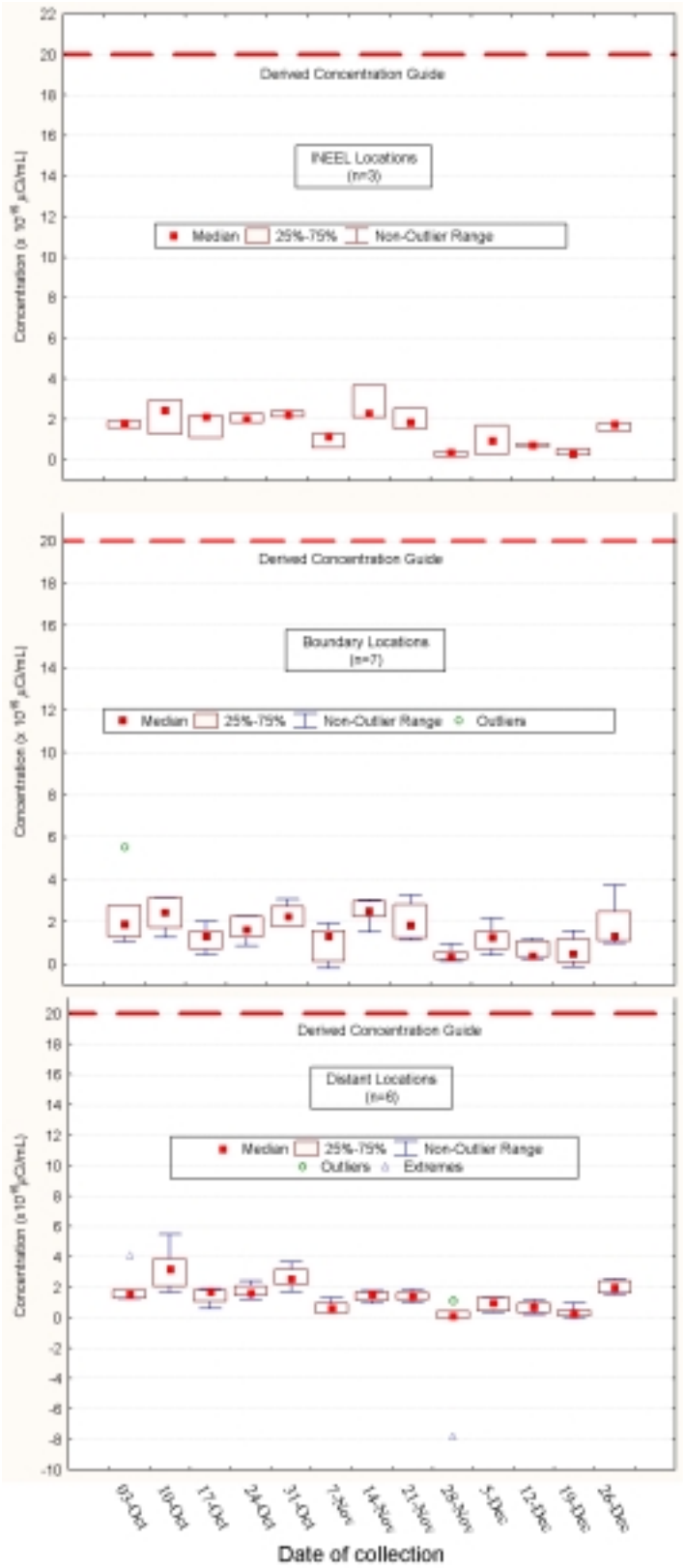


FIGURE 2. Weekly median gross alpha concentrations in air at ESER Program INEEL, Boundary, and Distant locations.

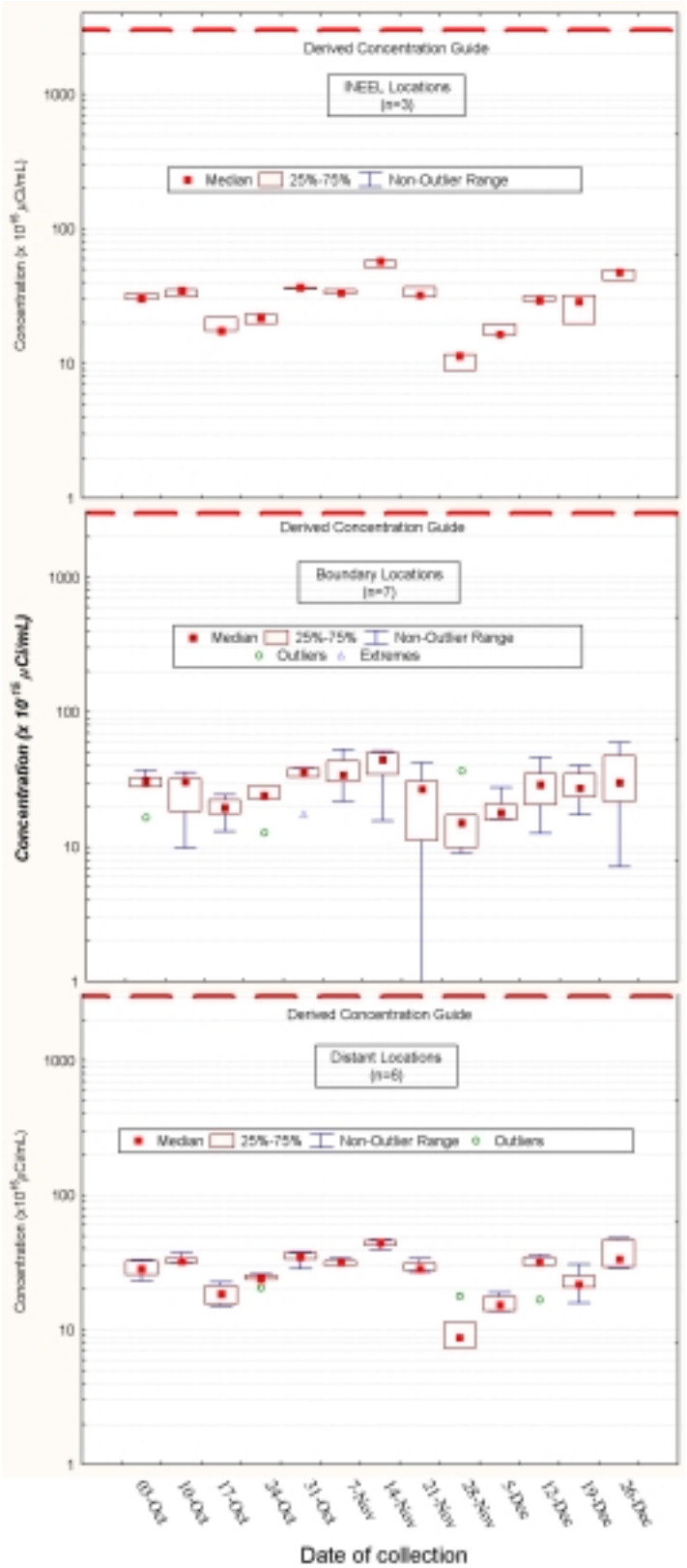


FIGURE 3. Weekly median gross beta concentrations in air at ESER Program INEEL, Boundary, and Distant locations.

