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Author(s):	Fuehne, David P.
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2013 LANL Radionuclide Air Emissions Report

Department of Energy Report

Site Name: Los Alamos National Laboratory

Location: County of Los Alamos, New Mexico

Operations Office Information:

Office: Los Alamos Field Office

Address: U. S. Department of Energy
National Nuclear Security Administration
Los Alamos Field Office
3747 West Jemez Road
Los Alamos, NM 87544

Contact: Hai Shen **Phone:** (505) 665-5046

Site Information:

Operator: Los Alamos National Security, LLC

Address: Los Alamos National Laboratory
PO Box 1663
Los Alamos, NM 87545

Contact: David Fuehne **Phone:** (505) 669-5619

Compliance Assessment:

2013 Off-Site Effective Dose Equivalent: 0.21 mrem

Executive Summary

This report describes the emissions of airborne radionuclides from operations at Los Alamos National Laboratory (LANL) for calendar year 2013, and the resulting off-site dose from these emissions. This document fulfills the requirements established by the National Emissions Standards for Hazardous Air Pollutants – Emissions of Radionuclides other than Radon from Department of Energy Facilities (40 CFR 61 Subpart H, referred to as the Radionuclide NESHAP or Rad-NESHAP). Compliance with this regulation and preparation of this document is the responsibility of LANL's Rad-NESHAP compliance program, which is part of the Environmental Protection Division. The information in this report is required under the Clean Air Act and is being submitted to the U.S. Environmental Protection Agency (EPA) Region 6.

The highest effective dose equivalent (EDE) to an off-site member of the public was calculated using procedures specified by the EPA and described in this report. LANL's EDE was 0.21 mrem for 2013. The annual limit is 10 millirem per year, established by the EPA in 40 CFR 61 Subpart H. All measured air emissions are modeled to a single location, dubbed the Maximally Exposed Individual (MEI).

During calendar year 2013, LANL continuously monitored radionuclide emissions at 28 "major" release points, or stacks. The Laboratory estimates emissions from an additional 53 "minor" release points using radionuclide usage source terms in lieu of stack monitoring. Also, LANL uses a network of air samplers around the Laboratory perimeter to monitor ambient airborne levels of radionuclides. To provide data for dispersion modeling and dose assessment, LANL maintains and operates meteorological monitoring systems. From these measurement systems, a comprehensive evaluation is conducted to calculate the MEI dose for the Laboratory.

The MEI can be any member of the public at any off-site location where there is a residence, school, business, or office. In 2013, this MEI location was a cluster of business at 2101 Trinity Drive, located on the rim of Los Alamos Canyon. Since there are other receptors in the immediate area, all emissions were modeled to the adjacent Airnet Station 324. This station is called the "Hillside 138" station. The primary contributor to the off-site dose measured at this location was resuspension of legacy contamination on the hillside below the Airnet station. Overall, the MEI dose in 2013 is similar to levels in recent years, excluding the elevated releases associated with the remediation of legacy waste disposal at Materials Disposal Area B (MDA-B) in 2011, as described in that year's annual report. Doses reported to the EPA for the past 10 years are shown in Table E1.

Table E1. Ten-Year Summary of Rad-NESHAP Dose Assessment for LANL

Year	EDE (mrem)	Highest EDE Location
2004	1.68	2470 East Road ("East Gate")
2005	6.46	2470 East Road ("East Gate")
2006	0.47	Los Alamos Airport Terminal
2007	0.52	DP Road, Airnet Station 326
2008	0.55	2470 East Road ("East Gate")
2009	0.55	2470 East Road ("East Gate")
2010	0.33	2201 Trinity Drive, Airnet Station 257
2011	3.53	278 DP Road, Airnet Station 317
2012	0.58	2201 Trinity Drive, Airnet Station 257
2013	0.21	2101 Trinity Drive, Airnet Station 324

2013 Noteworthy Events

Several events that took place in 2013 are worth discussion in this Executive Summary.

Use of DOE Technical Guidance Document SD 1027G to determine allowable radionuclide inventory. In November 2011, the Department of Energy issued revised supplemental guidance[1] for implementation of DOE Technical Standard 1027. This guidance, referred to as SD 1027G, incorporated the latest scientific principles regarding radionuclide behavior in the body and dose conversion factors issued by the International Council on Radiation Protection[2] in ICRP Publication 72. The end result of incorporating SD 1027G is that allowable inventory limits have changed for many radionuclides; some limits increased, some decreased, some remained relatively constant. Most notably, the allowable limit for plutonium-239, a common reference nuclide, increased from its prior limit of 8.4 grams. The new allowable inventory limit for a radiological facility is 38.6 grams of Pu-239 or equivalent material.

In 2013, inventory threshold changes from SD 1027G were incorporated at only one LANL facility – the Radiochemistry facility at Technical Area 48, Building 1 (TA-48-0001). The end result of the guidance is greater flexibility in operations and inventory management at the facility. No significant

[1] Department of Energy (DOE) Supplemental Guidance NA-1 SD G 1027, "Guidance on Using Release Fraction and Modern Dosimetric Information Consistently with DOE Standard 1027-92," November 2011. Commonly referred to as "SD 1027G." Provides updates to original document DOE Technical Standard 1027, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports," December 1992, Change Notice No. 1, September 1997.

[2] International Commission on Radiological Protection (ICRP) Publication 72, "Age-dependent Doses to Members of the Public from Intake of Radionuclides." Annals of the ICRP, 1995.

changes in emissions or off-site doses were noted at TA-48-1 stacks as a result of this change. A review of SD 1027G and its possible impacts on LANL radionuclide air emissions was developed by the Rad-NESHAP program[3] and was discussed at length with EPA Region 6 during a 2013 site visit (described below).

Molybdenum-99 target processing. As introduced in the 2012 report, LANL began tests to determine viability of producing molybdenum-99 at the LANSCE accelerator complex at TA-53. This experiment involves irradiation of uranium solution at LANSCE, then processing the samples at other LANL facilities (the Chemical & Metallurgical Research facility at Technical Area (TA)-3 and the TA-48 radiochemistry facility). The levels involved with initial tests in 2012 and 2013 were extremely low, and anticipated doses were well below the 0.1 millirem threshold that required any formal EPA notification. To account for any possible release of irradiation and fission products generated by this process, the LANL Rad-NESHAP program expanded their standard analysis library of nuclides for charcoal sample filters. Also, the real-time radioactive gas emissions monitoring program at LANSCE was expanded to evaluate potential emissions from this type of operation. In 2013, no radioactive gases were noted in the real-time gas emissions measurements at LANSCE, likely due to the long hold time between irradiation and target removal and venting. However, emissions of the longer-lived iodine-131 isotope were measured at the LANSCE stack where irradiation took place and at all three CMR Wing 9 stacks where targets were processed. These emissions totaled less than 1.5E-04 curies and correspond to an off-site dose of less than 9.0E-05 millirem.

Planned shutdown of stack monitoring system at TA-50 Building 37. Stack 01 at TA-50 Building 37 has been monitored for several years. There are no active sources in this building; rather, the only source of emissions is a section of contaminated ductwork and a HEPA filter on a legacy system that has not been operational since before 2001. Radionuclide emissions are occasionally measured from this stack, attributed to this legacy contamination. In the fall of 2013, the facility operations group removed the ductwork and HEPA system from this contaminated area, with the goal of removing all radiological work hazards for the building and streamlining building operations.

The stack monitoring system remained in operation for the entire year. Isotopic analysis of emissions sample media were performed separately on sample filters collected before the source term

[3] LA-UR-13-28472, Evaluation of DOE Technical Standard 1027 and Supplemental Guidance NA-1 SD G 1027. Examining Radionuclide NESHAP Impacts and Off-Site Dose Consequences. David Fuehne, January 28, 2014.

removal and those collected after the exhaust system changes. Monitoring data still showed very trace amounts of radioactive material in the exhaust air stream; we will repeat the test using isotopic analysis data from the first half of 2014 and evaluate at that time if the stack monitoring system needs to remain in operation. The plan is to shut down the stack sample system at this building in 2014 if emissions measurement data support this action.

<u>New source at TA-54 Dome 375</u>. As described in the 2012 Annual Report, the new "box line" waste processing facility at TA-54 Dome 375 began operations in early 2013. Dome 375 is designed to process large "fiberglass reinforced plywood" (FRP) waste boxes and other large items that are beyond the capabilities of existing repackaging facilities at LANL's TA-50 Building 69, TA-54 Dome 231 or TA-54 Building 412. The appropriate EPA notifications were provided in 2012 for anticipated start-up and in 2013 for actual start-up. Radioactive material operations began on March 4, 2013. Operations are contained in a large PermaCon structure within Dome 375, and air emissions are exhausted through a HEPA-filtered stack that is sampled for radiological particulate emissions per ANSI N13.1 criteria.

<u>Ongoing review of ambient air sampling network</u>. As described in the 2012 Annual Report, the Airnet ambient air monitoring program is undergoing review. The review has been slowed by loss of personnel and by other high-priority items arising. The Airnet review is expected to be finalized in late 2014, and some stations were temporarily shut down as part of the review process, and then later restarted. The stations used to demonstrate compliance with the Radionuclide NESHAP were not affected by these changes. At the end of calendar year 2013, LANL's list of operational Airnet stations include the EPA compliance stations, four stations used for regional background, three stations operating at nearby Native American Pueblos, a small network surrounding the dominant diffuse source at TA-54 Area G, and five additional stations which provide additional air monitoring coverage for Laboratory operations. Again, the Airnet system station site list will be re-evaluated, and further changes may be made when that review is finalized. LANL will work closely with EPA Region 6 to ensure regulatory endorsement of any changes to the compliance network.

<u>CAP88 Version 4 released</u>. The beta version of CAP88-PC Version 4 was released in 2013, and the EPA provided training for users at the 2013 Health Physics Society Annual Meeting. The production version

was released for use in January 2014. Per the EPA web site[4], "because Version 4 incorporates the latest science and is more versatile than the older versions [of CAP88], it is recommended" for use in demonstrating compliance with 40 CFR 61 Subpart H.

LANL used CAP88 version 4 for all of the monitored stack dose calculations in this report, summarized in Tables 12 and 13. Most of the non-monitored stack calculations still use CAP88-PC version 3, but source files are being updated over time. All new dose calculations are being performed with CAP88 Version 4.

Site Visit to LANL by EPA Region 6. In November 2013, the Regional Health Physicist from EPA Region 6 performed a site visit at LANL as part of his review of Subpart H sites in the Region. Several broad program areas were discussed, including DOE Standard 1027 and the Airnet siting review discussed above. Specific facility issues were also addressed, including assessment of evaporation operations at the Radioactive Liquid Waste Treatment Facility, inspections of the monitored stacks at TA-53, radioisotope generation and processing activities, and alternative methods for inspection and testing of tritium stack sampling systems. A summary of the visit[5] and anticipated deliverables based on the discussions during the site visit was sent to EPA in early December 2013.

[4] http://www.epa.gov/radiation/assessment/CAP88/

[5] LA_UR-13-29165, "Summary of Site Visit by EPA Region 6 regarding Rad-NESHAP Compliance" Sent to EPA Region 6 as part of memo ENV-DO-13-0325.

2013 LANL Radionuclide Air Emissions Report

Abstract

The emissions of radionuclides from Department of Energy Facilities such as Los Alamos National Laboratory (LANL) are regulated by the 1990 Amendments to the Clean Air Act, National Emissions Standards for Hazardous Air Pollutants (40 CFR 61 Subpart H). These regulations established an annual dose limit of 10 mrem to the maximally exposed member of the public attributable to emissions of radionuclides from LANL. This document describes the emissions of radionuclides from LANL and the dose calculations resulting from these emissions for calendar year 2013, meeting reporting requirements established in the regulations.

Section I. Facility Information

61.94(b)(1) Name and Location of Facility

Los Alamos National Laboratory (LANL or the Laboratory) and the associated residential areas of Los Alamos and White Rock are located in Los Alamos County in north-central New Mexico, approximately 100 km (60 mi) north-northeast of Albuquerque and 40 km (25 mi) northwest of Santa Fe. Figure 1 illustrates the Laboratory's location with respect to the nation, state, and county.

61.94(b)(2) List of Radioactive Materials Used at LANL

Since the Laboratory's inception in 1943, its primary mission has been nuclear weapons research and development. Programs include weapons development, stockpile stewardship, nonproliferation, magnetic and inertial fusion, nuclear fission, nuclear safeguards and security, isotope production, and laser isotope separation. There is also basic research in the areas of physics, chemistry, and biology.

The primary facilities involved in the emissions of radioactivity are outlined in this section. The facility locations are designated by technical area and building and shown in Figure 2. For example, the facility designation TA-3-29 is Building 29 at Technical Area (TA) 3. Potential radionuclide release points are listed in Table 1, with supporting information in later tables and in Section II of this report. Some of the sources described below are characterized as non-point (diffuse and fugitive) emissions. Off-site doses resulting from non-point emissions of radioactive particles and tritium oxide (tritiated water vapor or HTO) are measured and calculated using LANL's ambient air sampling network (Airnet).

Radioactive materials used at LANL include weapons-grade plutonium, heat-source plutonium, enriched uranium, depleted uranium, and tritium. Also, a variety of materials are generated through the process of activation; consequent emissions occur as gaseous mixed activation products (GMAP) and other particulate or vapor activation products (P/VAP).