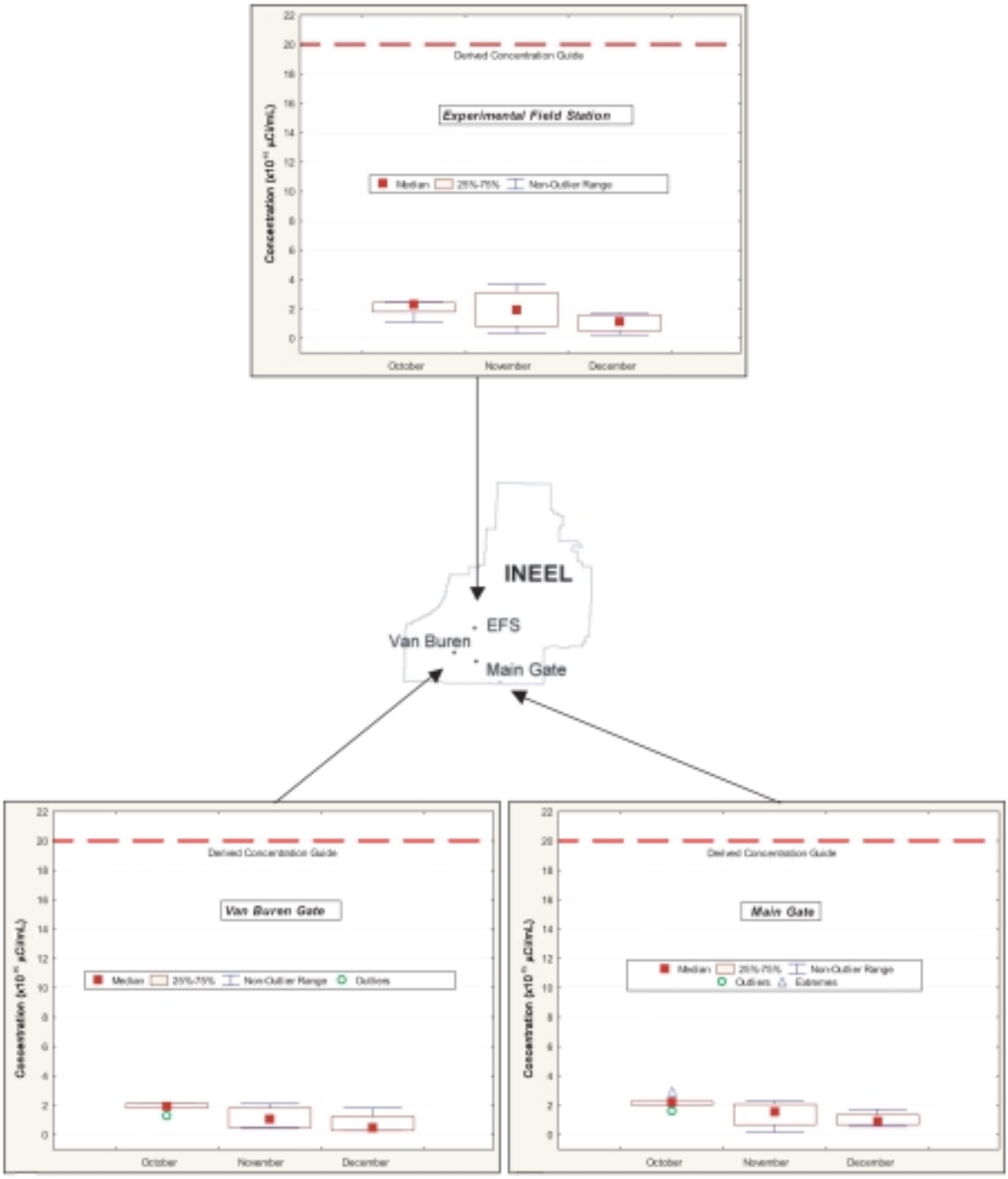


FIGURE 4. Monthly median gross alpha concentrations in air at INEEL locations.

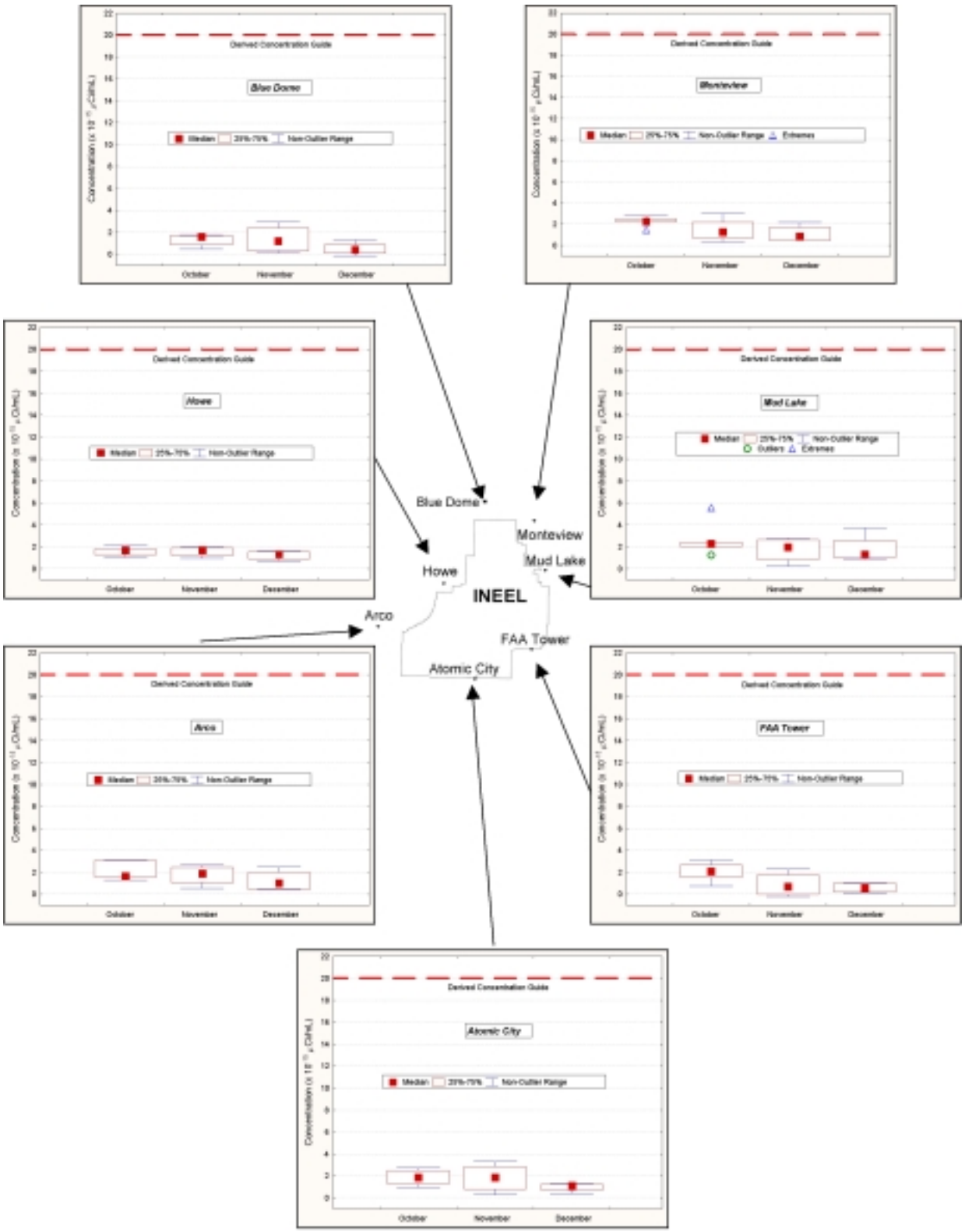


FIGURE 5. Monthly median gross alpha concentrations in air at Boundary locations.

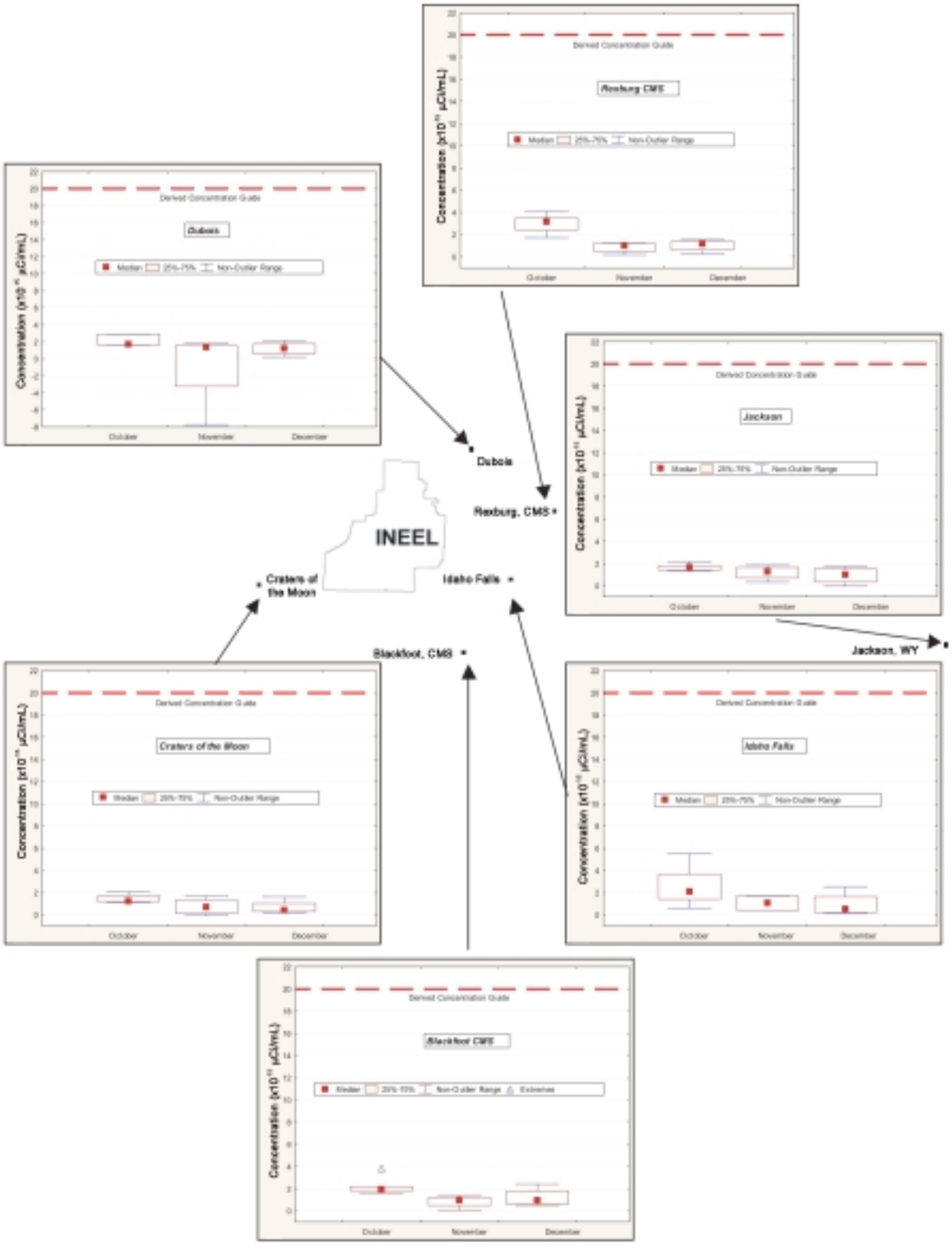


FIGURE 6. Monthly median gross alpha concentrations in air at Distant locations.

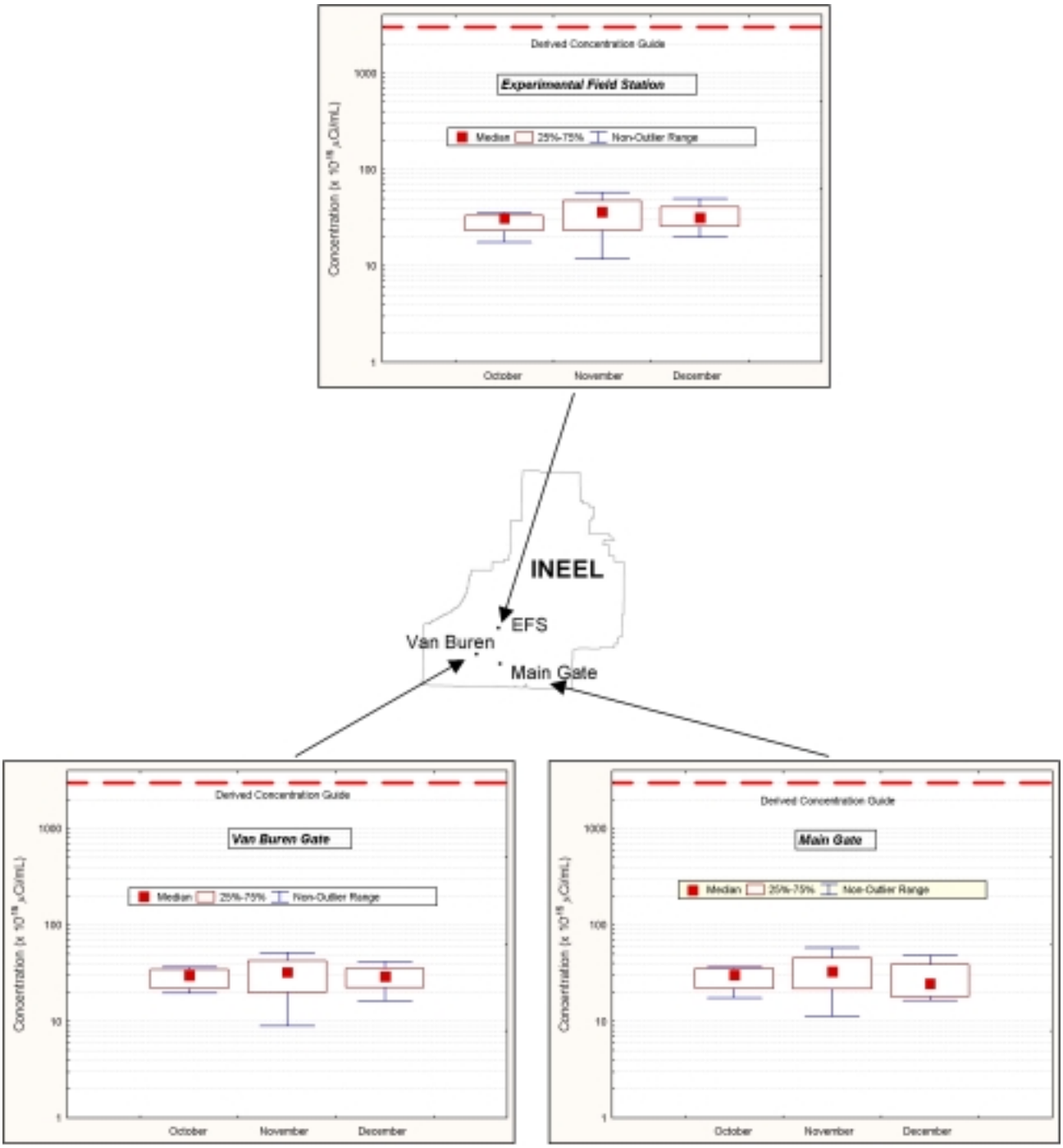


FIGURE 7. Monthly median gross beta concentrations in air at INEEL locations.

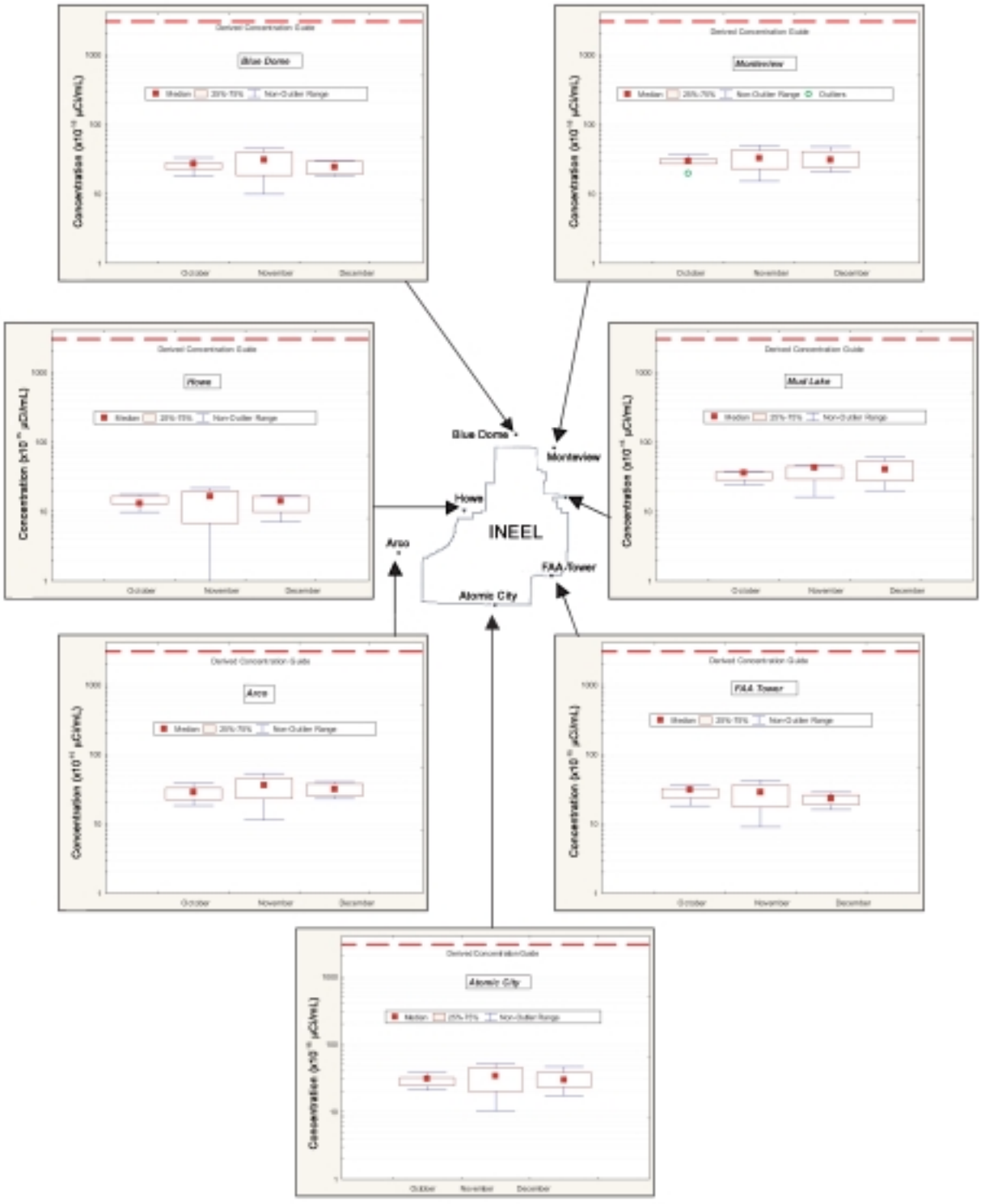


FIGURE 8. Monthly median gross beta concentrations in air at Boundary locations.