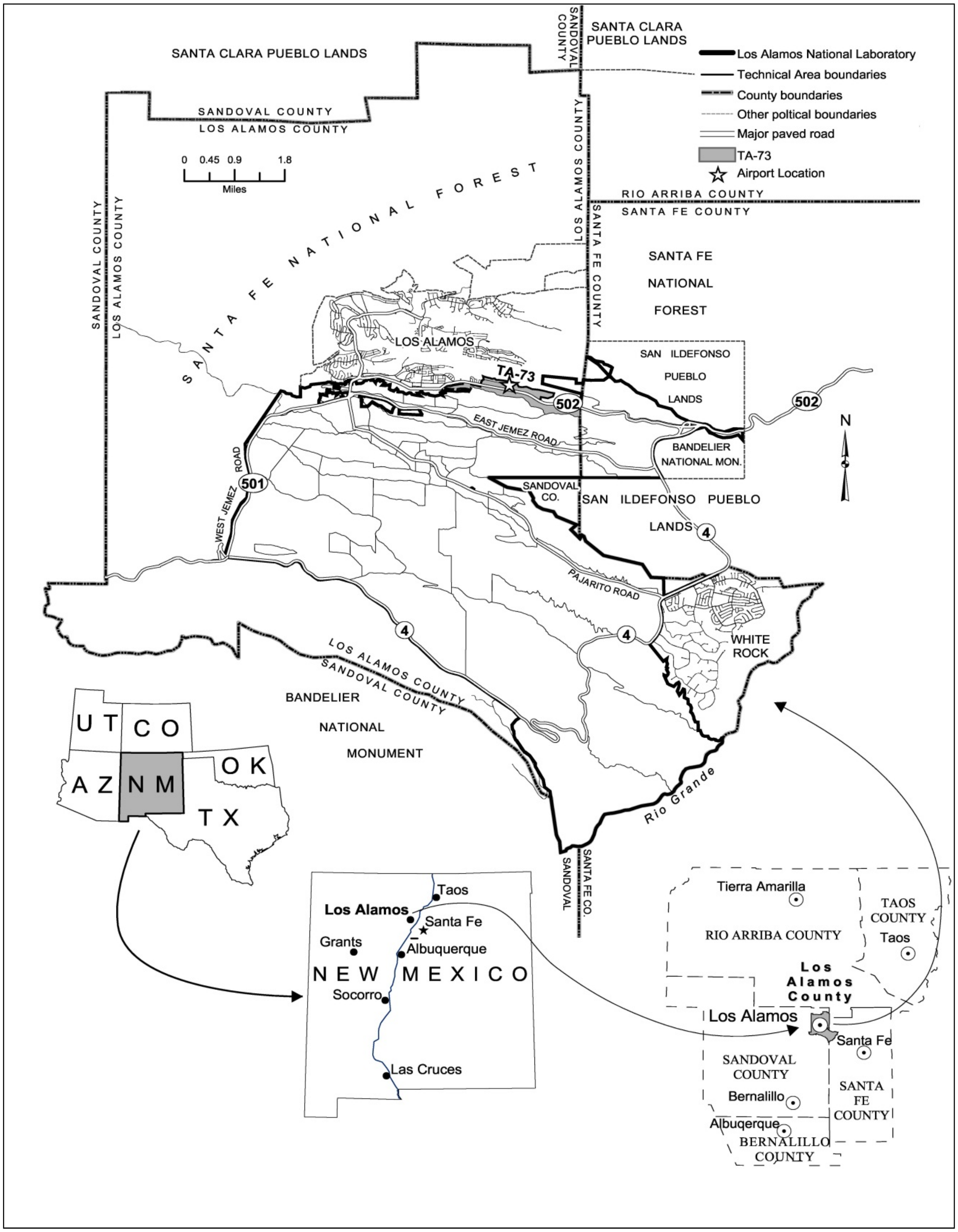

Figure 1. Location of Los Alamos National Laboratory.

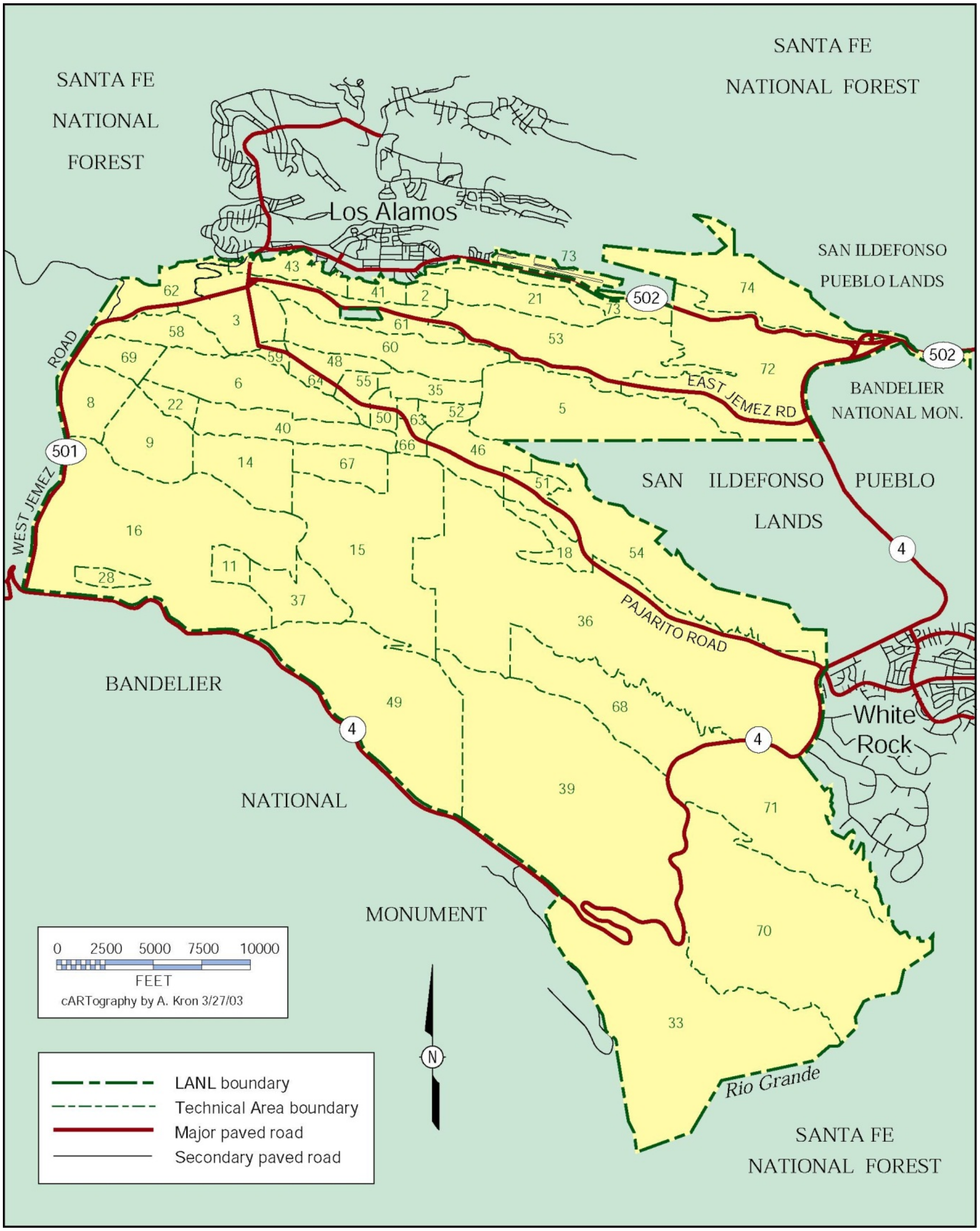

Figure 2. Los Alamos National Laboratory technical areas by number.

The radionuclides emitted from monitored point sources at LANL in calendar year 2013 are listed in Table 2. Tritium is released as either tritiated water vapor (called HTO) or elemental tritium gas (HT). Plutonium-239 can also contain Pu-240; the two isotopes are virtually indistinguishable by alpha spectroscopy, but have similar off-site dose conversions. GMAP emissions include ^{41}Ar, ^{11}C, ^{13}N, and ^{15}O. Various radionuclides such as ^{197m}Hg, ^{68}Ge, and ^{76}Br make up the majority of the P/VAP emissions.

61.94(b)(3) Handling and Processing of Radioactive Materials at LANL Technical Areas

LANL technical areas and operations summaries are listed below. Additional descriptions of LANL technical areas can be found in the annual site Environmental Report for LANL.[6] More thorough descriptions of LANL operations can be found in the Annual Site-Wide Environmental Impact Statement Yearbooks, the most recent being published for 2012.[7] A complete list of non-monitored sources and activities is found in the Radioactive Materials Usage Survey (RMUS), described in the next section.

The primary facilities responsible for radiological airborne emissions are as follows.

TA-3-29: The Chemistry and Metallurgy Research (CMR) facility conducts chemical and metallurgical research. The principal radionuclides used are isotopes of plutonium and other actinides. There are a variety of activities involving plutonium and uranium, which support many LANL and other U.S. Department of Energy (DOE) programs. As mentioned in prior years' reports, work is being consolidated from six wings down to just three wings; these three wings will remain active until approximately 2019, when operations are planned for phase-out in this facility. In late 2012, one stack fan was shut down (ES-37) and the associated sampling system turned off as well. In 2014, an operations review of some wings at CMR will be performed to determine the need for ongoing stack sampling from these wings.

TA-3-66: This is the Sigma facility, used for a variety of nuclear materials work. Primary materials are metallic and ceramic radionuclides, including depleted uranium. The uranium foundry is in this building. In recent years this facility has performed research and development work with low-enriched uranium (LEU) fuels used in research reactors. The stacks at Sigma are considered "minor" sources under Subpart H and not monitored.

TA-3-102: This machine shop is used for the metalworking of radioactive materials, primarily depleted uranium. The monitored stack at this facility (ES-22) was shut down in 2011; only minor operations are performed in this facility, and these operations do not meet requirements for a monitored

[6] Los Alamos National Laboratory, "Environmental Report 2012," LA-UR-13-27065, September 2013.
[7] Los Alamos National Laboratory, "SWEIS Yearbook - 2012," LA-UR-13-29469, December 2013.

stack. Planned moves of radionuclide operations from this facility to TA-3-141 (the Beryllium Test Facility) have been cancelled.

TA-3-1698: This facility is the Materials Science Laboratory. The building was designed to accommodate a wide variety of chemicals used in small amounts that are typical of many university and industrial labs conducting research in materials science. Small amounts of radioactive materials are used in experiments on materials properties (e.g., stress/strain measurements).

TA-15 and TA-36: These facilities conduct open-air explosive tests involving depleted uranium and weapons development testing. One building, TA-36-99, houses a "gas gun" focused explosive experiment that is ventilated through a non-monitored stack.

TA-15-312: This is the Dual-Axis Radiographic Hydrodynamic Test (DARHT) Facility. DARHT conducts high-explosive-driven experiments to investigate weapons functions and behavior during nonnuclear tests using advanced radiography. Starting in 2007, explosive operations at DARHT are conducted in containment vessels. Use of these vessels virtually eliminates air emissions from these operations. Following explosive operations, containment vessels undergo cleanout in building 15-534 and if needed, repair in building 15-285. Both of these latter two buildings are non-monitored point sources, tracked in the RMUS.

TA-16-205 and -450: This is the Weapons Engineering Tritium Facility (WETF). Buildings 205 and 450 were specifically designed and built to process tritium safely. The operations at WETF are divided into two categories: tritium processing and activities that support tritium processing. Examples of tritium-processing operations include the repackaging of tritium into smaller quantities and the packaging of tritium and other gases to user-specified pressures. Other operations include reacting tritium with other materials to form compounds and analyzing the effects of tritium. WETF operations have historically been housed in building 205, while building 450 was built for other tritium activities. Expansion of WETF into building 450 began in 2007. As part of this expansion, exhaust ducts were reconfigured so that emissions from TA-16-205 were routed into the TA-16-450 ES-05 stack. Therefore, the TA-16-205 stack ES-04 is discontinued as a point source and TA-16-450 ES-05 will be the point source for both buildings. The older emissions sampling system for building 205 is located in the exhaust duct coming out of building 16-205, and remains operational and able to measure emissions from that building. The new stack sampling system in stack ES-05 was certified to measure emissions from building 450, whenever that portion of the complex becomes active. This system will also measure emissions from building 205 operations, but was not certified for these operations under ANSI/HPS N13.1-1999 criteria. As discussed in the 2009 emissions report, the ES-05 stack monitor experienced technical problems, and its operations were discontinued in June 2009. Reported emissions for 2013 are measured with the 16-205 duct monitor, but exhausted through and modeled from the 16-450 ES-05 stack.

TA-21: The great majority of buildings at this decommissioned radiochemistry site have been decontaminated and demolished. The tritium operations in TA-21 were relocated in 2006 to other LANL sites, primarily WETF. In 2009, demolition of office and support buildings began. Radiological process buildings were demolished in 2010. Final remediation of building foundations, subsurface structures, and legacy disposal areas will take place in coming years. The MDA-B legacy waste disposal site is also considered part of TA-21. Excavation of MDA-B was completed in 2011; removal of excavation structures was achieved in late 2012.

TA-41-4: This building was formerly used as a tritium-handling facility. The tritium sources were removed in 2002. Most of the process buildings have been demolished. Diffuse tritium emissions could result from residual tritium contamination and cleanup operations.

TA-48: The principal activities carried out in this facility are radiochemical separations and hot cell operations supporting the medical radioisotope production program, the Yucca Mountain program, nuclear chemistry experiments, and geochemical and environmental research. These separations involve nanocurie to curie amounts of radioactive materials and use a wide range of analytical chemical separation techniques, such as ion exchange, solvent extraction, mass spectroscopy, plasma emission spectroscopy, and ion chromatography. Besides the hot cell operations, the building also houses the Actinide Research Facility and includes the other radiochemical operations described above. Building 1 at TA-48 contains the majority of operations, exhausted through three monitored stacks and several non-monitored stacks. Smaller (non-monitored) operations take place in other buildings around TA-48-1. Building 1 of TA-48 was the first to adopt SD 1027G radionuclide inventory thresholds as described in the Executive Summary to this report. While a larger number of isotope processing operations may theoretically result in increased air emissions, this was not noted in 2013.

TA-50-1: This waste management site consists of an industrial low-level radioactive liquid waste treatment facility, RLWTF. Transuranic liquid waste is also treated in this building. The building has one monitored stack (ES-2) and other smaller point sources which are not monitored. Two small cooling towers mentioned in the 2010 executive summary had been used for non-radiological purposes in the past; they operated briefly to evaporate treated effluent from RLW in 2010 but have not operated since 2010, and that practice has been discontinued. A new fuel-fired evaporator (described in the 2011 report) started radiological operations in 2011 and is being tracked as a non-monitored source.

TA-50-37: Currently there are no operations involving radioactive material in this building; long term plans for future operations that involve the use of radioactive actinides have not come to fruition. Stack sampling takes place due to legacy contamination issues. The facility is exploring the possibility of shutting down stack sampling if all criteria can be met. In September 2013, potentially contaminated ventilation components were removed to eliminate sources of emissions from this building. A study of measured emissions from the facility will determine if ongoing stack sampling is required for 2014 and beyond.

TA-50-69: This waste management site consists of a waste characterization, reduction, and repackaging facility. Waste drums are repackaged for on-site or off-site disposal. There is one monitored stack and three non-monitored sources at this building.

TA-53: This technical area houses the Los Alamos Neutron Science Center (LANSCE), a linear particle accelerator complex. There are two monitored stacks (on buildings TA-53-3 and TA-53-7) and several sources tracked in the non-monitored stacks program. The accelerator is used to conduct research in stockpile stewardship, radiobiology, materials science, and isotope production, among other areas. LANSCE consists of the Manuel Lujan Neutron Scattering Center, the Proton Storage Ring, the Weapons Neutron Research facilities, the Proton Radiography facility, and the high-intensity beam line (Line A). The facility accelerates protons and H- ions to energies of 800 MeV into target materials such as graphite and tungsten to produce neutrons and other subatomic particles. The design current of the accelerator is approximately 1000 microamperes, but most operations take place at beam currents of 120 microamperes or less. Airborne radioactive emissions result from proton beams and secondary particles passing through and activating air in target cells, beam stop, and surrounding areas, or activating water used in target cooling systems. The majority of the emissions are short-lived activation products such as ^{11}C, ^{13}N, and ^{15}O. Most of the activated air is vented through the main stacks; however, a fraction of the activated air becomes a fugitive emission from the target areas.

As a by-product of accelerator operations, cooling water can contain trace amounts of radionuclides. Two solar evaporative tanks were constructed and began operation in 1999 to evaporate this wastewater from the accelerator. Evaporation of water from these open-air tanks can result in a diffuse source of airborne tritium and other particulates. To support other Laboratory operations, these tanks can be used for evaporation of water from other LANL facilities.