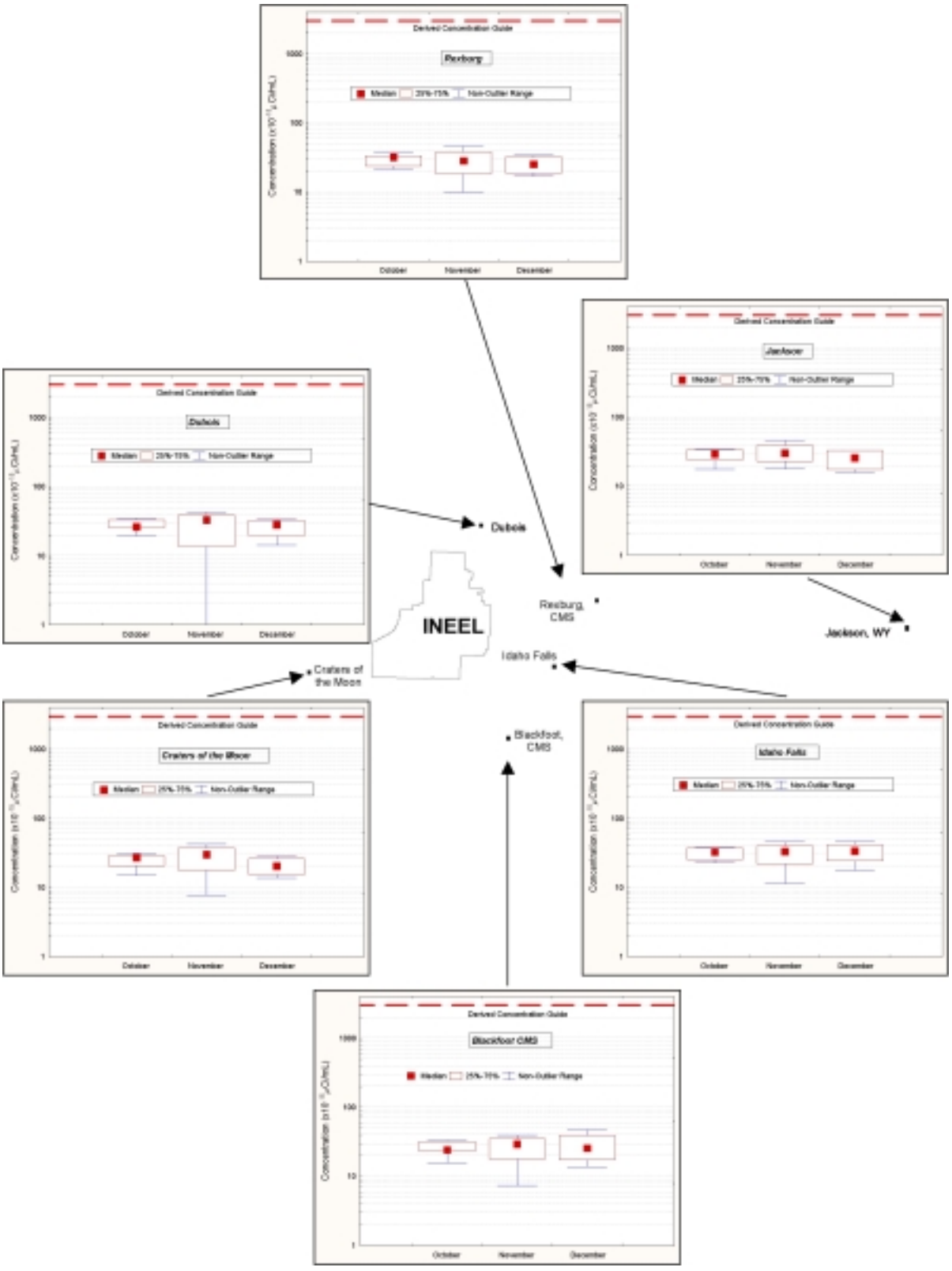


FIGURE 9. Monthly median gross beta concentrations in air at Distant locations.

Weekly filters for the fourth quarter of 2001 were composited by location. All samples were analyzed for gamma-emitting radionuclides, including ^{137}Cs. Composites were also analyzed for ^{90}Sr, ^{238}Pu, $^{239/240}$Pu, and ^{241}Am. Five samples collected from air monitoring stations (Arco, Blackfoot CMS, Blue Dome, Howe Q/A-2, and Van Buren) showed at least one human-made radionuclide greater than its related 2s value (Figure 10). All results were far less than their respective DCGs. In addition, ^{241}Am was detected in one blank sample. Because blank samples should have no detectable radioactivity and the result was between 2-3s, the result is questionable and most likely not valid. All results for composite filter samples are shown in Table C-3, Appendix C.

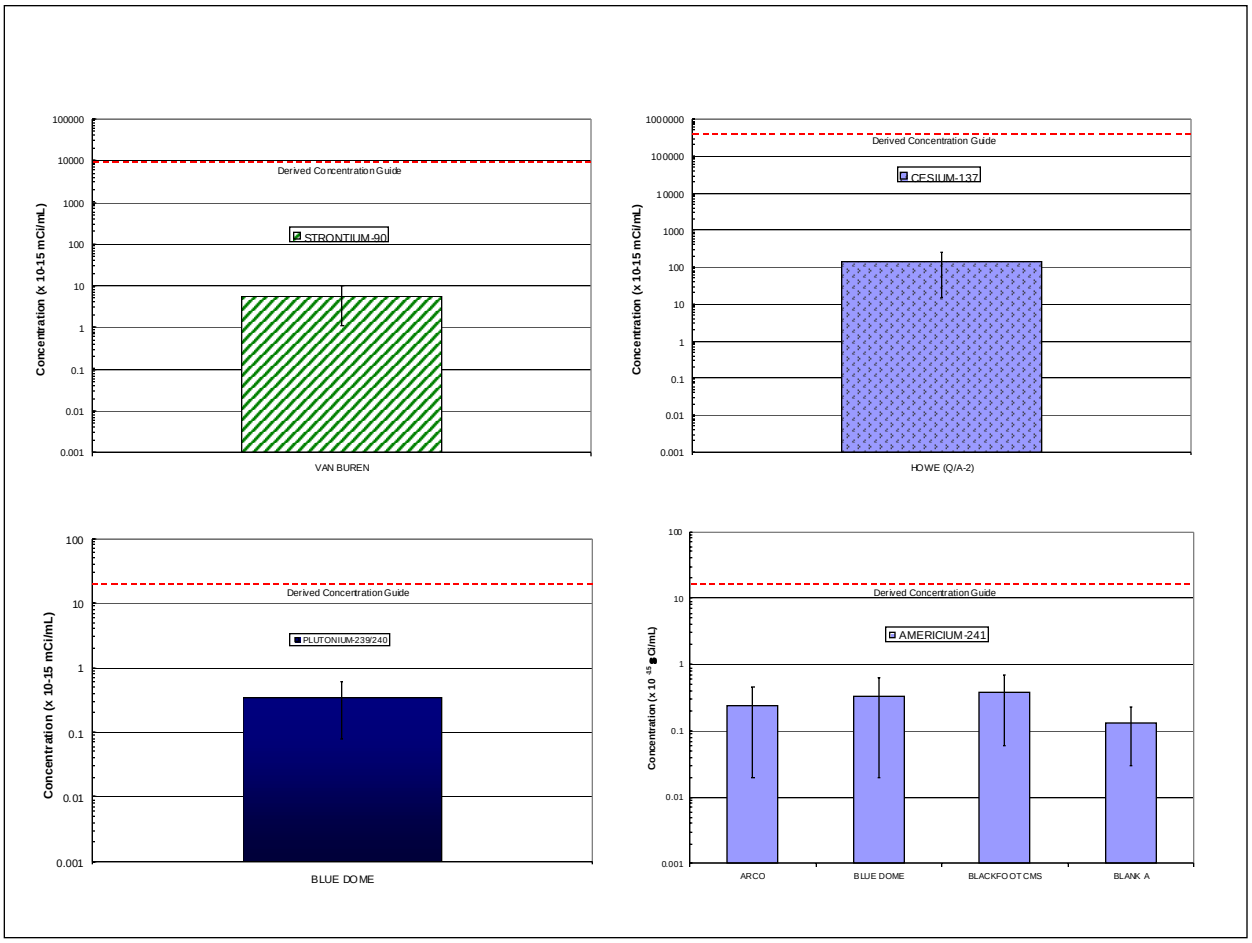


FIGURE 10. Specific radionuclides detected in quarterly composite air filters (by locations). Error bars (± 2 standard deviations) encompass each measurement.

3.2 Atmospheric Moisture Sampling

Eleven atmospheric moisture samples were obtained during the fourth quarter of 2001; one from Blackfoot, two from Rexburg, and four each from Idaho Falls and Atomic City. Atmospheric moisture is collected by pulling air through a column of silica gel to absorb water vapor. The water is then extracted from the silica gel by heat distillation. The resulting atmospheric moisture samples are then analyzed for tritium using liquid scintillation.

All sample results but one, collected from Rexburg in October, exceeded their respective 2s values. All were well below the Derived Concentration Guide (DCG) value of 1×10^{-7} µCi/mL (3.7×10^{-3} Bq/mL) for tritium in air. Tritium results for all atmospheric moisture samples are listed in Appendix C, Table C-4.

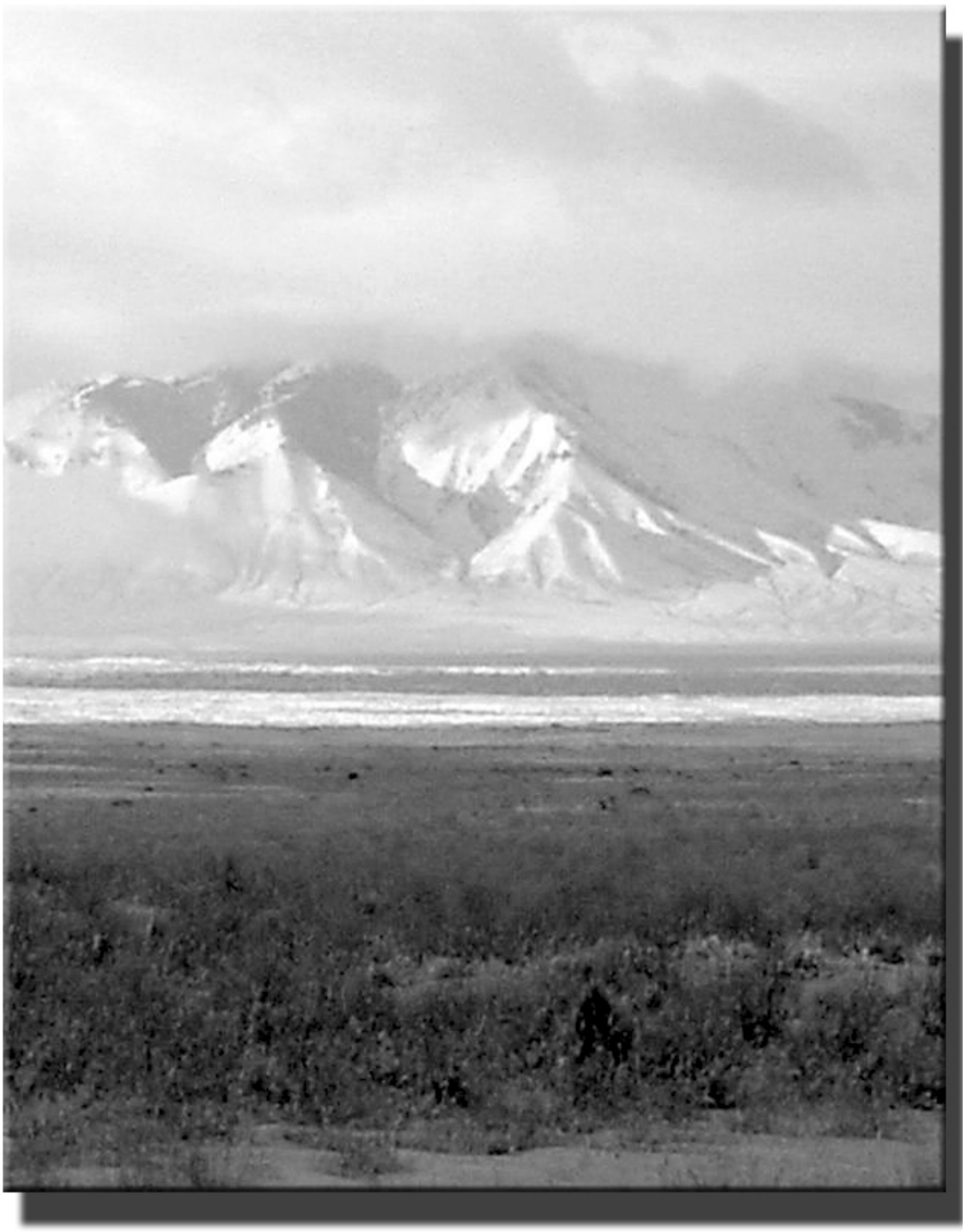
3.3 PM_{10} Air Sampling

The EPA began using a standard for concentrations of airborne particulate matter (PM) less than 10 micrometers in diameter in 1987 (40 CFR 50.6). Particles of this size can reach deeply into the lungs and are considered to be responsible for most of the adverse health effects associated with airborne particulate pollution. The air quality standards for fine particulates, generally referred to as PM_{10}, are an annual average of 50 µg/m^3, with a maximum 24-hour concentration of 150 µg/m^3.

The ESER Program operates three PM_{10} samplers, one each at the Community Monitoring Stations (CMS) in Rexburg and Blackfoot, and one in Atomic City. Sampling of PM_{10} is informational as no analyses are conducted for contaminants. Twenty-four hour sampling periods were scheduled to run once every six days. Equipment problems nullified the samples for October 9 in Atomic City and for October 3 and 27, and December 8 from Rexburg. A power failure nullified the December 2 sample from Blackfoot. A total of 14 samples each were collected from Blackfoot and Atomic City with a total of 12 collected from Rexburg. PM_{10} concentrations were well below all health standard levels for all samples. The maximum 24-hour concentration was 77.8 µg/m^3 on November 8, 2001, in Blackfoot. The average, maximum, and minimum results of the 24-hour samples are shown are shown in Table 1. Results for all PM_{10} samples are listed in Table C-5, Appendix C.

TABLE 1. Summary of 24-hour PM_{10} values (µg/m^3).

	Average	Maximum	Minimum
Atomic City	10.6	33.7	3.8
Blackfoot CMS	21.3	77.8	9.7
Rexburg CMS	18.8	56.2	9.7



4. WATER SAMPLING

The ESER program samples precipitation, surface water, and drinking water. Monthly composite precipitation samples are collected from Idaho Falls and the Central Facilities Area (CFA) on the INEEL. Weekly precipitation samples are collected from the Experimental Field Station (EFS) on the INEEL. Surface and/or drinking water are sampled twice each year at 19 locations around the INEEL. This occurs during the second and fourth quarters.

4.1 Precipitation Sampling

When adequate precipitation occurred, samples were taken of a monthly composite from Idaho Falls and CFA, and weekly from the EFS. A minimum sample volume of approximately 20 mL is needed for a single sample. Precipitation samples are analyzed for tritium. For the fourth quarter of 2001, there was enough precipitation for a total of twelve samples – three from Idaho Falls, three from CFA, and six from the EFS.

Tritium was detected in nine samples: two from Idaho Falls in November and December; three from CFA in October, November, and December; and four from the EFS in October, November, and December. While there is no regulatory limit for tritium in precipitation, the DOE DCG and maximum contaminant level set by EPA for tritium in drinking water can be used as a measure. The highest tritium concentration, 269.5 ± 65.8 pCi/L (10.0 ± 2.4 Bq/L), was measured in a sample collected from the EFS on October 31. This value is many times lower than the DCG value and the Safe Drinking Water Act Limit for tritium in drinking water.