In 2004, the Isotope Production Facility (IPF) began operations as part of the LANSCE facility. IPF uses a portion of the LANSCE beam to irradiate a variety of targets for different medical research and treatment uses. After irradiation, targets are processed at LANL hot cells at TA-48 or CMR. IPF has two stacks which are managed as part of the minor (non-monitored) source program.

TA-54: This waste management site consists of active and inactive shallow land burial sites for solid waste and is the primary storage area for mixed and transuranic radioactive waste. Waste characterization and processing operations also take place at TA-54 to prepare waste for shipment to the Waste Isolation Pilot Plant (WIPP). Shipments of transuranic waste for disposal at WIPP began in 1999. Characterization work includes analysis of headspace gases and radiography of waste drum contents; processing includes sorting, segregating, size-reduction, and repackaging of waste.

MDA G at TA-54 is also a known source of diffuse emissions of tritium vapor and direct radiation from above-ground storage of radioactive waste. Resuspension of soil contaminated with low levels of plutonium/americium has also created a diffuse source. Point sources at Area G include operations involving characterization, manipulation, or repackaging of waste containers. Two new monitored point sources came on-line in 2010, at Building 412 and Dome 231. These two new sources are waste processing facilities, preparing waste shipments for off-site disposal. The Dome 231 processing facility was expanded in 2012 to increase throughput capacity of the dome. In March 2013, a new building (Dome 375) began radiological operations to process larger waste containers. Minor sources of emissionsat TA-54 include drum characterization work at Building 33 and Dome 224 (new in 2013; described in detail later in this report), and air sample work outside of Area G in Building 1001.

TA-55: Building 4 of the Plutonium Facility (PF-4) provides a pit manufacturing capability and continues the role of providing the capability for research and development applications in chemical and metallurgical processes for recovering, purifying, and converting plutonium and other actinides. A wide range of activities (e.g., the heating, dissolution, forming, and welding of special nuclear materials) are also conducted. Additional activities include investigating the means to safely ship, receive, handle, and store nuclear materials and to manage wastes and residues from TA-55. Limited-scope tritium operations also take place in certain areas of TA-55. Building 2 of TA-55 houses associated support facilities for operations in PF-4, including the radiological sample analysis laboratory. Operations from this laboratory are tracked as part of LANL's non-monitored source program.

Building 400 at TA-55 is the Radiological Laboratory / Utility / Office Building (RLUOB), the first phase of the project to replace capabilities in TA-3 Building 29. A Congressionally approved line item project may eventually include a nuclear facility to replace remaining capabilities from TA-3 Building 29; design of a CMR Replacement (CMRR) nuclear facility was underway but the Administration announced its intent to delay construction for at least five years. RLUOB is designed to perform materials characterization work and actinide chemistry research. While the RLUOB stack became active in November 2012, radiological operations will not commence until late 2014 under current plans.

Section II. Air Emissions Data

61.94(b)(4) Point Sources

Monitored and unmonitored release points at LANL are listed in Table 1. The point sources are identified using an eight-digit identification number for each exhaust stack (StackID); the first two digits represent the LANL technical area, the next four the building, and the last two digits the stack number. Also listed in Table 1 are type, number, and efficiency of the effluent controls used on the release points. More information on effluent controls systems appear below.

In addition to the 28 monitored ("major") point sources, 53 unmonitored ("minor") release points in 37 LANL buildings are included in Table 1. Under 40 CFR 61.93(b)(4)(i), sampling of these minor release points is not required because each release point has a potential effective dose equivalent (PEDE) of less than 0.1 mrem/year at the critical receptor. However, in order to verify that emissions from unmonitored point sources remain low, LANL conducts periodic confirmatory measurements in the form of the annual *Radioactive Materials Usage Survey for Unmonitored Point Sources*.[8] The purpose of this survey is to collect and analyze radioactive materials usage and process information for the unmonitored point sources at LANL. In alternate years, the survey is expanded to review monitored sources and ensure proper emissions monitoring is taking place at these facilities. For 2013, all minor sources were analyzed. A full description of which sources are analyzed in each year is included in the referenced Usage Survey report.

The distance between each of the release points and the critical receptor is provided in Table 1. The critical receptor can be a residence, school, business, or office. In this report, the critical receptor is defined as the member of the public (at a fixed structure location) most impacted by a given release point. Air dispersion modeling is taken into account to determine the most critical receptor location; the nearest public receptor is not always the critical receptor if the nearest location is upwind from a source.

In compliance with Appendix D to 40 CFR 61, we have used data collected from the facilities in conjunction with engineering calculations and other methods to develop conservative emissions estimates from unmonitored point sources. Estimated PEDEs are calculated by modeling these emissions estimates

[8] R. Sturgeon, "2013 Radioactive Materials Usage Survey for Unmonitored Point Sources." ENV-CP memo, pending final publication at time of report development.

using the U.S. Environmental Protection Agency (EPA)-approved CAP88 dose modeling software. A comprehensive survey of all of LANL's monitored and unmonitored point sources is conducted annually or biannually, depending on the magnitude of potential emissions. The Laboratory has established administrative requirements to evaluate all potentially new sources. These requirements are established for the review of new Laboratory activities and projects, ensuring that air quality regulatory requirements will be met before the activity or project begins.[9]

Non-point Sources

There are a variety of non-point sources within the 111 km^2 of land (43 square miles) occupied by LANL. Non-point sources can occur as diffuse or large-area sources, or as leaks or fugitive emissions from facilities. Examples of non-point sources of airborne radionuclides include surface impoundments, evaporative tanks and basins, shallow land burial sites, open burn sites, live firing sites, outfalls, container storage areas, unvented buildings, waste treatment areas, solid waste management units, and tanks. Additionally, LANL considers a building to be a non-point source if there is no active process exhaust (e.g., no fume hood, glove box, etc.); no forced air exhaust to the environment; or is equipped with only standard heating/ventilating/air conditioning systems (e.g., occupational comfort cooling or heating).

LANL determines the potential impacts of non-point sources by measuring air concentrations of significant radionuclides at ambient air-sampling sites at locations of public receptors surrounding the Laboratory and at selected locations on Laboratory property. This network of ambient air sampling stations is called Airnet. The LANL Airnet system was approved for use in monitoring LANL's non-point radioactive air emission sources in 1996.[10] Based on the original methodology approved by EPA, additional procedures were developed to identify when new Airnet stations were required to assure continued compliance with the Radionuclide NESHAP.[11,12]

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9 Los Alamos National Laboratory Procedure, "Air Quality Reviews," P408, January 2014.
10 U.S. Environmental Protection Agency, *Federal Register*, Vol. 60, No. 107, June 5, 1995.
11 Los Alamos National Laboratory Procedure, "Evaluating New Diffuse Sources and New Receptors for AIRNET Coverage," ESH-17-238, R0, December 2001.
12 Letter to Mr. George Brozowski, Radiation Program Manager, Environmental Protection Agency from Mr. Steve Fong, Office of Environment, Department of Energy, May 11, 2001.

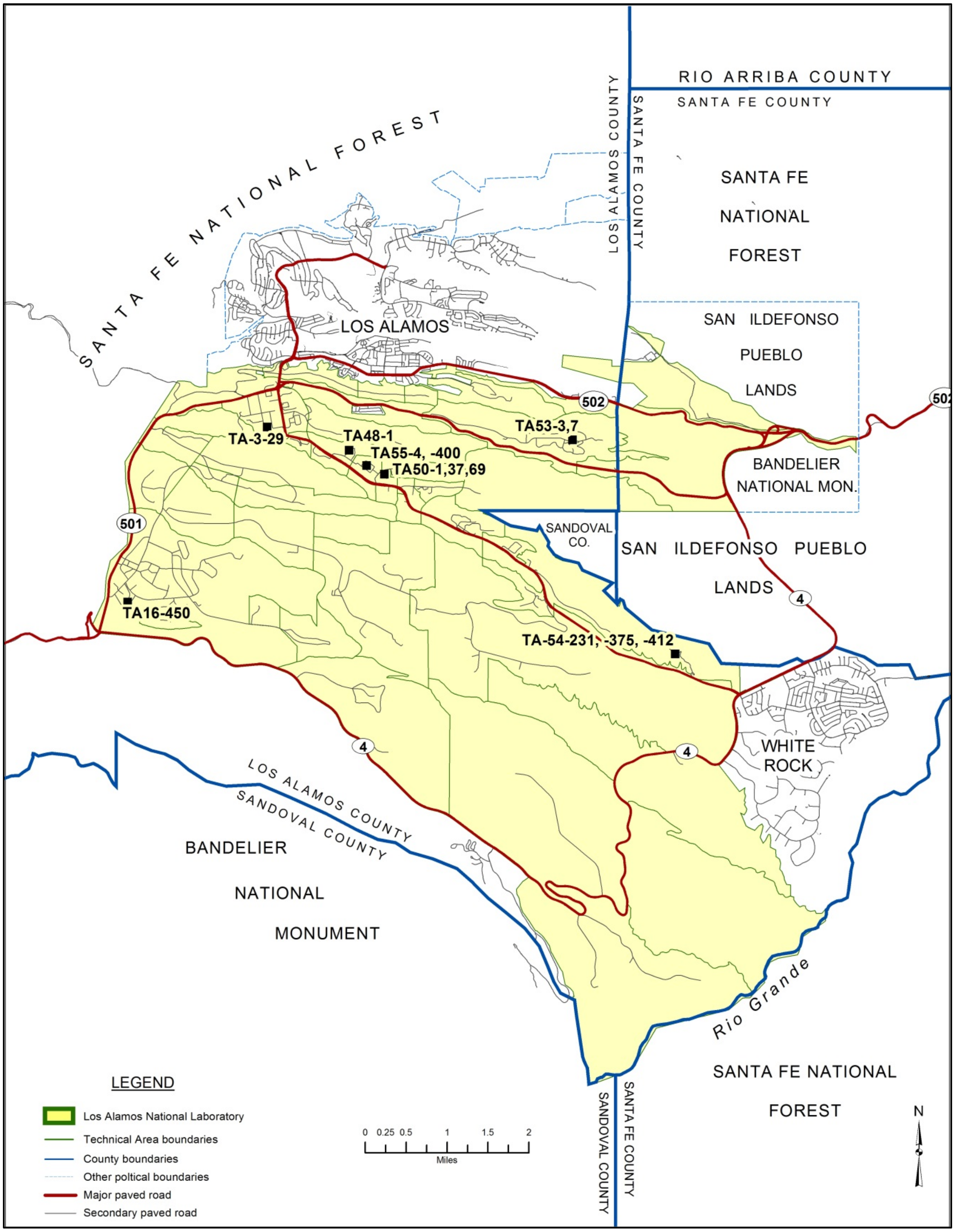

Figure 3. Location of facilities with continuously operated stack-sampling systems for airborne radionuclide emissions.

Radionuclide Emissions

Table 2 lists the radionuclides released from monitored point sources, along with the annual emissions in curies for each radionuclide. The point sources are identified using an eight-digit identification number for each exhaust stack: the first two digits represent the LANL technical area, the next four digits the building, and the last two digits the stack number. No detectable emissions are denoted as "none." Extensive notes appear at the end of the source term table. A map showing the general locations of the facilities continuously monitored for radionuclide emissions is shown in Figure 3.

Pollution Controls

The most common type of filtration for emission control purposes at LANL is the high-efficiency particulate air (HEPA) filter, as noted in Table 1. HEPA filters are constructed of sub-micrometer glass fibers that are pressed and glued into a compact, paper-like, pleated media.

At LANL, each HEPA filter system on active operational sources is tested at least once every 12 months. The nominal performance criteria for HEPA filter systems are a maximum penetration of 5×10^{-4} for one stage (99.95% removal) and maximum penetration of 2.5×10^{-7} for two stages in series (99.999925% removal). In these quoted values, filter penetration and percent removal are defined below.

Penetration = (downstream concentration) / (upstream concentration)

Removal = [1 - (penetration)] * 100%

Note that in recent years, changes to HEPA filter testing methods and equipment at LANL have resulted in limitations in the ability to certify very high levels of aerosol removal. Therefore, LANL is now only certifying all filters at the "single stage" penetration & removal criteria, regardless of the number of filter bank stages installed at the facility. Table 1 lists the number of filter banks installed at the facility and the nominal removal efficiency, not the certified tested removal efficiency.

Other types of filters used in ventilation systems are Aerosol 95; RIGA-Flow 220, 221, and 222; and FARR 30/30. These units are typically used as prefilters in HEPA filtration systems. These filters are significantly less efficient than HEPA filters and are typically used for removing gross particulate matter larger than 5 μm.

The above-mentioned filters are only effective for particles. When the contaminant of concern is in the form of a gas or vapors, activated charcoal beds can be used. Charcoal beds collect the gas contaminant through an adsorption process in which the gas comes in contact with the charcoal and adheres directly to the surface of the charcoal. The charcoal can be coated with different types of materials to make the adsorption process more efficient for specific types of contaminants. Typically, charcoal beds achieve an efficiency of 98% capture. Efficiency of a charcoal filter can vary with different chemical pollutants in the exhaust air stream.

Tritium effluent controls are generally composed of a catalytic reactor and a molecular sieve bed. Tritium-contaminated effluent is passed through a catalyst that converts gas-phase or elemental tritium (HT) into tritiated water vapor (HTO). This HTO is then collected as water on a molecular sieve bed. This process can be repeated until the tritium level is at, or below, the desired level. The effluent is then vented through the stack.

A delay system is used to reduce some of the short-lived radionuclides generated by activation at LANSCE. Emissions from a concentrated source of activated gas (the off-gas system for the 1L target cooling system) are directed into a long transport line. The transit time through this system allows short-lived gaseous radionuclides to decay before emission from the stack. This delay system is used to provide a reduction in radionuclide emissions from the 1L target area exhausted through stack 53000702.

Compliance with Maintenance and Inspection Requirements under the Revised Rad-NESHAP

The 2003 revisions to Subpart H established several inspection and maintenance requirements for monitored stacks. These requirements are based on American National Standards Institute/Health Physics Society N13.1-1999, *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities*. Annual visual inspection of particulate monitoring systems is a component of the Laboratory's program to comply with these requirements. In 2013, we performed stack inspections and/or cleaning operations on 24 monitored stacks. For the one tritium stack at TA-16, the annual in-place performance test serves as the annual inspection, per EPA alternative method approval. Two of the monitored stacks do not meet Subpart H requirements for "major" sources and did not have inspections performed on them. Finally, the stack at TA-53 Building 7 ES-2 was not inspected due to roof access and associated safety issues. This TA-53 stack inspection issue was discussed during the EPA Region 6 site visit in November 2013. This accounts for the 28 monitored stacks at LANL

Of the inspections performed in 2013, sample systems on 11 stacks showed evidence of particulate deposition in the sampler or the transport line. These systems will be addressed as part of the current year's sampler inspection cycle.

In 2013, no radiological material was measured on inspection or cleaning equipment. Therefore, no additions to the source term are required from this pathway for this year.

Section III. Dose Assessment

61.94(b)(7) Description of Dose Calculations

Effective dose equivalent (EDE or dose) calculations for point sources, unmonitored point sources, and non-point gaseous activation products from LANSCE were performed with the CAP88 code. LANL had used the original mainframe version of CAP88 (version 0) through the 2005 report; CAP88 version 3 was used for 2006-2012 reports; and CAP88 version 4 adopted for this 2013 report. Verification of the CAP88 code is performed by running the EPA test case before and after performing the dose calculations.