Due to cosmic ray reactions in the upper atmosphere, low levels of tritium exist in the environment at all times. Tritium measured in fourth quarter ESER samples were within the range of values measured elsewhere. The EPA's ERAMS program collects precipitation samples from across the United States. From 1978 to 2001 tritium measured in those samples ranged from -2.00 to 7.38×10^6 pCi/L (-7.4 to 2.7×10^6 Bq/L) (EPA 2002). Data for all precipitation samples collected by the ESER Program, fourth quarter, 2001, are listed in Table C-6 (Appendix C).

4.2 Drinking Water Sampling

A drinking water sample was collected from tap water at each of fourteen locations throughout southeast Idaho. One duplicate drinking water sample was also collected from the Minidoka sampling location. All samples were analyzed for gross alpha, gross beta, and tritium (^{3}H).

Three drinking water samples had gross alpha results greater than their respective 2s values. Eleven of 14 drinking water samples had gross beta results greater than their associated 2s values. The DCG values for gross alpha and gross beta in water are 30 and 100 pCi/L, respectively. The EPA limits for gross alpha and gross beta in water are 15 and 50 pCi/L, respectively (Safe Drinking Water Act, 40 CFR 141). The maximum gross alpha concentration in the drinking water, from Monteview, was 1.9 ± 1.5 pCi/L (0.07 ± 0.06 Bq/L) and was lower than the DCG value and the EPA limit. The maximum gross beta concentration of 11.1 ± 2.5 pCi/L (0.4 ± 0.09 Bq/L), measured at Monteview, was also lower than the DCG value and the Safe Drinking Water Act limit. Gross alpha and beta concentrations measured in fourth quarter drinking water samples were within the range of values observed in the past.

Gross alpha and beta activity is a function of amount of alpha and beta emitting radionuclides present in the sample. The majority of gross alpha and beta activity in water is primarily from naturally occurring uranium, thorium, radium, and their decay products. Gross alpha and beta concentrations were not higher at locations "down stream" from the INEEL, indicating no INEEL contributions to gross alpha or beta concentrations measured in drinking water.

Tritium analyses showed seven drinking water samples with tritium results greater than their associated 2s values. The highest value of 144.3 ± 64.6 pCi/L (5.3 ± 2.4 Bq/L) was measured in a sample collected at Shoshone. The DCG value for tritium in drinking water is 80,000 pCi/L (2,960 Bq/L). The Safe Drinking Water Act sets a limit of 20,000 pCi/L (740 Bq/L) for tritium. The level of tritium measured in the sample from Shoshone was many times lower than the DCG value and the Safe Drinking Water Act limit. The EPA's ERAMS program collects drinking water samples from across the United States. From October 1996 through September 1997 tritium measured in 304 samples ranged from -83 to 560 pCi/L (-3.1 to 20.7 Bq/L) (EPA 1996, EPA 1997a, EPA 1997b, EPA 1997c). Table C-7 of Appendix C lists all drinking water sample results.

4.3 Surface Water Sampling

Surface water samples, and a duplicate, were collected from five locations along the Snake River in the area where the Snake River Plain Aquifer discharges. One sample was collected from an upstream location at Idaho Falls. Samples were analyzed for the same constituents as drinking water.

Gross alpha activity was not detected in any of the surface water samples. All surface water samples had detectable levels of gross beta activity. One of the surface water samples collected at Hagerman exceeded the 2s value for tritium. The maximum result for gross beta of 8.1 ± 2.1 pCi/L, or 0.3 ± 0.08 Bq/L) is less than the DCG and the SDWA limit. Levels of gross beta activity in all samples are within the range of results observed from recent years. The presence of gross alpha and gross beta in surface water (particularly the springs) is related to dissolution of naturally occurring radionuclides (i.e., uranium and radium) by groundwater as it flows through the surrounding basalts. The tritium result [73.4 ± 64.5 pCi/L (2.7 ± 2.4 Bq/L)] is far less than the DCG and the SDWA limit for tritium in drinking water and well within results measured in the past. Surface water results were similar to drinking water results. Table C-7 of Appendix C lists all data for the surface water samples.

5. AGRICULTURAL PRODUCTS AND WILDLIFE SAMPLING

Another potential pathway for contaminants to reach humans is through the food chain. The ESER Program samples multiple agricultural products and game animals around the INEEL and Southeast Idaho. Specifically, milk, wheat, potatoes, garden lettuce, sheep, big game, waterfowl, and marmots 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. See Table A-1, Appendix A, for more details on agricultural product and wildlife sampling. This section discusses results from milk, large game, potatoes, and waterfowl.

5.1 Milk Sampling

Milk samples were collected weekly in Idaho Falls and monthly at eight other locations around the INEEL (Figure 11) during the fourth quarter of 2001. All samples were analyzed for gamma emitting radionuclides. Samples from four locations (Arco, Howe, Dietrich, and Roberts) were analyzed for ^{90}Sr.

Iodine-131 was detected in two samples, from Roberts and Idaho Falls. Three samples (Idaho Falls, and Rupert in November; and Blackfoot in December) had a ^{137}Cs concentration greater than their 2s uncertainty (Figure 12). Of the four samples analyzed for ^{90}Sr all had concentrations greater than their associated 2s value. Data for ^{131}I and ^{137}Cs in milk samples are listed in Table C-8. Data for ^{90}Sr in milk samples are listed in Table C-9, both in Appendix C.

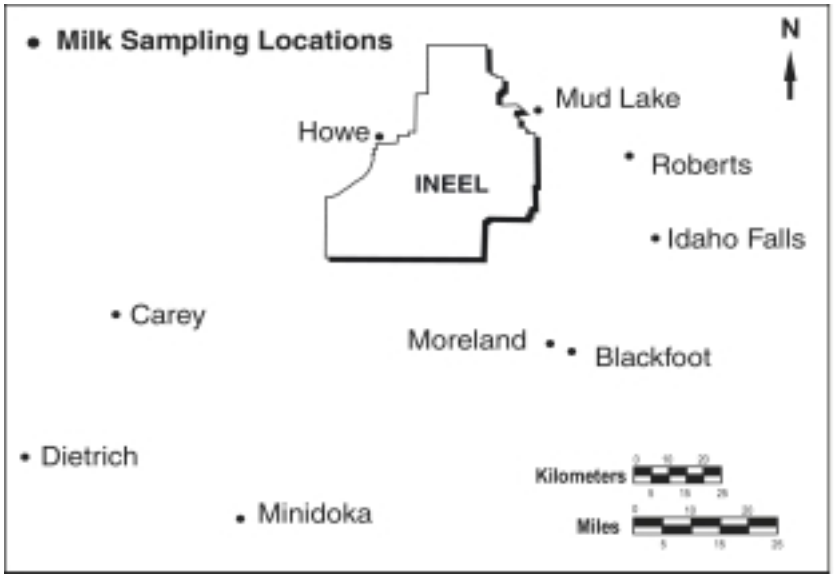


FIGURE 11. ESER Program milk sampling locations.

The two samples with ^{131}I initially detected in them were reanalyzed. The reanalysis yielded results that were less than their associated 2s values. All detections of ^{137}Cs in milk around the INEEL were at very low concentrations and indistinguishable from levels expected from ^{137}Cs released from historical fallout events (e.g. from nuclear weapons tests and Chernobyl) (EPA 1997). There are no established limits for ^{137}Cs in milk but, for comparison, the EPA has set the limit for ^{137}Cs in drinking water at 120 pCi/L. This Safe Drinking Water limit is based on a 4 mrem per year limit and the assumption that two liters per day are consumed. The maximum concentration (2.9 ± 2.6 pCi/L) measured in milk during the fourth quarter, 2001 is many times lower than the 120 pCi/L limit. Data for ^{131}I and ^{137}Cs in all ESER milk samples taken during the fourth quarter, 2001, are listed in Table C-8 (Appendix C).