Development of Source Term

Tritium emissions

Tritium emissions from the Laboratory's tritium facilities are measured using a collection device known as a bubbler. This device enables the Laboratory to determine not only the total amount of tritium released but also if it is in the chemical form of elemental tritium (HT) or tritiated water vapor (HTO). The bubbler operates by pulling a continuous sample of air from the stack, which is then "bubbled" through three sequential vials containing ethylene glycol. The ethylene glycol collects the water vapor from the sample of air, including any tritium that is part of a water molecule (tritium oxide, or HTO). After bubbling through these three vials, essentially all the water vapor and associated HTO is removed from the air, leaving elemental tritium, or HT. The sample air stream is then passed through a palladium catalyst that converts the HT to HTO. The sample is pulled through three additional vials containing ethylene glycol, which collects the newly formed HTO. The amount of HTO and HT is determined by analyzing the ethylene glycol for the presence of tritium using liquid scintillation counting. Since different chemical forms are collected in different vials, the system will discriminate HTO vapor from HT gas, allowing separate dose assessment with CAP88-PC versions 3 and 4. Bubblers are in use to measure tritium emissions from TA-16 (WETF) and TA-55 PF-4's south stack.

Tritium emissions from LANSCE do not require monitoring under 40 CFR 61.93(b)(4)(i). The primary source for airborne tritium emissions at LANSCE is activation of water vapor in air and activation and subsequent evaporation of water in the cooling system of beam targets. Because of the low relative contribution of tritium to the off-site dose at LANSCE, formal monitoring for tritium was discontinued after July 2001. However, the tritium emissions for 2013 can be calculated based on the rate of generation measured in 2001, using representative parameters.

In past years, very low-level tritium operations also took place from TA-55 Building 4, in the northern portion of the building exhausted through ES-15. While the southern stack ES-16 is monitored for tritium emissions, at ES-15, tritium is not a pollutant of concern. Similarly, operators at the WCRR waste repackaging facility at TA-50-69 occasionally process waste drums containing trace amounts of tritium. No tritium operations took place in either of these facilities in 2013; had there been tritium operations at these facilities, the potential upper bound limit of emissions would be included in the Table 2 source term. Calculations and user estimations would be used to determine this upper bound, adequate for a non-significant radionuclide at these sources.

Radioactive particulate emissions

Emissions of radioactive particulate matter, generated by operations at facilities such as the CMR facility (TA-3-29) and the Plutonium Facility (TA-55), are sampled using a glass-fiber filter. A continuous sample of stack air is pulled through the filter, where small particles of radioactive material are captured. These samples are analyzed weekly using gross alpha/beta counting and gamma spectroscopy to identify any increase in emissions and to identify short-lived radioactive materials. Every six months, LANL composites these stack samples for subsequent analysis at an off-site laboratory. These composite samples are analyzed to determine the total activity of materials such as ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, ^{239}Pu, and ^{241}Am. These semiannual composite data are then combined with estimates of sampling losses and stack and sample flows to calculate emissions. Short-lived progeny are assumed to be emitted in secular equilibrium with their long-lived parent nuclides. For example, we measure for the presence of ^{90}Sr and assume that an equal amount of the progeny ^{90}Y is emitted as well.

Vapor form emissions

Vapor emissions, generated by LANSCE operations and by hot-cell activities at TA-3-29 and TA-48, are sampled using an activated charcoal filter or canister. A continuous sample of stack air is pulled through a charcoal filter upon which vaporous emissions of radionuclides are adsorbed. The amount and identity of the radionuclide(s) present on the filter are determined through the use of gamma spectroscopy. These analytical results are used in conjunction with facility information to calculate emissions. Examples of radionuclides of this type include ^{68}Ge and ^{76}Br.

Gaseous mixed activation products (GMAP)

GMAP emissions resulting from activities at LANSCE are measured using real-time monitoring data. A continuously-operating air flow-through ionization chamber is operated in series with a high-purity germanium (HPGe) detector and data acquisition system. A sample of stack air is pulled through the ionization chamber to measure the total amount of radioactivity in the sample, while specific radioisotopes are identified through the use of gamma spectroscopy and decay curve analysis with the HPGe system. This information is then used to calculate emissions. Radionuclides of this type include ^{11}C, ^{13}N, and ^{15}O.

Summary of Input Parameters

EDE to potential receptors was calculated for all radioactive air emissions from sampled LANL point sources. The radionuclide releases for the point sources monitored in 2013 are provided in Table 2. Input parameters for these point sources are provided in Table 3. The geographic locations of the release points, given in New Mexico State Plane coordinates, are provided in Table 4. The relationship of the highest receptor location to the individual release points are provided in Table 5. Other site-specific parameters and the sources of these data are provided in Table 6.

LANL operates an on-site network of meteorological monitoring towers. Data gathered by the towers are summarized and formatted for input to the CAP88 program. For 2013, data from three different towers were used for the air-dispersion modeling; the tower data that are most representative of the release point are applied. Due to data collection issues at the TA-53 and TA-54 towers, annual data from 2012 were used for these towers. Copies of the meteorological data files used for the annual 2013 dose assessments are provided in Table 7. Note that due to the extent of the data in Table 7, that table has been moved to Appendix 1. There are three files included in Table 7, detailing wind speed and direction information from TA-6, TA-53, and TA-54 meteorology towers.

The Laboratory also enters population array data to the CAP88 program. The data file represents a 16-sector polar-type array, with 20 radial distances for each sector. Population arrays are developed for each release point using U.S. Census data, and the population files used at LANL were updated in late 2012 using 2010 census data[13], Different population files are used depending on where the dominant LANL source is located in a given year. For 2013, LANL's dominant emitter was minor sources

[13] M. McNaughton and B. Brock, "Population Files for use with CAP88 at Los Alamos. LA-UR-12-22801. January 2012.

distributed throughout the Laboratory; therefore, the "LANL area source" array is used for population dose assessment. This array appears in Table 8. For agricultural array input, LANL is currently using the default values in CAP88.

Public Receptors

Compliance with the annual dose standard is determined by calculating the highest EDE to any member of the public at any off-site point where there is a residence, school, business, or office. The Laboratory routinely evaluates public areas to assure that any new residence, school, business, or office is identified for the EDE calculation. As per EPA guidance,[14] personnel that work in leased space within the boundaries of the Laboratory are not considered members of the public for the EDE determination. Personnel of this type are considered to be subcontractors to DOE, similar to security guards and maintenance workers.

Point Source Emissions Modeling

The CAP88 version 4 program was used to calculate doses from both the monitored and unmonitored point sources at LANL. The CAP88 program uses on-site meteorological data to calculate atmospheric dispersion and transport of the radioactive effluents. CAP88 version 4 includes all radionuclides for which there are dose conversion factors in the EPA's Federal Guidance Reports.[15,16,17] In 2013, all monitored radionuclides were included in CAP88 for the monitored stacks source term. Some minor sources (non-monitored stacks) used exotic radionuclides (usually very short-lived) not in the CAP88 version 4 library; these were addressed per procedure. Updates of "non-CAP88 nuclides" for monitored and non-monitored point sources will have been described in previous memos to EPA Region 6, most recently in a 2011 memo[18].

[14] Frank Marcinowski, Acting Director, Radiation Protection Division, "Criteria to Determine Whether a Leased Facility at Department of Energy (DOE) is Subject to Subpart H," Office of Radiation and Indoor Air, U. S. Environmental Protection Agency, March 26, 2001.

[15] K. F. Eckerman, A. B. Wolbarst, and A. C. B. Richardson, Federal Guidance Report No. 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C., 1988.

[16] K. F. Eckerman and J. C. Ryman, Federal Guidance Report No. 12, "External Exposures to Radionuclides in Air, Water, and Soil Exposure-to-Dose Coefficients for General Application," U.S. Environmental Protection Agency, Washington, D.C., 1993

[17] K. F. Eckerman, R. W. Leggett, C. B. Nelson, J. S. Puskin, and A. C. B. Richardson, Federal Guidance Report No. 13, "Cancer Risk Coefficients for Environmental Exposure to Radionuclides," U.S. Environmental Protection Agency, Washington, D.C., 1999

[18] M. McNaughton memo to G. Brozowski, "Documentation of Dose Calculation Methods for Radionuclides Not Included in CAP88 Version 3." Memo WES-EDA-11-0023, December 21, 2011.

LANSCE Diffuse / Fugitive Emission Modeling

Some of the GMAP created at the accelerator target cells or at other accelerator beam line locations migrate into room air and into the environment. These diffuse or fugitive sources are continuously monitored throughout the beam-operating period. In 2013, approximately 11 Ci of ^{11}C and 05 Ci of ^{41}Ar were released from LANSCE as fugitive emissions.[19] These sources were modeled as area sources using CAP88 version 4, and the specific input parameters are provided in Table 9.

Environmental Data Used for Non-point Source Emission Estimation

The net annual average ambient concentration of airborne radionuclides measured at 23 air sampling stations (Figure 4) is calculated by subtracting an appropriate background concentration value.[20] The net concentration at each air sampler is converted to the annual EDE using Table 2 of Appendix E of 40 CFR 61 and applying the valid assumption that each Table 2 value is equivalent to 10 mrem/year from all appropriate exposure pathways (100% occupancy assumed at the respective location).[21] Dose assessment results from each air sampler are given in Table 10. The operational performance and analytical completeness of each air sampler is provided in Table 11.

Note that for 2013, some stations not designated as historical compliance stations did not have tritium (H-3) measured at that location. For these stations, it is known that tritium is not a pollutant of concern for these locations. These stations have the notation "n/a" in the tritium dose or analytical completeness column.

[19] Los Alamos National Laboratory, "2013 Annual Source Term for Radionuclide Air Emissions," ENV-ES:14-0109, June 9, 2014.

[20] Los Alamos National Laboratory Procedure, "Air Pathway Dose Assessment," ENV-ES-QP-502.4, November 2011

[21] U.S. Environmental Protection Agency, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities," *Code of Federal Regulations*, Title 40, Part 61.90, Subpart H, 1989.

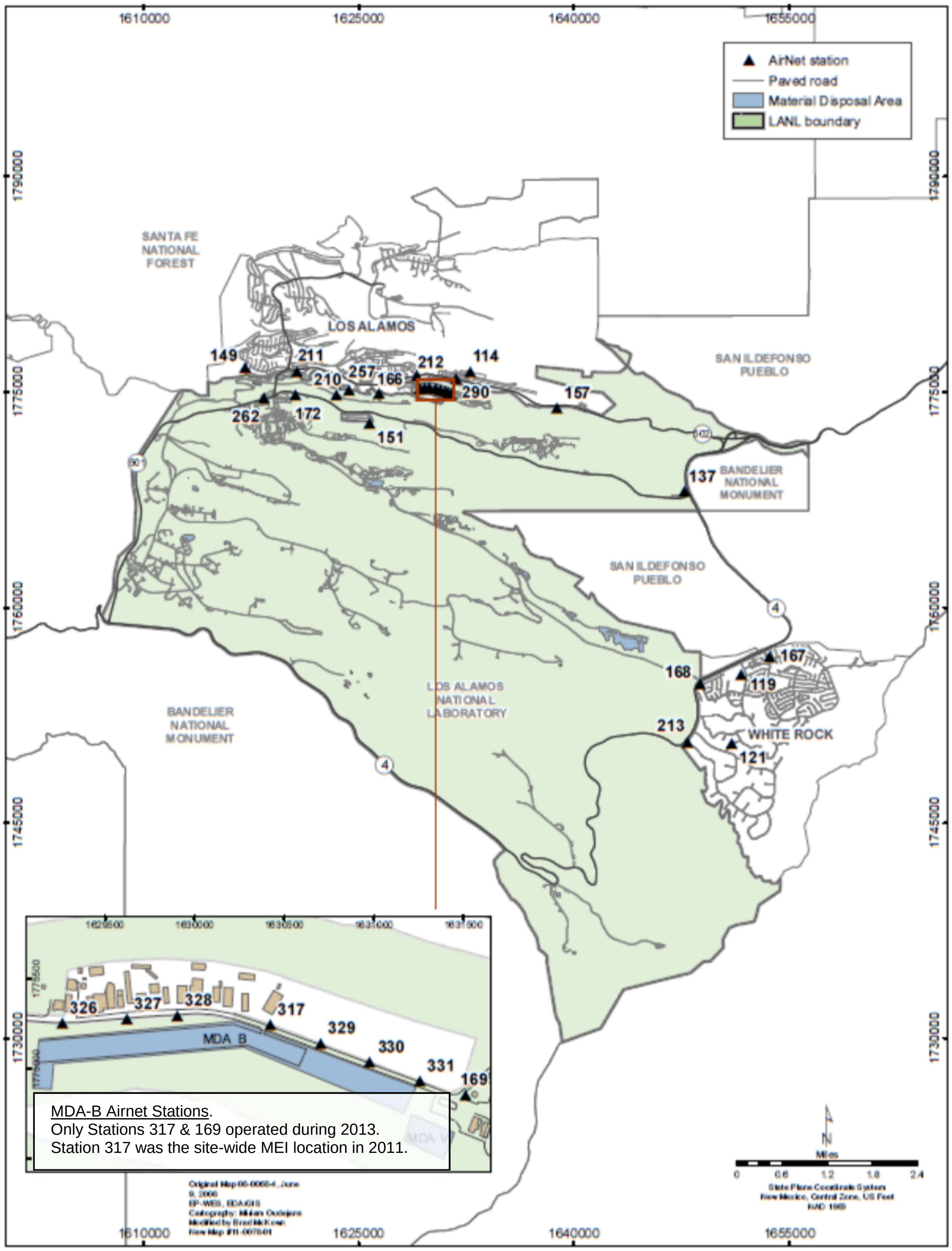

Figure 4. Locations of air sampling stations used for non-point source emissions compliance.

LANSCE Monthly Assessments

The Laboratory evaluates and reports the dose from short-lived radioactive gases released from LANSCE exhaust stack 53000702 on a monthly basis. This is so we can track and trend the emissions and identify any issues that need addressing throughout the year. The monthly dose values are calculated using actual meteorology for the month and the resulting doses are shown in Table 12. For 2013 the Laboratory also evaluated this stack's total gaseous emissions for the year in a single CAP88 run and compared the results to the monthly values summed for the calendar year. When evaluated to the LANSCE facility critical receptor, the sum of monthly doses is a dose of 0.0308 mrem, and the annual total single analysis result is 0.0319 millirem, a difference of 3.5%. This same comparison, when emissions are modeled to the LANL site-wide MEI for 2013, results in a sum of monthly analyses equal to 0.000342 millirem and a single annual analysis equal to 0.000321 millirem. This difference is 6.3%. (see Table 12 for details). These differences are very minor, and for conservatism, LANL uses the maximum value of either the annual evaluation or the sum of the monthly doses for EPA reported doses.

Aside from these monthly GMAP runs from 53000702, all other CAP88 assessments are performed using annual source term and annual meteorological inputs. This decision reflects the year-round sampling for PVAP nuclides, while GMAP is only measured during beam operations. The summary of off-site dose analyses from the LANSCE facility is contained in Table 12.

Highest EDE Determination

For most of the past decade, the maximally exposed individual (MEI) location has been at 2470 East Road, usually referred to as "East Gate." The dose was mostly a result of LANSCE emissions. Emissions reduction efforts in place at LANSCE since 2005 have resulted in very low off-site doses from TA-53 stacks. Emissions were further reduced by improvements made in the new beam Target/Moderator/Reflector System (TMRS) that was installed in early 2010. Because the LANSCE emissions are so low in recent years, the location of the MEI is not as readily apparent as in the past and requires more detailed evaluation, as follows.

We know that the dose from LANSCE emissions can be a significant contributor at its facility critical receptor location (East Gate), but much less so at other possible MEI locations. To evaluate different MEI locations, we normally start by determining the LANSCE doses at the East Gate location, and combine that with the Airnet measurements at East Gate to determine a comparison point. We then examine all other Airnet measurements at receptor locations that match or exceed this comparison point. At these locations, Airnet measurements are summed with doses from the LANSCE facility emissions, modeled with CAP88 to determine dose at each location. Recall that the MEI location must be a school, business, residence, or office.

In 2013, the measured ambient air dose at station 324 was higher than other station measurements by a clear margin. To see if station 324 would be the site MEI, we compare the measured Airnet dose at that location with likely candidates where stack emissions may contribute significantly to the Airnet dose. We first modeled the stack and diffuse emissions from LANSCE (the highest stack source term) to the LANSCE critical receptor at East Gate, for a total of 0.0514 mrem. We then added the Airnet measurements at East Gate (0.019 mrem). Together, these totaled 0.0704 millirem. This is still less than the Station 324 value of 0.08 mrem. Therefore, Station 324 is the MEI location for 2013. Due to the cluster of buildings in the immediate area around Station 324, all doses were modeled to the Airnet station itself rather than any specific building.

This site at Station 324 is located above hillsides in Los Alamos Canyon which have known plutonium contamination. Station 324 routinely measures among the higher air concentrations of the network, and the measured air concentration is entirely dependent on wind speed, vegetation cover, and dryness of the soil & its readiness for resuspension. Current LANL operations have minimal effect on Station 324 measurements; measured air concentrations at this location are almost entirely due to legacy contamination from Manhattan Project-era operations.

To get the total MEI dose at this location, we start with the Airnet measured dose at Station 324 and then add (1) the doses modeled by CAP88 dose from all LANL monitored stacks and LANSCE diffuse sources to this MEI location and (2) the sum of all non-monitored stack potential emissions as modeled by CAP88 to the individual facility receptors for these non-monitored stacks. Details are in the next section and in Table 13.

61.92 Compliance Assessment

The highest EDE to any member of the public at any off-site point where there is a residence, school, or business was 0.21 mrem for radionuclides released by LANL in 2013. This dose was calculated by adding up (1) the dose contributions for each of the point sources at LANL, modeled to the MEI location; (2) the diffuse/fugitive gaseous activation products from LANSCE modeled to this MEI location; (3) the dose measured by the ambient air sampler in the vicinity of the public receptor location; and (4) the potential dose contribution of 0.124 mrem from unmonitored stacks. Because the emissions estimates from unmonitored stacks do not account for pollution control systems, the actual dose from these minor sources is significantly less than the reported potential dose value. Table 13 of this report provides the compliance assessment summary, broken down by stack. The location of the Maximally Exposed Individual (MEI) from LANL operations is a business at 2101 Trinity Drive, adjacent to Airnet Station 324.

Section IV. Construction and Modifications

61.94(b)(8) Constructions, Modifications, and 61.96 Activity Relocations

A brief description of construction and modifications that were completed in 2013 for which the requirement to apply for approval to construct or modify was waived under section 61.96 is given below:

PR-ID: 13A-0014 – TA-53 Argon-39 Purification

In late 2013, experimenters at LANSCE used cryogen "freeze-out" techniques and water vapor traps to make a pure Ar-39 sample from an irradiation target. The target had contained small amounts of tritium and water vapor prior to the purification. The analysis used small amounts of tritium, Ar-39, and Ar-42 (modeled as progeny K-42). Total activity of all three nuclides was less than 0.5 curies. Total potential off-site dose from this operation was 0.00032 millirem. Operations were tracked in the Radioactive Materials Usage Survey.

PR-ID: 13P-0061 - Detection of chemicals

In autumn of 2013, a series of experiments were performed at LANL firing sites to evaluate dispersion and detection of chemicals in the environment. These chemicals included depleted uranium. Over the course of four days, chemicals were released in a series of very short "puff" releases. Less than 5 kilograms of material were released; the off-site dose to the maximally exposed individual member of the public resulting from these experiments totaled less than 0.0015 millirem. While the initial testing protocol is complete in 2013, LANL may continue these experiments in future years, using similar quantities of material, if funding and mission need develops. Radiological emissions from these activities are measured by the Airnet system of ambient air monitoring stations and reported in this annual report as part of typical diffuse emission results (e.g., Tables 10 and 11 of this report).

Expansion of Waste Drum Operations in TA-54 Dome 224

In the summer of 2013, facility operations at TA-54 Area G expanded the program of waste drum filter installation and headspace gas analysis into TA-54 Dome 224. This work is similar to the Drum

Vent System in TA-54 Building 33, but handles contaminated 55-gallon drums that are double-packed inside larger 85-gallon drums. The operations in Dome 224 include the installation of HEPA filters into drums to prevent over-pressurization and the extraction and analysis of headspace gas samples.

The emissions analysis from Dome 224 used a process similar to Building 33 for installation of drum filters and headspace gas sampling, but also included an assessment of potential emissions from any contamination on the surfaces of the inner drum. Calculations based on a subset of drums to be worked in 2013 indicated potential doses would be less than 0.1 millirem. Actual operations in 2013 resulted in a potential emissions of 0.0281 millirem. This source is included in the 2013 RMUS. Operations will continue in future years.

Section V. Additional Information

This section is provided pursuant to DOE guidance and is not required by Subpart H reporting requirements.

Unplanned Releases

During 2013, there were no instances of unplanned releases from the Laboratory via the airborne pathway.

Environmental Monitoring

In addition to the Airnet monitors identified in this report, additional environmental monitoring stations are operated at LANL and include several environmental monitoring stations located near the LANSCE boundary inhabited by the public. Measurement systems at these stations include thermoluminescent dosimeters, continuously operated air samplers, and in-situ high-pressure ion chambers. The combination of these measurement systems allows for monitoring of radionuclide air concentrations and the radiation exposure rate. Results for air sampling associated with NESHAP compliance are included in this document, while results for all monitoring data are published in the Annual Site Environmental Report for compliance with DOE Orders.

Other Supplemental Information

The following information is included for completeness, but not directly required under 40 CFR 61 Subpart H regulations.

- 80-km collective effective (population) dose for 2013 airborne releases: **0.14 person-rem**.

- Compliance with Subparts Q and T of 40 CFR 61—Radon-222 Emissions.
  These regulations apply to ^{222}Rn emissions from DOE storage/disposal facilities that contain by-product material. "By-product material" is the tailings or wastes produced by the extraction or concentration of uranium from ore. Although this regulation targets uranium mills, LANL has likely stored small amounts of by-product material used in experiments in the TA-54 low-level waste facility, MDA G; this practice makes the Laboratory subject to this regulation. Subject facilities cannot exceed an emissions rate of 20 pCi/m2 s of ^{222}Rn. In 1993 and 1994, LANL conducted a study to characterize emissions from the MDA G disposal site.[22] This study showed an average emission rate of 0.14 pCi/m2 s for MDA G. The performance assessment for MDA G has determined that there will not be a significant increase in ^{222}Rn emissions in the future.[23]
- Potential to exceed 0.1 mrem from LANL sources of ^{222}Rn or ^{220}Rn emissions: not applicable at LANL.
- Status of compliance with EPA effluent monitoring requirements as of June 3, 1996: LANL is in compliance with these requirements.

[22] Bart Eklund, "Measurements of Emission Fluxes from Technical Area 54, Areas G and L," Radian Corporation report, Austin, Texas, 1995

[23] Los Alamos National Laboratory, "Performance Assessment and Composite Analysis for Los Alamos National Laboratory Materials Disposal Area G," LA-UR-97-85, 1997.

Table 1. 40-61.94(b)(4-5) Release Point Data

Stack ID	Location TA-Bldg	Effluent Controls	# of Effluent Controls*	Control Efficiency*	Monitored Stack?	Nearest Receptor (m)	Receptor Direction
03001600	TA-03-16	None	0	0%		968	N
03002913	TA-03-29-1	unknown	0	0%		859	NNE
03002914	TA-03-29-2	HEPA	2*	99.95% each*	X	733	NE
03002915	TA-03-29-2	HEPA	2*	99.95% each*	X	734	NE
03002919	TA-03-29-3	Aerosol 95	1	80%	X	838	NNE
03002920	TA-03-29-3	Aerosol 95	1	80%	X	837	NNE
03002923	TA-03-29-4	FARR 30/30	1	20%	X	618	NNW
03002924	TA-03-29-4	FARR 30/30	1	20%	X	618	NNW
03002928	TA-03-29-5	HEPA	2*	99.95% each*	X	938	NE
03002929	TA-03-29-5	HEPA	2*	99.95% each*	X	939	NE
03002932	TA-03-29-7	HEPA	2*	99.95% each*	X	858	NNE
03002933	TA-03-29-7	HEPA	2*	99.95% each*	X	857	NNE
03002944	TA-03-29-9	RIGA-Flow	1	80%	X	939	NNE
03002945	TA-03-29-9	RIGA-Flow	1	80%	X	941	NNE
03002946	TA-03-29-9	RIGA-Flow	1	80%	X	940	NNE
03003299	TA-03-32	unknown	0	0%		641	NNE
03003400	TA-03-34	none	0	0%		668	NNE
03003501	TA-03-35	HEPA	1	99.95%		683	NNE
03006601	TA-03-66	none	0	0%		695	N
03006602	TA-03-66	none	0	0%		709	N
03006603	TA-03-66	none	0	0%		708	N
03006604	TA-03-66	none	0	0%		708	N
03006605	TA-03-66	none	0	0%		714	N
03006606	TA-03-66	none	0	0%		670	N
03006626	TA-03-66	HEPA	1	99.95%		618	N
03006654	TA-03-66	HEPA	1	99.95%		665	N
03006699	TA-03-66	none	0	0%		669	N
03010225	TA-03-102	HEPA	1	99.95%		772	N
03169800	TA-03-1698	none	0	0%		717	NNE
09002103	TA-09-21	none	0	0%		3044	NE
09003499	TA-09-34	none	0	0%		2879	NE

Table 1 (Continued) Release Point Data

Stack ID	Location TA-Bldg	Effluent Controls	# of Effluent Controls	Control Efficiency*	Monitored Stack?	Nearest Receptor (m)	Receptor Direction
15028599	TA-15-285	HEPA	1	99.95%		3719	NNE
15053401	TA-15-534	HEPA	1	99.95%		3282	NNE
16020299	TA-16-202	none	0	0%		1185	S
16020599	TA-16-205	none	0	0%		752	SSW
16045005	TA-16-450	none	0	0%	X	772	S
35000200	TA-35-2	none	0	0%		1294	NNW
35021305	TA-35-213	none	0	0%		1010	N
35045599	TA-35-455	Unknown	0	0%		1055	N
36000104	TA-36-1	unknown	0	0%		5379	SE
39006999	TA-39-69	unknown	0	0%		3071	ENE
43000100	TA-43-1	none	0	0%		122	NNE
46002499	TA-46-24	none	0	0%		2887	N
46003100	TA-46-31	none	0	0%		2792	N
46004106	TA-46-41	none	0	0%		2890	N
46015405	TA-46-154	none	0	0%		2769	N
46015899	TA-46-158	none	0	0%		3053	N
46020099	TA-46-200	none	0	0%		2743	N
48000107	TA-48-1	HEPA/Charco	2*	99.95% each*	X	754	NNE
48000111	TA-48-1	none	0	0%		874	NNE
48000115	TA-48-1	none	0	0%		764	NNE
48000135	TA-48-1	none	0	0%		797	NNE
48000145	TA-48-1	none	0	0%		893	NNE
48000154	TA-48-1	HEPA	2*	99.95% each*	X	756	NNE
48000160	TA-48-1	HEPA	1	99.95%	X	769	NNE
48000166	TA-48-1	HEPA	2*	99.95% each*		867	NNE
48000167	TA-48-1	HEPA	2*	99.95% each*		897	NNE
48000168	TA-48-1	none	0	0%		874	NNE
48004500	TA-48-45	none	0	0%		742	N

Table 1 (Continued)

Stack ID	Location TA-Bldg	Effluent Controls	# of Effluent Controls	Control Efficiency*	Monitored Stack?	Nearest Receptor (m)	Receptor Direction
50000102	TA-50-1	HEPA	1	99.95% each*	X	1185	N
50000299	TA-50-2	none	0	0%		1215	N
50003701	TA-50-37	HEPA	2*	99.95% each*	X	1171	N
50006901	TA-50-69	HEPA	1	99.95%		1199	N
50006902	TA-50-69	HEPA	1	99.95%		1188	N
50006903	TA-50-69	HEPA	2*	99.95% each*	X	1187	N
50006999	TA-50-69	unknown	0	0%		1190	N
50025799	TA-50-257	none	0	0%		1201	N
53000116	TA-53-1	unknown	0	0%		1443	ENE
53000303	TA-53-3	HEPA	1	99.95%	X	806	NNE
53000702	TA-53-7	HEPA	1	99.95%	X	957	NNE
53001599	TA-53-15	none	0	0%		1096	NNE
53001899	TA-53-18	none	0	0%		1019	NNE
53098401	TA-53-984	none	0	0%		1049	NE
53109099	TA-53-1090	none	0	0%		1009	NNE
54003399	TA-54-33	None	0	0%		2058	ESE
54022499	TA-54-224	None	0	0%		2246	ESE
54023199	TA-54-231	HEPA	1	99.95%	X	1480	SE
54037599	TA-54-375	HEPA	1	99.95%	X	1783	SE
54041299	TA-54-412	HEPA	1	99.95%	X	1660	SE
54100199	TA-54-1001	None	0	0%		4999	ESE
54100999	TA-54-1009	None	0	0%		4781	ESE
55000201	TA-55-2	None	0	0%		1111	NNE
55000415	TA-55-4	HEPA	4*	99.95% each*	X	1018	NNE
55000416	TA-55-4	HEPA	4*	99.95% each*	X	1091	NNE
55040099	TA-55-400	HEPA	1	99.95%	X	1302	N

Notes: * As described in the main text, LANL only tests HEPA filter banks down to 0.0005 penetration & 99.95% removal. This table reports the actual number of installed HEPA bank stages and nominal/design removal efficiencies, not tested efficiencies.