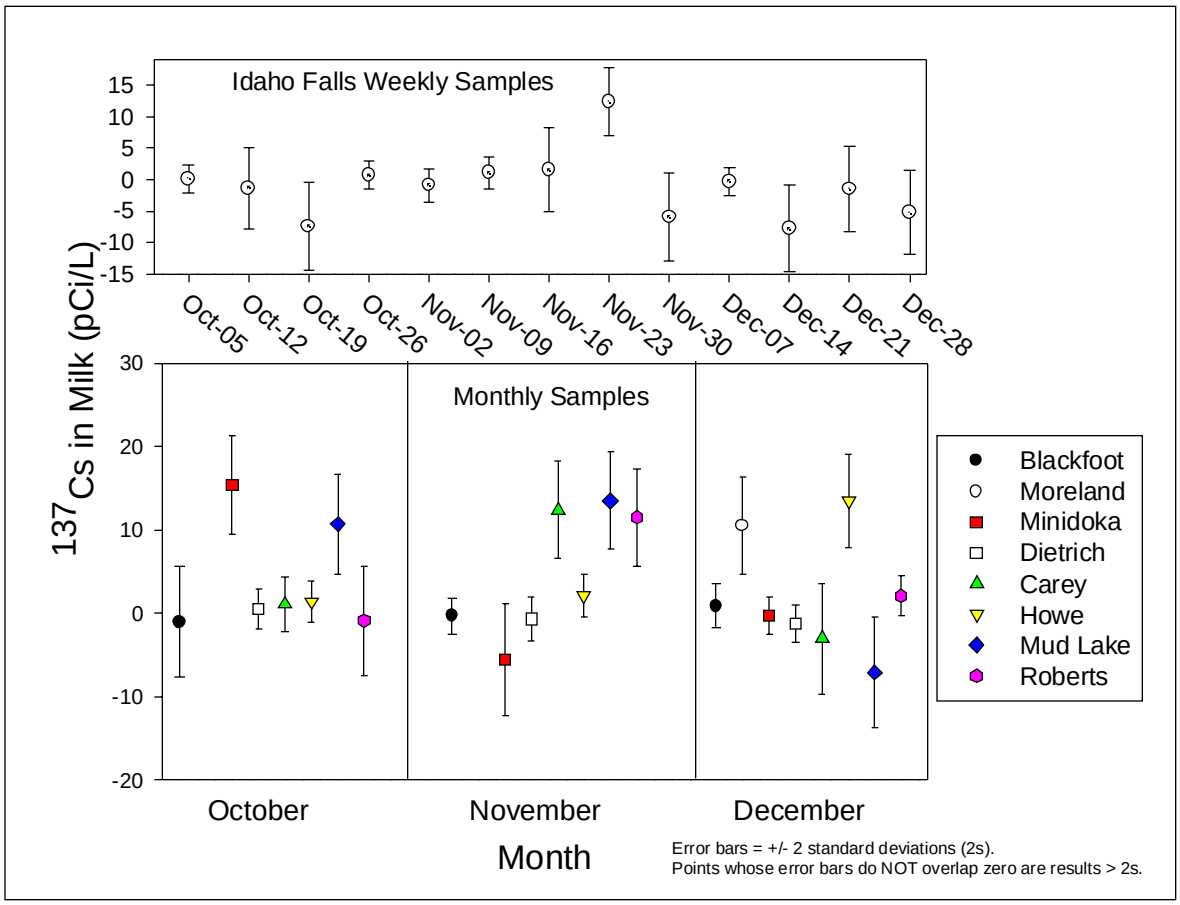


FIGURE 12. Cesium-137 concentrations in milk sampled during the fourth quarter, 2001. There are no regulatory limits on ^{137}Cs in milk but, for comparison, the EPA has set the limit for ^{137}Cs in drinking water at 120 pCi/L (based on a 4 mrem/yr limit and assumed 2 L/d consumption).

Chemically, ^{90}Sr acts similar to calcium. Therefore, it is expected that, if ^{90}Sr were present, it would be found in substances with high calcium content such as milk. The EPA's ERAM program samples milk from approximately 55 sites across the United States. These data showed ^{90}Sr results in milk to be greater than the 2s level in about 63% of samples with a range of –0.15 to 2.12 pCi/L (-0.006 to 0.078 Bq/L) (EPA, 1997). While ^{90}Sr levels in the three samples analyzed for ^{90}Sr were greater than their associated 2s values, all results were within the range measured across the United States. All ^{90}Sr detected in fourth quarter ESER milk samples were at very low concentrations and indistinguishable from levels expected from ^{90}Sr released from historical fallout events (e.g. from nuclear weapons tests and Chernobyl) (EPA 1997). There are no established limits for ^{90}Sr in milk but, for comparison, the EPA has set the limit for ^{90}Sr in drinking water at 8 pCi/L. This Safe Drinking Water limit is based on a 4 mrem per year limit and the assumption that two liters per day are consumed. The maximum concentration [1.2 ± 0.7 pCi/L (0.05 ± 0.03 Bq/L)] measured in milk during the fourth quarter, 2001 is lower than the 8 pCi/L limit. Data for ^{90}Sr in fourth quarter milk samples are listed in Table C-9 (Appendix C).

5.2 Large Game Animal Sampling

Three game animals were sampled during the fourth quarter of 2001. All were killed as a result of vehicular collisions. These accidents all involved mule deer (*Odocoileus hemionus*). Thyroid, liver, and muscle tissue were collected from each animal. Each sample collected was analyzed for gamma emitting radionuclides. Liver and/or muscle tissue of all animals had detectable concentrations of naturally occurring ^{40}K. Cesium-137 and ^{131}I were not detected in any sample. Data for all big game samples are listed in Appendix C, Table C-10.

5.3 Potato Sampling

Potatoes were collected from various growers in southeast Idaho as well as from locations around the United States (Figure 13). All samples were analyzed for gamma emitting radionuclides and ^{90}Sr.

No potato sample collected during the fourth quarter contained levels of ^{90}Sr or ^{137}Cs above its respective 2s level. Naturally occurring ^{40}K was detected in all samples. All data for ^{137}Cs in potato samples are shown in Table C-11 of Appendix C. All data for ^{90}Sr in potato samples are shown in Table C-12.

FIGURE 13. Potato sampling locations.

5.4 Waterfowl Sampling

Fourteen waterfowl were collected during 2001: three each from the INTEC percolation ponds and Market Lake and four each from the Argonne National Laboratory-West (ANL-W) and Test Reactor Area (TRA) ponds. All were analyzed for gamma emitting radionuclides with a subset analyzed for ^{90}Sr, plutonium-238 (^{238}Pu), plutonium-239/240 ($^{239/240}$Pu), and americium-241 (^{241}Am). Concentrations of radionuclides detected in edible tissues are shown in Table 2. Seven ducks had detectable levels of at least one radionuclide in edible tissue. However, the most detections and highest concentrations were found in ducks sampled from the TRA waste ponds. Both ^{137}Cs and ^{60}Co were measured at greater than 3s levels in the muscle tissue of all of the ducks sampled from the TRA ponds. Duck hunting is not allowed on the INEEL, but a maximum potential exposure scenario to humans would be someone collecting a duck directly from the TRA radioactive waste ponds and immediately consuming all muscle, liver, heart, and gizzard tissue (average 225 g). The maximum potential dose from eating 225 g (8 oz) of meat from ducks collected in 2001 was estimated to be 0.08 mrem. This dose is far less than 360 mrem we receive each year from ambient sources and the 100 mrem per year regulatory dose limit. Results for all duck samples are listed in Table C-13 of Appendix C.

TABLE 2. Detected radionuclides in edible tissues of ducks.

Sample ID	Location	Radionuclide	Concentration ± 2s (pCi/g)	Concentration ± 2s (Bq/g)
01-WF-10-01	Market Lake	Americium-241	1.31E-03 ± 1.30E-03	4.85E-05 ± 4.81E-05
01-WF-12-01	TRA East Pond	Americium-241	4.04E-03 ± 2.30E-03	1.49E-04 ± 8.51E-05
01-WF-7-01	INTEC Perc Ponds	Americium-241	2.45E-03 ± 1.90E-03	9.07E-05 ± 7.03E-05
01-WF-11-01	TRA East Pond	Cesium-137	3.79E-01 ± 3.76E-02	1.40E-02 ± 1.39E-03
01-WF-13-01	TRA East Pond	Cesium-137	1.69E-01 ± 1.53E-02	6.24E-03 ± 5.67E-04
01-WF-14-01	TRA East Pond	Cesium-137	7.05E-01 ± 4.14E-02	2.61E-02 ± 1.53E-03
01-WF-3-01	ANL-W Industrial Waste Pond	Cesium-137	2.97E-02 ± 4.86E-03	1.10E-03 ± 1.80E-04
1-WF-11-01	TRA East Pond	Cobalt-60	2.55E+00 ± 9.58E-02	9.44E-02 ± 3.55E-03
01-WF-13-01	TRA East Pond	Cobalt-60	3.09E+00 ± 9.66E-02	1.14E-01 ± 3.58E-03
01-WF-14-01	TRA East Pond	Cobalt-60	1.97E+01 ± 5.70E-01	7.30E-01 ± 2.11E-02
01-WF-11-01	TRA East Pond	Europium-152	2.89E-01 ± 4.40E-02	1.07E-02 ± 1.63E-03
01-WF-13-01	TRA East Pond	Europium-152	7.01E-02 ± 1.85E-02	2.59E-03 ± 6.83E-04
01-WF-14-01	TRA East Pond	Europium-152	1.95E-01 ± 3.24E-02	7.20E-03 ± 1.20E-03
01-WF-13-01	TRA East Pond	Niobium-95	3.01E+00 ± 1.95E+00	1.11E-01 ± 7.23E-02
01-WF-12-01	TRA East Pond	Strontium-90	1.17E-01 ± 3.80E-02	4.33E-03 ± 1.41E-03
01-WF-14-01	TRA East Pond	Zinc-65	1.72E+00 ± 1.74E-01	6.35E-02 ± 6.44E-03

6. ENVIRONMENTAL RADIATION

The ESER and its predecessors have placed an array of thermoluminescent dosimeters (TLDs) distributed throughout the Eastern Snake River Plain (Figure 14) to measure the amount of radiation in the environment. The TLDs are changed in May and again in November. The results of the November sampling (the period May 2001 through November 2001) are discussed below.