Table 2. 40-61.94(b)(7) User Supplied Data—Radionuclide Emissions

StackID	Nuclide	Annual Emission (Ci)
03002914	Pu-238	2.82E-08
03002915	Pu-238	1.77E-09
03002915	Sr-90	1.07E-08
03002915	Y-90(p)	1.07E-08
03002915	Th-230	8.54E-09
03002915	U-234	2.51E-08
03002915	U-238	2.21E-08
03002915	Pa-234m(p)	2.21E-08
03002915	Th-234(p)	2.21E-08
03002919	Am-241	9.14E-07
03002919	Pu-238	2.96E-07
03002919	Pu-239	1.22E-06
03002919	Th-228	4.18E-08
03002919	Th-230	2.29E-08
03002919	U-234	1.37E-07
03002919	Pa-234m(p)	4.45E-08
03002919	Th-234(p)	4.45E-08
03002919	U-238	4.45E-08
03002920	Am-241	1.81E-08
03002920	Pu-238	1.03E-08
03002920	Pu-239	6.14E-08
03002920	Sr-90	2.96E-08
03002920	Y-90(p)	2.96E-08
03002920	Th-228	2.36E-08
03002920	U-234	1.59E-07
03002923	U-234	3.54E-07
03002923	U-238	5.14E-08
03002923	Pa-234m(p)	5.14E-08
03002923	Th-234(p)	5.14E-08
03002924	Am-241	1.39E-08
03002924	Pu-238	2.02E-06
03002924	Pu-239	2.92E-08
03002924	Th-228	1.00E-07
03002924	U-234	2.59E-06
03002924	U-238	3.82E-08
03002924	Pa-234m(p)	3.82E-08
03002924	Th-234(p)	3.82E-08
03002928	Pu-238	1.65E-08
03002928	Pu-239	2.91E-08
03002928	Th-228	4.07E-08
03002929	U-234	2.30E-07
03002929	U-238	8.58E-08
03002929	Pa-234m(p)	8.58E-08
03002929	Th-234(p)	8.58E-08
03002932	U-234	1.85E-07
03002932	U-238	9.46E-08
03002932	Pa-234m(p)	9.46E-08
03002932	Th-234(p)	9.46E-08
03002933	Pu-239	3.70E-09
03002933	Th-228	2.90E-08
03002933	U-234	5.27E-08
03002933	U-238	3.76E-08
03002933	Pa-234m(p)	3.76E-08
03002933	Th-234(p)	3.76E-08
03002944	I-131	8.27E-05
03002944	U-235	1.89E-08
03002944	U-238	6.91E-08
03002944	Pa-234m(p)	6.91E-08
03002944	Th-234(p)	6.91E-08
03002945	I-131	1.92E-06
03002946	I-131	2.73E-05
16045005	H-3(Gas)	9.45E+00
16045005	H-3(HTO)	4.27E+01
48000107	As-74	1.98E-05
48000107	Br-77	2.88E-03
48000107	Br-82	6.60E-05
48000107	Cs-137	8.63E-08
48000107	Ge-68	4.86E-03
48000107	Ga-68(p)	4.86E-03
48000107	Se-75	1.41E-04
48000154	Sr-90	1.73E-08
48000154	Y-90(p)	1.73E-08
48000154	U-238	6.26E-09
48000154	Pa-234m(p)	6.26E-09
48000154	Th-234(p)	6.26E-09
48000160	Se-75	1.43E-06
50000102	Pu-238	1.62E-08
50000102	Pu-239	9.91E-09
50000102	Sr-90	2.23E-07
50000102	Y-90(p)	2.23E-07

StackID	Nuclide	Annual Emission (Ci)
50000102	U-238	4.89E-08
50000102	Pa-234m(p)	4.89E-08
50000102	Th-234(p)	4.89E-08
50003701	Sr-90	9.70E-09
50003701	Y-90(p)	9.70E-09
50003701	Th-230	1.99E-09
50006903	Pu-238	2.45E-10
50006903	Pu-239	1.40E-10
50006903	Sr-90	9.95E-10
50006903	Y-90(p)	9.95E-10
50006903	U-234	1.12E-09
50006903	U-238	7.40E-10
50006903	Pa-234m(p)	7.40E-10
50006903	Th-234(p)	7.40E-10
53000303	Ar-41	1.50E+00
53000303	C-11	3.61E+01
53000303	Be-7	2.25E-05
53000303	Br-82	5.02E-05
53000303	H-3(HTO)	1.29E+01
53000702	Ar-41	1.00E+01
53000702	C-10	1.48E-01
53000702	C-11	5.43E+01
53000702	N-13	1.91E+01
53000702	N-16	4.06E-01
53000702	O-14	1.49E-01
53000702	O-15	2.57E+01
53000702	Be-7	6.67E-07
53000702	Br-76	2.37E-04
53000702	Br-77	7.00E-06
53000702	Br-82	1.77E-03
53000702	H-3(HTO)	4.03E+00
53000702	Hg-197m	4.64E-04
53000702	Hg-197	4.64E-04
53000702	I-131	4.41E-07
53000702	Os-191	1.04E-06

StackID	Nuclide	Annual Emission (Ci)
53000702	Se-75	8.72E-07
54023199	Sr-90	2.18E-09
54023199	Y-90(p)	2.18E-09
54023199	U-234	5.14E-09
54023199	U-238	4.55E-09
54023199	Pa-234m(p)	4.55E-09
54023199	Th-234(p)	4.55E-09
54037599	Pu-239	1.66E-09
54037599	U-234	1.26E-08
54041299	Sr-90	4.30E-09
54041299	Y-90(p)	4.30E-09
54041299	U-234	2.07E-09
55000415	Pu-239	2.82E-10
55000415	U-234	2.05E-08
55000415	U-235	3.53E-09
55000415	U-238	2.07E-08
55000415	Pa-234m(p)	2.07E-08
55000415	Th-234(p)	2.07E-08
55000416	H-3(Gas)	2.01E+00
55000416	H-3(HTO)	1.49E+00
55000416	Pu-239	4.50E-10
55000416	Th-228	5.32E-09
55000416	U-234	2.61E-08
55000416	U-235	5.39E-09
55000416	U-238	2.06E-08
55000416	Pa-234m(p)	2.06E-08
55000416	Th-234(p)	2.06E-08
55040099	None	0.00E+00
Diffuse Sources at TA-53 LANSCE		
53DIF1LS	Ar-41	1.25E-01
53DIF1LS	C-11	2.99E+00
53DIF3SY	Ar-41	3.59E-01
53DIF3SY	C-11	8.62E+00

Table 2 Notes:

Stacks at the Chemistry & Metallurgy Research (CMR) facility identified as 03002914 through 03002933 are recorded in the RADAIR database as N3002914 through N3002933, to indicate measurements made with the New sampling systems, effective 2001.

Starting in 2006, particulate emissions from TA-55 stacks 55000415 and 55000416 are measured from new sample systems, which consist of four independent sample systems on each stack. The four samplers are identified as 5500415A, -B, -C, and -D; and 5500416A, -B, -C, and -D. Stack emissions data reported in this table represent average emission values measured from these four samplers. In the RADAIR database, these average emissions are given the stack ID 5500415X and 5500416X, with the "X" indicating the calculated average value from the four samples. The emissions of tritium (H-3, both HT and HTO forms) from the ES-16 stack use a different sample system, and references remain unchanged in the database.

Radionuclides with the designator "(p)" are short-lived progeny in secular equilibrium with their parent radionuclide; e.g., Ga-68 (progeny) is in equilibrium with Ge-68 (parent).

Non-point emissions sources 53DIF3SY and 53DIF1LS are separated from the main source term table because they are addressed in different sections of the annual emissions report.

Stack 16045005 (ES-5) exhausts buildings TA-16-450 and TA-16-205. The ES-5 stack sampler was not operational, so reported emissions are measured by the sampler in the exhaust duct from 16-205, designated 16020504. That sampler captures all emissions from the facility, as 16-450 operations have not commenced.

A nuclide listing of "None" indicates no measured releases at that stack for this calendar year.

Table 3. 40-61.94(b)(7) User-Supplied Data—Monitored Stack Parameters

StackID	Height (m)	Diameter (m)	Exit Velocity (m/s)	Nearest Meteorological Tower
03002914	15.9	1.07	18.0	TA-6
03002915	15.9	1.05	9.3	TA-6
03002919	15.9	1.07	20.0	TA-6
03002920	15.9	1.07	5.3	TA-6
03002923	15.9	1.07	17.0	TA-6
03002924	15.9	1.06	7.1	TA-6
03002928	15.9	1.05	17.6	TA-6
03002929	15.9	1.07	17.0	TA-6
03002932	15.9	1.07	14.3	TA-6
03002933	15.9	1.06	16.4	TA-6
03002944	16.5	1.52	6.4	TA-6
03002945	16.5	1.52	7.7	TA-6
03002946	16.5	1.88	5.2	TA-6
16045005	18.3	1.18	15.5	TA-6
48000107	13.4	0.30	18.9	TA-6
48000154	13.1	0.91	5.2	TA-6
48000160	12.4	0.38	6.9	TA-6
50000102	15.5	1.82	9.5	TA-6
50003701	12.4	0.91	4.2	TA-6
50006903	10.5	0.31	6.2	TA-6
53000303	33.5	0.91	10.2	TA-53
53000702	13.1	0.91	8.0	TA-53
54023199	0.61	0.61	0 vertical 10.2 horizontal	TA-54
54037599	0.76	0.90	0 vertical 10.4 horizontal	TA-54
54041299	0.61	0.61	0 vertical 4.4 horizontal	TA-54
55000415	9.5	0.93	7.5	TA-6
55000416	9.5	0.94	10.9	TA-6
55040099	26.0	1.88	12.6	TA-6

Table 4. 61.94(b)(7) User-Supplied Data—Monitored Stack Parameters—NM State Plane Coordinates (NAD '83)

StackID	Easting	Northing
03002914	1,619,176	1,772,806
03002915	1,619,171	1,772,805
03002919	1,619,252	1,772,350
03002920	1,619,257	1,772,352
03002923	1,618,691	1,772,719
03002924	1,618,686	1,772,718
03002928	1,618,774	1,772,265
03002929	1,618,767	1,772,265
03002932	1,619,268	1,772,267
03002933	1,619,272	1,772,269
03002937	1,618,966	1,772,397
03002944	1,618,987	1,772,121
03002945	1,618,977	1,772,120
03002946	1,618,982	1,772,121
16045005	1,609,426	1,760,910
48000107	1,623,591	1,770,693
48000154	1,623,744	1,770,650
48000160	1,623,613	1,770,638
50000102	1,626,157	1,769,086
50003701	1,625,757	1,769,111
50006903	1,625,579	1,769,065
53000303	1,638,133	1,771,546
53000702	1,638,057	1,771,054
54023199	1,644,758	1,757,255
54037599	1,644,020	1,757,838
54041299	1,644,568	1,757,946
55000415	1,624,870	1,769,742
55000416	1,624,675	1,769,550
55040099	1,624,983	1,768,754

Table 5. 40-61.94(b)(7) User-Supplied Data—Highest Off-Site Dose Location for Monitored Release Points

StackID	Associated Meteorological Tower	Distance to LANL Highest Dose Location (m)	Direction to LANL Highest Dose Location
03002914	TA-06	1754	ENE
03002915	TA-06	1753	ENE
03002919	TA-06	1790	ENE
03002920	TA-06	1789	ENE
03002923	TA-06	1902	ENE
03002924	TA-06	1903	ENE
03002928	TA-06	1934	ENE
03002929	TA-06	1936	ENE
03002932	TA-06	1797	ENE
03002933	TA-06	1796	ENE
03002944	TA-06	1894	ENE
03002945	TA-06	1898	ENE
03002946	TA-06	1896	ENE
16045005	TA-06	6295	NE
48000107	TA-06	1341	NNE
48000154	TA-06	1345	N
48000160	TA-06	1356	NNE
50000102	TA-06	1870	NNW
50003701	TA-06	1834	NNW
50006903	TA-06	1838	N
53000303	TA-53	4267	WNW
53000702	TA-53	4297	WNW
54023199	TA-54	8210	NW
54037599	TA-54	7925	NW
54041299	TA-54	8023	NW
55000415	TA-06	1608	N
55000416	TA-06	1661	N
55040099	TA-06	1910	N

Table 6. 40-61.94(b)(7) User-Supplied Data—Other Input Parameters

Description	Value	Units	CAP88 Variable Name (source code/V0 identifiers)
Annual rainfall rate	45	cm/y	RR
Lid height	1600	m	LIPO
Annual ambient temperature	9	deg C	TA
Absolute humidity	5.5	g/m^3	
E-vertical temperature gradient	0.02	K/m	TG
F-vertical temperature gradient	0.035	K/m	TG
G-vertical temperature gradient	0.035	K/m	TG
Food supply fraction - local vegetables	1		F1V
Food supply fraction - vegetable regional	0		F2V
Food supply fraction - vegetable imported	0		F3V
Food supply fraction - meat local	1		F1B
Food supply fraction - meat regional	0		F2B
Food supply fraction - meat imported	0		F3B
Food supply fraction - milk local	1		F1M
Food supply fraction - milk regional	0		F2M
Food supply fraction - milk imported	0		F3M
Ground surface roughness factor	0.5		GSCFAC

Table 7: 40-61.94(b)(7) User-Supplied Data—Wind Frequency Array

Due to the extent of data reported in Table 7, this table has been moved to Appendix 1.

Table 8. 40-61.94(b)(7) User-Supplied Data—Population Array

Estimated 2010 Population within 80 km of Los Alamos National Laboratory (revised 2012)

	Distances from Los Alamos – "LANL Area Source"												
Direction (sector)	250	750	1500	2500	3500	4500	7500	15000	25000	35000	45000	55000	70000
N	4	13	89	231	274	514	1350	16	103	1077	0	945	641
NNW	4	17	102	173	375	282	1299	7	22	291	0	0	528
NW	8	4	58	146	218	266	1030	2	27	56	821	0	1153
WNW	4	19	34	65	115	142	281	0	35	41	0	0	3305
W	0	0	22	26	25	30	18	14	119	575	0	135	257
WSW	0	0	0	0	0	0	2	14	1	696	0	4673	0
SW	0	0	0	0	0	0	5	5	0	0	0	3965	0
SSW	0	0	0	0	0	0	36	6	1766	2392	5674	4591	100236
S	0	0	0	0	0	0	20	9	31	274	0	0	6060
SSE	0	0	0	0	0	0	765	51	406	6811	3328	0	0
SE	0	0	0	0	0	0	5764	1	1318	88346	9870	218	6
ESE	0	0	0	0	0	0	36	14	868	10461	0	803	2430
E	0	0	22	26	25	30	18	1915	5002	511	588	1	598
ENE	4	19	34	65	115	142	281	2600	5419	4317	194	1128	1752
NE	8	4	58	146	218	266	1030	1314	17067	2878	1604	1597	3527
NNE	4	17	102	173	375	282	1299	15	2739	479	3483	0	58

Table 9. 40-61.94(b)(7) User-Supplied Data Modeling Parameters for LANL Non-Point Sources

Non-Point Source	Area of Source (m^2)	Radionuclide	Emission (Ci)
TA-53 Beam Switchyard StackID = 53DIF3SY	484	^{41}Ar ^{11}C	3.59E-01 8.62+00
TA-53-1L Service Area Stack ID = 53DIF1LS	1.0	^{41}Ar ^{11}C	1.25E-01 2.99+00

Non-Point Source	Distance to Nearest Receptor Location [Critical receptor] (meters)	Direction to Nearest Receptor Location [Critical Receptor]
TA-53 Beam Switchyard StackID = 53DIF3SY	774	NNE
TA-53-1L Service Area Stack ID = 53DIF1LS	943	NNE

Non-Point Source	Distance to LANL Maximum Dose Location (m)	Direction to LANL Maximum Dose Location
TA-53 Beam Switchyard StackID = 53DIF3SY	4246	WNW
TA-53-1L Service Area Stack ID = 53DIF1LS	4304	WNW

Table 10. Environmental Data—Compliance Stations

2013 Effective Dose Equivalent measured at air sampling locations around LANL (net millirem)									
Site	**Site Name**	**H-3**	**Am-241**	**Pu-238**	**Pu-239**	**U-234**	**U-235**	**U-238**	**Total (mrem)**
114	Los Alamos Airport	0.00	0.00	0.00	0.00	0.01	0.00	0.01	**0.01**
119	Rocket Park (formerly Pinon School)	0.01	0.00	-0.01	0.00	0.01	0.00	0.01	**0.01**
121	Pajarito Acres	0.01	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**
133	Bandelier Fire Lookout (near park entrance)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
137	Well PM-1 (E. Jemez Road)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	**0.02**
149	48th Street (Twin Tanks Complex)	0.01	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**
151	Royal Crest Trailer Court	0.00	0.00	0.00	0.02	0.00	0.00	0.00	**0.02**
157	Eastgate	0.01	0.00	0.00	-0.01	0.01	0.00	0.01	**0.02**
166	McDonalds	0.00	0.00	0.00	0.00	0.00	0.00	0.01	**0.02**
167	White Rock Fire Station	0.00	0.00	0.00	-0.01	0.01	0.00	0.00	**0.01**
168	White Rock Nazarene Church	0.01	0.00	0.00	-0.01	0.00	0.00	0.00	**0.02**
169	TA-21 Area B	0.00	0.00	0.00	0.01	0.01	0.00	0.01	**0.03**
172	Los Alamos County Landfill	0.00	0.00	0.00	0.00	0.02	0.00	0.02	**0.05**
206	Eastgate - Backup	0.00	0.00	0.00	0.00	0.01	0.00	0.01	**0.02**
210	LA Canyon	0.00	0.00	0.00	0.00	0.00	0.00	0.01	**0.01**
211	LA Hospital	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
212	Crossroads Bible Church (formerly Trinity Bible Church)	0.01	0.00	0.00	0.01	0.02	0.00	0.01	**0.05**
213	Monte Rey South	0.01	0.00	0.00	0.00	0.01	0.00	0.01	**0.03**
262	TA-3 Research Park	0.01	0.00	0.00	0.00	0.01	0.00	0.01	**0.02**
290	Los Alamos Airport Road	0.00	0.00	0.00	0.00	0.01	0.00	0.01	**0.02**
307	TA-16 Near S-Site Cafeteria	0.01	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**
317	A15 - West End		0.00	0.00	0.04	0.01	0.00	0.01	**0.06**
324	Hill Side 138	0.00	0.00	-0.01	0.07	0.01	0.00	0.01	**0.08**
348	State Road 502/Mid-Runway		0.00	0.00	0.00	0.01	0.00	0.01	**0.02**

* As discussed in the 2012 report, Station 324 replaced Station 257 as a compliance measurement point in November 2012.

22 "compliance" stations; +1 station 317 for inter-year comparison.

Table 11. Environmental Data—Compliance Stations

2013 Sampler Operational Completeness and Analytical Completeness									
Site #	**Site Name**	**Station % Run Time**	**Am-241**	**H-3**	**Pu-238**	**Pu-239**	**U-234**	**U-235**	**U-238**
114	Los Alamos Airport	99.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
119	Rocket Park (formerly Pinon School)	99.26	100.00	100.00	100.00	100.00	100.00	100.00	100.00
121	Pajarito Acres	99.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
133	Bandelier Fire Lookout (near park entrance)	97.51	100.00	96.00	100.00	100.00	100.00	100.00	100.00
137	Well PM-1 (E. Jemez Road)	98.86	100.00	100.00	100.00	100.00	100.00	100.00	100.00
149	48th Street (Twin Tanks Complex)	98.10	100.00	100.00	100.00	100.00	100.00	100.00	100.00
151	Royal Crest Trailer Court	97.31	100.00	100.00	100.00	100.00	100.00	100.00	100.00
157	Eastgate	97.72	100.00	96.00	100.00	100.00	100.00	100.00	100.00
166	McDonalds	98.97	100.00	100.00	100.00	100.00	100.00	100.00	100.00
167	White Rock Fire Station	99.26	100.00	100.00	100.00	100.00	100.00	100.00	100.00
168	White Rock Nazarene Church	99.19	100.00	100.00	100.00	100.00	100.00	100.00	100.00
169	TA-21 Area B	98.47	100.00	100.00	28.57	28.57	100.00	100.00	100.00
172	Los Alamos County Landfill	96.69	100.00	100.00	100.00	100.00	100.00	100.00	100.00
206	Eastgate - Backup	98.17	100.00	100.00	100.00	100.00	100.00	100.00	100.00
210	LA Canyon	98.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
211	LA Hospital	98.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
212	Crossroads Bible Church	98.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
213	Monte Rey South	96.74	100.00	100.00	100.00	100.00	100.00	100.00	100.00
262	TA-3 Research Park	98.53	100.00	100.00	100.00	100.00	100.00	100.00	100.00
290	Los Alamos Airport Road	99.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
307	TA-16 Near S-Site Cafeteria	98.97	100.00	100.00	100.00	100.00	100.00	100.00	100.00
317	A15 - West End	90.80	100.00		28.57	28.57	100.00	100.00	100.00
324*	Hill Side 138	97.41	100.00	100.00	100.00	100.00	100.00	100.00	100.00
348	State Road 502/ Mid-Runway	91.01	100.00		100.00	100.00	100.00	100.00	100.00
	Average:	**99.48**	**100.0**	**99.33**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

* As discussed in the 2012 Annual Report, Station 324 replaced Station 257 as a compliance measurement point in November 2012.

Table 12. LANSCE Monthly Assessments, Comparison with Annual Analyses, and Facility Dose Summary

Description	StackID	Dose at Critical Receptor @ East Gate (mrem)	Dose at LANL MEI receptor @ Airnet 324 (mrem)
LANSCE stack January GMAP	53000702	4.07E-03	6.15E-05
LANSCE stack February GMAP	53000702	6.06E-03	6.35E-05
LANSCE stack March GMAP	53000702	1.11E-03	8.23E-06
LANSCE stack April GMAP	53000702	None	None
LANSCE stack May GMAP	53000702	None	None
LANSCE stack June GMAP	53000702	None	None
LANSCE stack July GMAP	53000702	None	None
LANSCE stack August GMAP	53000702	3.17E-03	2.17E-05
LANSCE stack September GMAP	53000702	6.08E-03	6.05E-05
LANSCE stack October GMAP	53000702	4.63E-03	5.38E-05
LANSCE stack November GMAP	53000702	3.91E-03	4.00E-05
LANSCE stack December GMAP	53000702	1.76E-03	3.27E-05
Sum of monthly GMAP runs for this stack	53000702	3.08E-02	3.42E-04
GMAP single annual analysis for this stack	53000702	3.19E-02	3.21E-04
Difference, sum of monthly vs. annual analyses:		*3.5%*	*6.3%*

To be conservative, the **maximum value** of the two above methods will be used for all further reporting of GMAP emissions from the main LANSCE stack 53000702. Values are highlighted above for each receptor location.

SUMMARY OF LANSCE FACILITY DOSE		Dose at Critical Receptor @ East Gate (mrem)	Dose at LANL MEI receptor @ Airnet 324 (mrem)
LANSCE stack	53000303	9.14E-03	2.47E-04
LANSCE stack GMAP (see above)	53000702	3.19E-02	3.42E-04
LANSCE stack PVAP	53000702	1.50E-03	6.65E-05
LANSCE Diffuse/Fugitive Emissions – Beam Switchyard	53DIF3SY	7.16E-03	3.31E-05
LANSCE Diffuse/Fugitive Emissions – 1L Service Area	53DIF1LS	1.66E-03	1.10E-05
2013 LANSCE facility summary:		5.14E-02	7.00E-04

GMAP = Gaseous Mixed Activation products; short-lived radioactive gases (e.g., C-11, O-15, Ar-41).

PVAP = Particulate & Vapor Activation Products (e.g., Na-24, Br-76).

Note: All CAP88 analyses above are annual assessments, with the exception of the monthly GMAP analyses for stack 53000702, as described.

Note: For completeness, the "Summary" portion of this table is reproduced in Table 13, next page, for both the facility critical receptor (East Gate) and the LANL Maximally Exposed Individual (MEI) receptor.

Table 13. 40-61.92 Highest Effective Dose Equivalent Summary All LANL Sources

Description	StackID	Dose for Site Critical Receptor (mrem)	Dose at Airnet Station 324 receptor (mrem)
CMR Stack – Wing 2	03002914	1.24E-06	6.04E-07
CMR Stack – Wing 2	03002915	5.34E-07	2.59E-07
CMR Stack – Wing 3	03002919	1.25E-04	4.91E-05
CMR Stack – Wing 3	03002920	8.71E-06	4.01E-06
CMR Stack – Wing 4	03002923	1.57E-06	5.84E-07
CMR Stack – Wing 4	03002924	1.59E-04	6.61E-05
CMR Stack – Wing 5	03002928	3.03E-06	1.61E-06
CMR Stack – Wing 5	03002929	8.66E-07	4.60E-07
CMR Stack – Wing 7	03002932	1.08E-06	4.79E-07
CMR Stack – Wing 7	03002933	1.70E-06	7.26E-07
CMR Stack – Wing 9	03002944	6.53E-05	2.53E-05
CMR Stack – Wing 9	03002945	1.45E-06	5.71E-07
CMR Stack – Wing 9	03002946	2.14E-05	8.26E-06
WETF Stack – new	16045005	7.87E-03	1.33E-03
Radiochemistry Stack	48000107	4.82E-03	2.36E-03
Radiochemistry Stack	48000154	1.79E-07	7.37E-08
Radiochemistry Stack	48000160	6.76E-07	3.14E-07
Waste Management Stack	50000102	1.73E-06	6.69E-07
Waste Management Stack	50003701	6.85E-08	2.59E-08
Waste Management Stack	50006903	3.01E-08	1.52E-08
LANSCE-Stack	53000303	9.14E-03	2.47E-04
LANSCE-Stack – GMAP (See Note 1 below)	53000702	3.19E-02	3.42E-04
LANSCE- Annual – Partic/Vapor	53000702	1.50E-03	6.65E-05
LANSCE Fugitive - Beam Switch Yard	53DIF3SY	7.16E-03	3.31E-05
LANSCE Fugitive - 1L Service Area	53DIF1LS	1.66E-03	1.10E-05
Waste Processing Stack	54023199	6.49E-08	4.18E-10
Waste Processing Stack	54037599	1.44E-07	1.12E-09
Waste Processing Stack	54041299	3.01E-08	2.84E-10
Plutonium Facility Stack	55000415	2.42E-07	1.05E-07
Plutonium Facility Stack	55000416	1.01E-03	4.77E-04
Radiological Lab/Utility/Office Bldg	55040099	0.00E+00	0.00E+00
Unmonitored Stacks - No credit for controls	99000000	1.24E-01	1.24E-01
Air Sampler Net Dose @ this location	99000010	N/A (Various Locations)	0.08
Total maximally exposed individual dose (mrem)			**= 0.21 mrem (report value)**

Note 1: As described in Table 12, the reporting value for GMAP emissions from 53000702 is the maximum value of either the annual GMAP dose assessment or the sum of monthly GMAP dose assessments. Data for TA-53 stacks here is reproduced from Table 12.

61.94(b)(9) Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. See 18 U.S.C. 1001.

Signature: ______________________________ Date: ______

Owner: Kimberly Davis Lebak
Manager
Los Alamos Field Office, NA-00-LA
National Nuclear Security Administration
U. S. Department of Energy

Signature: ______________________________ Date: _____________

Operator: Michael T. Brandt
Associate Director
Environment, Safety, and Health
Los Alamos National Security, LLC
Los Alamos National Laboratory

Appendix 1 – Meteorology Data

Due to the extent of data reported in Table 7, that table has been moved to this appendix.

Table 7: 40-61.94(b)(7) User-Supplied Data—Wind Frequency Arrays

Table 7a: CAP88 Input Data for 2013 TA-6 Meteorological Tower (98.9% Data Completeness)

N	A	0.000490.000230.000000.000000.000000.00000
NNE	A	0.001070.000290.000000.000000.000000.00000
NE	A	0.001670.000920.000000.000000.000000.00000
ENE	A	0.002600.000750.000000.000000.000000.00000
E	A	0.003260.001300.000000.000000.000000.00000
ESE	A	0.002660.001820.000000.000000.000000.00000
SE	A	0.002310.001790.000000.000000.000000.00000
SSE	A	0.001440.001850.000000.000000.000000.00000
S	A	0.000840.001070.000000.000000.000000.00000
SSW	A	0.000690.000690.000030.000000.000000.00000
SW	A	0.000260.000230.000000.000000.000000.00000
WSW	A	0.000430.000400.000000.000000.000000.00000
W	A	0.000320.000260.000000.000000.000000.00000
WNW	A	0.000200.000230.000000.000000.000000.00000
NW	A	0.000230.000060.000000.000000.000000.00000
NNW	A	0.000400.000290.000030.000000.000000.00000
N	B	0.000120.000260.000030.000000.000000.00000
NNE	B	0.000290.000520.000000.000000.000000.00000
NE	B	0.000520.000890.000030.000000.000000.00000
ENE	B	0.000950.001070.000000.000000.000000.00000
E	B	0.001130.001990.000000.000000.000000.00000
ESE	B	0.000810.002080.000000.000000.000000.00000
SE	B	0.001130.002450.000000.000000.000000.00000
SSE	B	0.000720.002370.000000.000000.000000.00000
S	B	0.000320.001530.000120.000000.000000.00000
SSW	B	0.000170.000430.000000.000000.000000.00000
SW	B	0.000140.000400.000000.000000.000000.00000
WSW	B	0.000060.000260.000000.000000.000000.00000
W	B	0.000140.000260.000060.000000.000000.00000
WNW	B	0.000030.000200.000090.000000.000000.00000
NW	B	0.000000.000140.000000.000000.000000.00000
NNW	B	0.000120.000170.000030.000000.000000.00000
N	C	0.000170.000580.000030.000000.000000.00000
NNE	C	0.000490.001470.000090.000000.000000.00000
NE	C	0.001010.003900.000170.000000.000000.00000
ENE	C	0.001560.003410.000140.000000.000000.00000
E	C	0.002400.004960.000030.000000.000000.00000
ESE	C	0.001530.005370.000120.000000.000000.00000
SE	C	0.001410.007650.000260.000000.000000.00000
SSE	C	0.001010.009470.001700.000000.000000.00000
S	C	0.000490.006610.001850.000000.000000.00000
SSW	C	0.000290.001990.001180.000000.000000.00000
SW	C	0.000200.001300.000580.000000.000000.00000
WSW	C	0.000170.000490.000460.000000.000000.00000
W	C	0.000060.000810.000630.000030.000000.00000
WNW	C	0.000090.000810.000610.000030.000000.00000
NW	C	0.000140.000750.000380.000000.000000.00000
NNW	C	0.000200.000580.000120.000000.000000.00000