Dosimeter locations are divided into Boundary and Distant groupings. Total exposure for the period for each distant group is listed in Table 4. The average exposure rate for locations in the Boundary group ranged from a low of 0.32 mR/day at Birch Creek to a high of 0.40 mR/day at Mud Lake. The overall average was 0.35 mR/day. The Distant set had a high of 0.43 mR/day at Rexburg and a low of 0.33 mR/day at Jackson, Wyoming. The overall average Distant value was 0.36 mR/day. There was no statistical difference between Boundary and Distant locations. Furthermore, all values are in line with past readings. Table C-15 shows the results for each location.

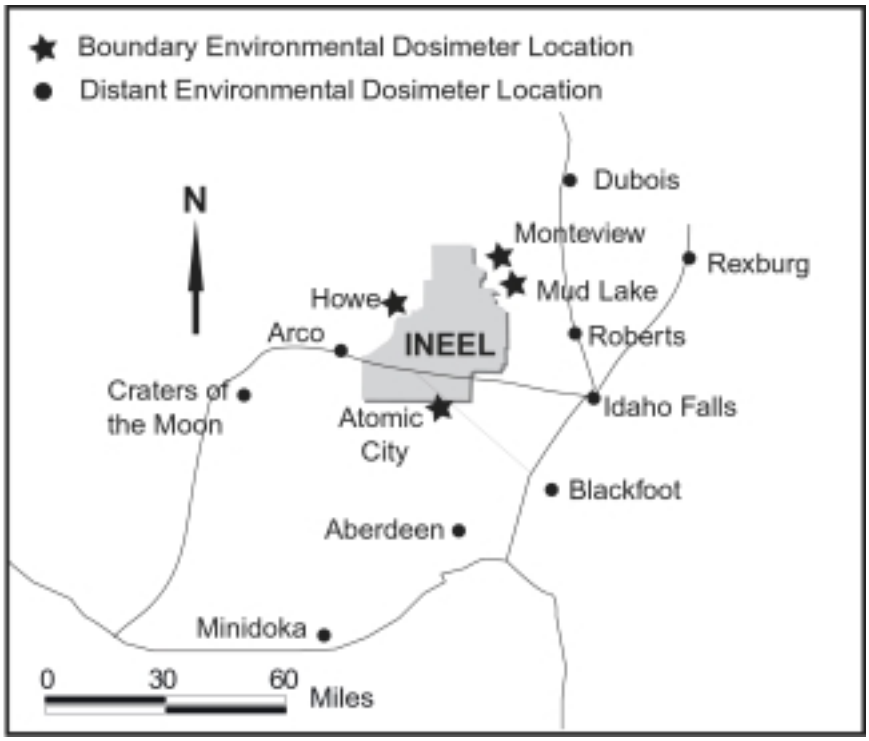


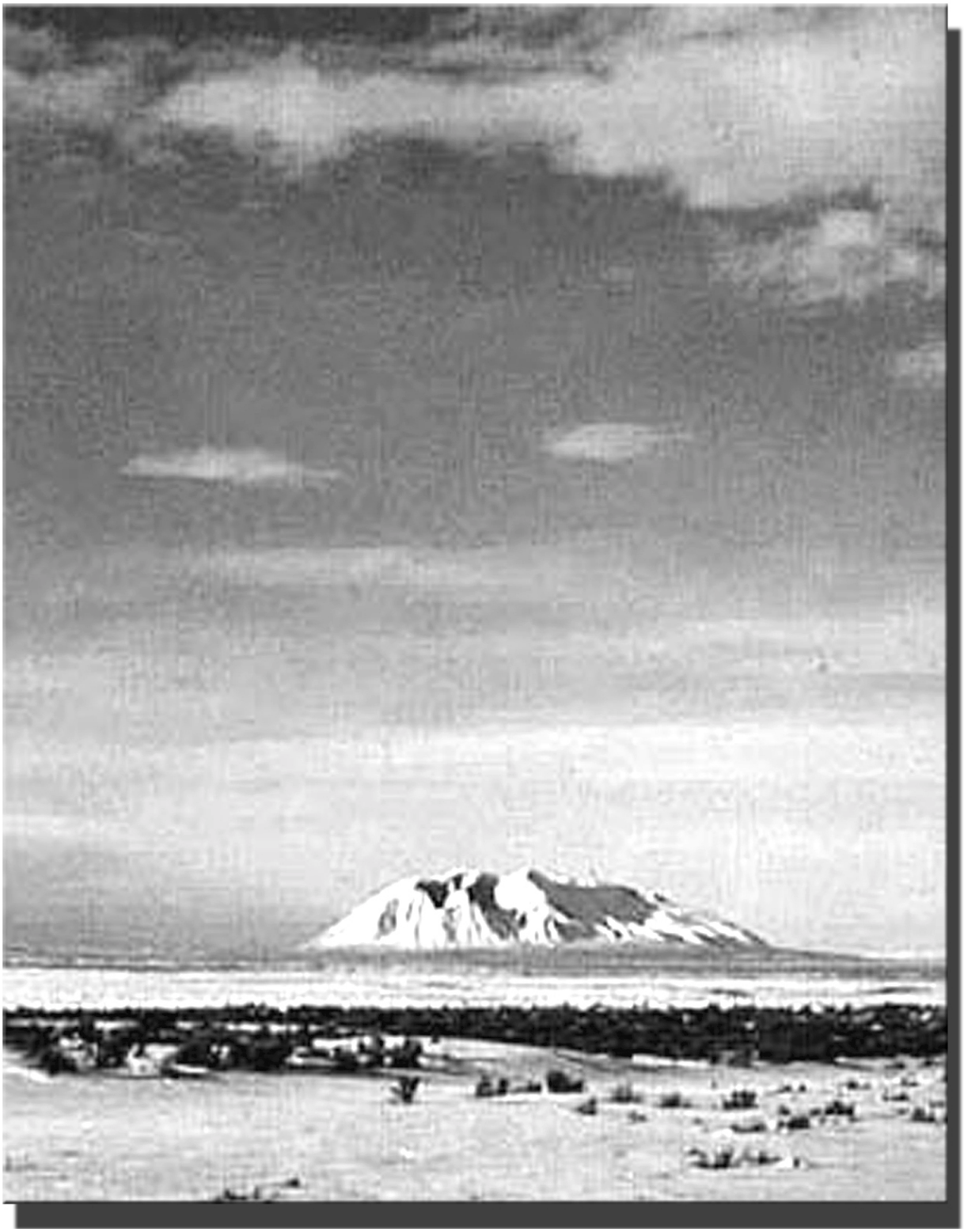
FIGURE 14. TLD locations.

TABLE 3. TLD exposures from May 2001 to November 2001.

	Exposure (mR)	
Location	**Boundary**	**Distant**
Average	65.5	66.2
Maximum	75.1	80.4
Minimum	60.2	47.9

7. SUMMARY AND CONCLUSIONS

The only radionuclides measured that could be attributed to the INEEL were ^{60}Co and ^{137}Cs in some of the ducks collected from locations adjacent to contaminated waste ponds on the INEEL. No radionuclides in any other samples taken during the fourth quarter, 2001, 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, except for ducks, were not different from values measured at other locations across the United States. Concentrations of ^{60}Co and ^{137}Cs in ducks from TRA were higher than in samples taken from offsite locations but all concentrations would require a person to consume hundreds of birds to approach regulatory dose limits. Concentrations in all of the samples collected and analyzed during the fourth quarter, 2001 were below guidelines set by both the DOE and the EPA for protection of the public.



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APPENDIX C

SAMPLE ANALYSIS RESULTS