(Table continued next page)

Table 7a (continued)

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  N D 0.004300.007880.003670.001070.000140.00000
NNE D 0.005510.011800.004820.001470.000380.00000
 NE D 0.004590.011170.003900.000380.000060.00000
ENE D 0.005280.008230.001070.000000.000000.00000
  E D 0.006520.006580.000320.000030.000000.00000
ESE D 0.003550.006700.000780.000000.000000.00000
 SE D 0.003720.010760.002970.000000.000000.00000
SSE D 0.004360.019250.018040.001360.000000.00000
  S D 0.004070.020810.037140.006670.000430.00000
SSW D 0.004210.016570.031860.009840.000690.00000
 SW D 0.003230.008600.017200.008690.001620.00040
WSW D 0.003550.006230.011260.009610.001330.00009
  W D 0.002630.006640.014030.014200.004100.00046
WNW D 0.002830.007160.014690.013880.004730.00052
 NW D 0.003290.007680.012350.006120.001100.00003
NNW D 0.003920.006900.004910.000890.000030.00000
  N E 0.001820.004990.002020.000000.000000.00000
NNE E 0.001790.004700.001330.000000.000000.00000
 NE E 0.001010.002080.000140.000000.000000.00000
ENE E 0.001180.001130.000060.000000.000000.00000
  E E 0.000980.000520.000030.000000.000000.00000
ESE E 0.000890.000520.000090.000000.000000.00000
 SE E 0.000720.000870.000060.000000.000000.00000
SSE E 0.001390.002480.000120.000000.000000.00000
  S E 0.001850.009180.001360.000000.000000.00000
SSW E 0.002220.016880.003980.000000.000000.00000
 SW E 0.002140.013560.009580.000000.000000.00000
WSW E 0.001760.004560.002910.000000.000000.00000
  W E 0.001530.003200.001730.000000.000000.00000
WNW E 0.001210.005140.004560.000000.000000.00000
 NW E 0.001880.008540.004330.000000.000000.00000
NNW E 0.002050.004990.001390.000000.000000.00000
  N F 0.009470.010510.000630.000000.000000.00000
NNE F 0.005400.003980.000000.000000.000000.00000
 NE F 0.003060.000520.000000.000000.000000.00000
ENE F 0.002140.000290.000000.000000.000000.00000
  E F 0.001760.000090.000000.000000.000000.00000
ESE F 0.001730.000550.000000.000000.000000.00000
 SE F 0.001620.000170.000000.000000.000000.00000
SSE F 0.002630.000430.000000.000000.000000.00000
  S F 0.003260.001500.000000.000000.000000.00000
SSW F 0.005050.004010.000000.000000.000000.00000
 SW F 0.007160.013680.000610.000000.000000.00000
WSW F 0.010100.025800.002020.000000.000000.00000
  W F 0.009380.023260.000690.000000.000000.00000
WNW F 0.007760.018180.000890.000000.000000.00000
 NW F 0.009260.024700.000630.000000.000000.00000
NNW F 0.009240.015320.000380.000000.000000.00000
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Table 7 (continued)

Table 7b: CAP88 Input Data for 2012 TA-53 Meteorological Tower (99.96% Data Completeness)

N	A	0.001000.000340.000000.000000.000000.00000
NNE	A	0.002080.000630.000000.000000.000000.00000
NE	A	0.003330.001280.000000.000000.000000.00000
ENE	A	0.004130.002990.000000.000000.000000.00000
E	A	0.003390.002310.000000.000000.000000.00000
ESE	A	0.002730.002790.000030.000000.000000.00000
SE	A	0.002900.002190.000000.000000.000000.00000
SSE	A	0.002140.001880.000000.000000.000000.00000
S	A	0.001110.001540.000030.000000.000000.00000
SSW	A	0.000600.000800.000000.000000.000000.00000
SW	A	0.000630.000480.000000.000000.000000.00000
WSW	A	0.000510.000340.000000.000000.000000.00000
W	A	0.000260.000310.000000.000000.000000.00000
WNW	A	0.000430.000260.000000.000000.000000.00000
NW	A	0.000400.000260.000000.000000.000000.00000
NNW	A	0.000480.000460.000000.000000.000000.00000
N	B	0.000140.000310.000000.000000.000000.00000
NNE	B	0.000650.000770.000000.000000.000000.00000
NE	B	0.000710.001310.000000.000000.000000.00000
ENE	B	0.001400.002930.000030.000000.000000.00000
E	B	0.000970.003190.000000.000000.000000.00000
ESE	B	0.001000.003100.000030.000000.000000.00000
SE	B	0.000800.002140.000000.000000.000000.00000
SSE	B	0.000630.001990.000000.000000.000000.00000
S	B	0.000400.001820.000000.000000.000000.00000
SSW	B	0.000230.000510.000000.000000.000000.00000
SW	B	0.000110.000340.000030.000000.000000.00000
WSW	B	0.000060.000170.000000.000000.000000.00000
W	B	0.000060.000260.000030.000000.000000.00000
WNW	B	0.000030.000340.000000.000000.000000.00000
NW	B	0.000140.000090.000060.000000.000000.00000
NNW	B	0.000110.000280.000030.000000.000000.00000
N	C	0.000200.000830.000430.000000.000000.00000
NNE	C	0.000770.002250.000370.000030.000000.00000
NE	C	0.001080.004300.000510.000000.000000.00000
ENE	C	0.001480.006720.000230.000000.000000.00000
E	C	0.001480.006860.000260.000000.000000.00000
ESE	C	0.001280.005870.000110.000000.000000.00000
SE	C	0.000830.005040.000280.000000.000000.00000
SSE	C	0.000850.007150.000630.000000.000000.00000
S	C	0.000570.005240.000910.000000.000000.00000
SSW	C	0.000200.002250.000540.000000.000000.00000
SW	C	0.000140.001170.000430.000030.000000.00000
WSW	C	0.000110.000570.000600.000000.000000.00000
W	C	0.000140.000710.000680.000000.000000.00000
WNW	C	0.000060.000770.000680.000000.000000.00000
NW	C	0.000030.000280.000310.000000.000000.00000
NNW	C	0.000310.000480.000260.000000.000000.00000

(Table continued next page)

Table 7b (continued)

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  N D 0.006090.009710.009480.003300.000200.00000
NNE D 0.006580.011560.010360.004560.000650.00003
 NE D 0.005750.009880.006430.001080.000060.00000
ENE D 0.004730.010140.002990.000200.000000.00000
  E D 0.003390.009650.001940.000060.000000.00000
ESE D 0.003360.005610.001540.000170.000000.00000
 SE D 0.002650.006350.002250.000370.000000.00000
SSE D 0.001990.011650.014120.005270.000680.00006
  S D 0.002760.014750.037300.019050.001110.00040
SSW D 0.002420.011300.036930.023290.002330.00125
 SW D 0.002160.009450.020900.009910.000970.00009
WSW D 0.001740.006180.012700.009850.002530.00034
  W D 0.001680.005520.014720.008600.001910.00011
WNW D 0.002050.004700.008880.007000.002140.00006
 NW D 0.002900.003700.005180.004070.000510.00026
NNW D 0.004440.005670.005150.001910.000400.00006
  N E 0.004470.010220.001540.000000.000000.00000
NNE E 0.004380.007630.002160.000000.000000.00000
 NE E 0.002930.006060.001050.000000.000000.00000
ENE E 0.001990.002960.000460.000000.000000.00000
  E E 0.001590.001940.000170.000000.000000.00000
ESE E 0.000910.001710.000110.000000.000000.00000
 SE E 0.000830.000940.000090.000000.000000.00000
SSE E 0.001000.001960.000970.000000.000000.00000
  S E 0.001280.005380.007400.000000.000000.00000
SSW E 0.001170.010820.027670.000000.000000.00000
 SW E 0.001710.020840.015230.000000.000000.00000
WSW E 0.001510.008230.010340.000000.000000.00000
  W E 0.001820.009420.009480.000000.000000.00000
WNW E 0.002050.006720.004870.000000.000000.00000
 NW E 0.002510.005210.002510.000000.000000.00000
NNW E 0.003730.007920.003900.000000.000000.00000
  N F 0.006210.002360.000000.000000.000000.00000
NNE F 0.006090.001990.000170.000000.000000.00000
 NE F 0.005470.002220.000000.000000.000000.00000
ENE F 0.004640.001000.000000.000000.000000.00000
  E F 0.003360.000570.000000.000000.000000.00000
ESE F 0.003100.000370.000000.000000.000000.00000
 SE F 0.003160.001170.000000.000000.000000.00000
SSE F 0.002820.001340.000060.000000.000000.00000
  S F 0.002990.002960.000030.000000.000000.00000
SSW F 0.003700.007400.001400.000000.000000.00000
 SW F 0.003840.004750.000340.000000.000000.00000
WSW F 0.003270.007740.003330.000000.000000.00000
  W F 0.003050.009110.004670.000000.000000.00000
WNW F 0.004610.006490.000260.000000.000000.00000
 NW F 0.004610.003730.000540.000000.000000.00000
NNW F 0.005470.003500.000570.000000.000000.00000
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Table 7 (continued)

Table 7c: CAP88 Input Data for 2012 TA-54 Meteorological Tower (99.95% Data Completeness)

N	A	0.000570.000280.000000.000030.000000.00000
NNE	A	0.001080.000650.000000.000000.000000.00000
NE	A	0.001710.001420.000000.000000.000000.00000
ENE	A	0.003500.002450.000000.000000.000000.00000
E	A	0.005980.004100.000000.000000.000000.00000
ESE	A	0.005180.003080.000000.000000.000000.00000
SE	A	0.003530.002140.000000.000000.000000.00000
SSE	A	0.002310.002160.000000.000000.000000.00000
S	A	0.000850.001650.000000.000000.000000.00000
SSW	A	0.000830.000880.000000.000000.000000.00000
SW	A	0.000650.000510.000000.000000.000000.00000
WSW	A	0.000310.000430.000000.000000.000000.00000
W	A	0.000230.000370.000000.000000.000000.00000
WNW	A	0.000370.000280.000000.000000.000000.00000
NW	A	0.000400.000310.000000.000000.000000.00000
NNW	A	0.000340.000370.000030.000000.000000.00000
N	B	0.000090.000400.000030.000000.000000.00000
NNE	B	0.000170.000600.000030.000000.000000.00000
NE	B	0.000310.001540.000030.000000.000000.00000
ENE	B	0.000850.002650.000000.000000.000000.00000
E	B	0.001110.003050.000000.000000.000000.00000
ESE	B	0.001080.002530.000000.000000.000000.00000
SE	B	0.000650.002160.000000.000000.000000.00000
SSE	B	0.000510.001880.000000.000000.000000.00000
S	B	0.000280.001820.000110.000000.000000.00000
SSW	B	0.000090.001080.000060.000000.000000.00000
SW	B	0.000110.000340.000030.000000.000000.00000
WSW	B	0.000060.000310.000000.000000.000000.00000
W	B	0.000000.000280.000090.000000.000000.00000
WNW	B	0.000060.000260.000030.000000.000000.00000
NW	B	0.000060.000140.000000.000000.000000.00000
NNW	B	0.000030.000200.000000.000000.000000.00000
N	C	0.000170.000340.000260.000000.000000.00000
NNE	C	0.000140.001450.000340.000000.000000.00000
NE	C	0.000570.004210.000230.000000.000000.00000
ENE	C	0.000970.007200.000280.000000.000000.00000
E	C	0.001050.006440.000140.000000.000000.00000
ESE	C	0.000850.004640.000030.000000.000000.00000
SE	C	0.000570.003500.000060.000000.000000.00000
SSE	C	0.000480.003590.000400.000000.000000.00000
S	C	0.000370.004900.001030.000000.000000.00000
SSW	C	0.000480.002960.000850.000000.000000.00000
SW	C	0.000170.001400.000460.000000.000000.00000
WSW	C	0.000060.000540.000680.000030.000000.00000
W	C	0.000060.000400.001450.000090.000000.00000
WNW	C	0.000090.000480.000910.000000.000000.00000
NW	C	0.000060.000510.000280.000000.000000.00000
NNW	C	0.000000.000340.000090.000000.000000.00000

(Table continued next page)

Table 7c (continued)

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  N D 0.003590.004870.003250.002360.000170.00000
NNE D 0.004610.009480.012070.005780.001280.00006
 NE D 0.004410.016120.012360.001400.000140.00003
ENE D 0.004360.010540.002360.000230.000000.00000
  E D 0.002560.005580.001110.000060.000030.00000
ESE D 0.001790.002930.000680.000060.000000.00000
 SE D 0.001310.003250.001960.000370.000000.00000
SSE D 0.001250.005040.006860.004930.001220.00028
  S D 0.001420.009940.024200.020960.005270.00020
SSW D 0.001480.012590.036620.039270.006690.00271
 SW D 0.002110.009540.019250.012240.001650.00031
WSW D 0.002510.006610.008570.007260.001250.00006
  W D 0.003100.005780.009820.004580.000200.00000
WNW D 0.003530.004270.008170.003250.000570.00000
 NW D 0.004160.005810.004810.002990.000280.00000
NNW D 0.003840.004840.002620.001370.000200.00000
  N E 0.002420.004560.003640.000000.000000.00000
NNE E 0.001850.004360.003450.000000.000000.00000
 NE E 0.001540.002650.001480.000000.000000.00000
ENE E 0.000850.001510.000460.000000.000000.00000
  E E 0.000770.000940.000060.000000.000000.00000
ESE E 0.000770.000140.000060.000000.000000.00000
 SE E 0.000570.000430.000090.000000.000000.00000
SSE E 0.000400.000910.000770.000000.000000.00000
  S E 0.000650.002650.004470.000000.000000.00000
SSW E 0.000880.005270.013150.000000.000000.00000
 SW E 0.001280.008340.016260.000000.000000.00000
WSW E 0.001400.005980.003390.000000.000000.00000
  W E 0.002080.007800.003190.000000.000000.00000
WNW E 0.003020.009600.003500.000000.000000.00000
 NW E 0.002900.008230.002450.000000.000000.00000
NNW E 0.002930.005520.001620.000000.000000.00000
  N F 0.008400.014070.001540.000000.000000.00000
NNE F 0.006830.009820.000800.000000.000000.00000
 NE F 0.003220.003190.000200.000000.000000.00000
ENE F 0.001850.001250.000000.000000.000000.00000
  E F 0.001480.000310.000000.000000.000000.00000
ESE F 0.001140.000090.000000.000000.000000.00000
 SE F 0.000710.000200.000000.000000.000000.00000
SSE F 0.000940.000630.000030.000000.000000.00000
  S F 0.001080.001450.000060.000000.000000.00000
SSW F 0.001590.005300.001080.000000.000000.00000
 SW F 0.002360.014180.006950.000000.000000.00000
WSW F 0.003050.020470.006380.000000.000000.00000
  W F 0.006320.022670.004730.000000.000000.00000
WNW F 0.007800.020240.000830.000000.000000.00000
 NW F 0.011280.040210.001540.000000.000000.00000
NNW F 0.009990.021180.002990.000000.000000.00000
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