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2011 LANL Radionuclide Air Emissions Report

Los Alamos
NATIONAL LABORATORY
EST. 1943

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U. S. Department of Energy Report

2011 LANL Radionuclide Air Emissions

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Location: County of Los Alamos, New Mexico

Operations Office Information:

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Compliance Assessment:

2011 Off-Site Effective Dose Equivalent: 3.53 mrem

Executive Summary

This report describes the emissions of airborne radionuclides from operations at Los Alamos National Laboratory (LANL) for calendar year 2011, 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 task, 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 3.53 mrem for 2011. 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 2011, LANL continuously monitored radionuclide emissions at 28 "major" release points, or stacks. The Laboratory estimates emissions from an additional 55 "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 2011, this MEI location was a business at 278 DP Road. This business is the easternmost building on DP Road, directly across the street from a cleanup operation of legacy waste at Materials Disposal Area B (MDA-B). The primary contributor to the off-site dose measured at this location was airborne emissions from MDA-B cleanup operations. Other contributors to the reported off-site dose included the potential emissions from non-monitored (minor) emissions sources throughout the Laboratory and emissions of short-lived radioactive gases from the LANSCE accelerator facility. While the overall off-site dose represents an increase relative to previous years, it should be noted that the successful remediation of MDA-B resulted in the overall reduction of risk, through excavation and managed disposal of the radioactive material from MDA-B.

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
2002	1.69	2470 East Road (“East Gate”)
2003	0.65	2470 East Road (“East Gate”)
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

2011 Significant Events

Several events that took place in 2011 are worth discussion in this Executive Summary.

Completion of excavation at Materials Disposal Area B. Preliminary excavation of the Manhattan Project-era radioactive waste disposal facility at MDA-B began in February 2010, with large-scale excavation operations starting in June of that year and continuing through most of 2011. In January 2011, minor scope changes were made in which much of the MDA-B excavated soil would be re-used at LANL, as long as the soil meets certain criteria for such on-site re-use. Ambient air emissions measurement operations at MDA-B were conducted according to the MDA-B Emissions Management Plan, including actions taken when elevated emissions were measured.

Following completion of excavation, a small number of waste management activities took place, extending into 2012. These include processing gas cylinders, soil handling, and other operations. Excavation enclosures remain in place at MDA-B, awaiting final disposition.

Status of further cleanup activities at TA-21. As described in the 2010 report, demolition of legacy buildings at TA-21 was completed in 2010 and 2011. Further work, including removal of sub-surface piping, foundation slabs, etc., was originally to be addressed in 2012. Due to funding limitations, LANL is focusing work in 2012 on disposition of waste from TA-54, deferring additional TA-21 work for later years. The work described above, as well as remediation of other legacy TA-21 disposal sites such as MDA-T, MDA-A and the General’s Tanks in MDA-A will be planned in coming years. When work at

these areas resumes, air monitoring programs will be developed as appropriate to manage potential emissions from these sites.

Expansion of waste processing at TA-54. As described in last year's report, two new waste processing sources came on-line in 2010. Construction on a third source, TA-54 Dome 375, is planned to start operations in 2012. A pre-construction application for this source was submitted to EPA Region 6 in June 2011. Approval was received in July, and construction commenced in late 2011. Dome 375 will have a monitored stack, with the stack design modeled after the stack at TA-54 Dome 231. A full suite of testing was performed on the Dome 231 stack in July 2011, meeting all design criteria in ANSI/HPS N13.1-1999.

Changes to Radioactive Liquid Waste Treatment Facility. Changes to the Radioactive Liquid Waste Treatment Facility (RLWTF) at TA-50 Building 1 were described in the 2010 report. There were no liquid discharges to the environment from the RLWTF in 2011. All treated effluent was instead routed to an evaporator, TA-50 Building 257. Prior to operations at Building 257, an evaluation of operations determined that this building does not require continuous stack emissions monitoring. Rather, Building 257 is tracked as a minor (non-monitored) point source in the Radioactive Materials Usage Survey (RMUS). The sum of potential off-site doses from all LANL minor sources in the RMUS is included as a line-item in Table 13. The main RLWTF stack on Building 1 remains a monitored source of emissions.

Upgrade CMR Wings 5 and 7 exhaust fans. Operations in the Chemistry and Metallurgy Research (CMR) building are being consolidated in three wings (Wings 5, 7, and 9), while other wings are undergoing risk reduction activities to prepare for building shutdown. To maintain operational status in Wings 5 and 7 of CMR, exhaust fans were replaced in each of these wings. Each wing has two exhaust fans, each leading to a monitored stack. These four fans were replaced over the course of 2011, with one fan being off at a time in each wing while the other fan maintained exhaust flow for the wing. Emissions monitoring continued throughout the process. Now that all flows are stabilized, LANL Rad-NESHAP personnel will evaluate the new flows for any possible changes to monitoring systems that may be needed.

Stack shutdown at TA-3-102-ES-22. The stack exhaust fan at TA-3 Building 102, Stack 22 (ES-22) malfunctioned in late January 2011. Per Rad-NESHAP policy, sampling operations stayed operational in anticipation of fan repair and restart. After repair attempts were unsuccessful, the facility operations team decided to discontinue use of this fan. Radiological operations in this area are scheduled to be moved to a new building in future years. In the interim, any ongoing operations in the current building will not be exhausted to the outside air. Stack sampling operations ceased at the end of CY 2011, with no plans to restart.

Fukushima reactor accident and resulting radionuclide air concentrations. Following the Great East Japan Earthquake and subsequent tsunami in March 2011, accidents at nuclear power reactors at Fukushima Daiichi resulted in airborne concentrations of radioactive materials. As this plume spread around the globe, LANL's air monitoring program was able to measure trace quantities of fission products in the air in New Mexico. These fission products included isotopes of iodine, strontium, and cesium. After comparison with current and historical LANL operations, such measurements were identified as being from the Fukushima releases and not representative of LANL emissions. These measurements were therefore rejected from analysis and reporting as LANL emissions. A complete discussion of LANL measurements related to the Fukushima incident will be included in the 2011 Environmental Report. Levels in New Mexico were far below any health concern, and these detections are more a testament to the sensitivity of our air monitoring instrumentation.

Las Conchas wildfire. LANL operations were suspended during the Las Conchas wildfire, which started in late June 2011, lasting until early July. The fire, which was the largest in New Mexico history at that time, burned areas north, west and south of the Laboratory but did not have significant impacts on LANL property. Ambient air monitoring efforts were increased during the fire to fully quantify what, if any, impact the fire had on radiological air concentrations. Measurements indicate that the air concentrations were identical to those normally associated with large-scale wildfires, and there were no LANL radionuclide emissions from the fire. A more detailed description of this event will be included in the 2011 Environmental Report.

2011 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 2011, 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).

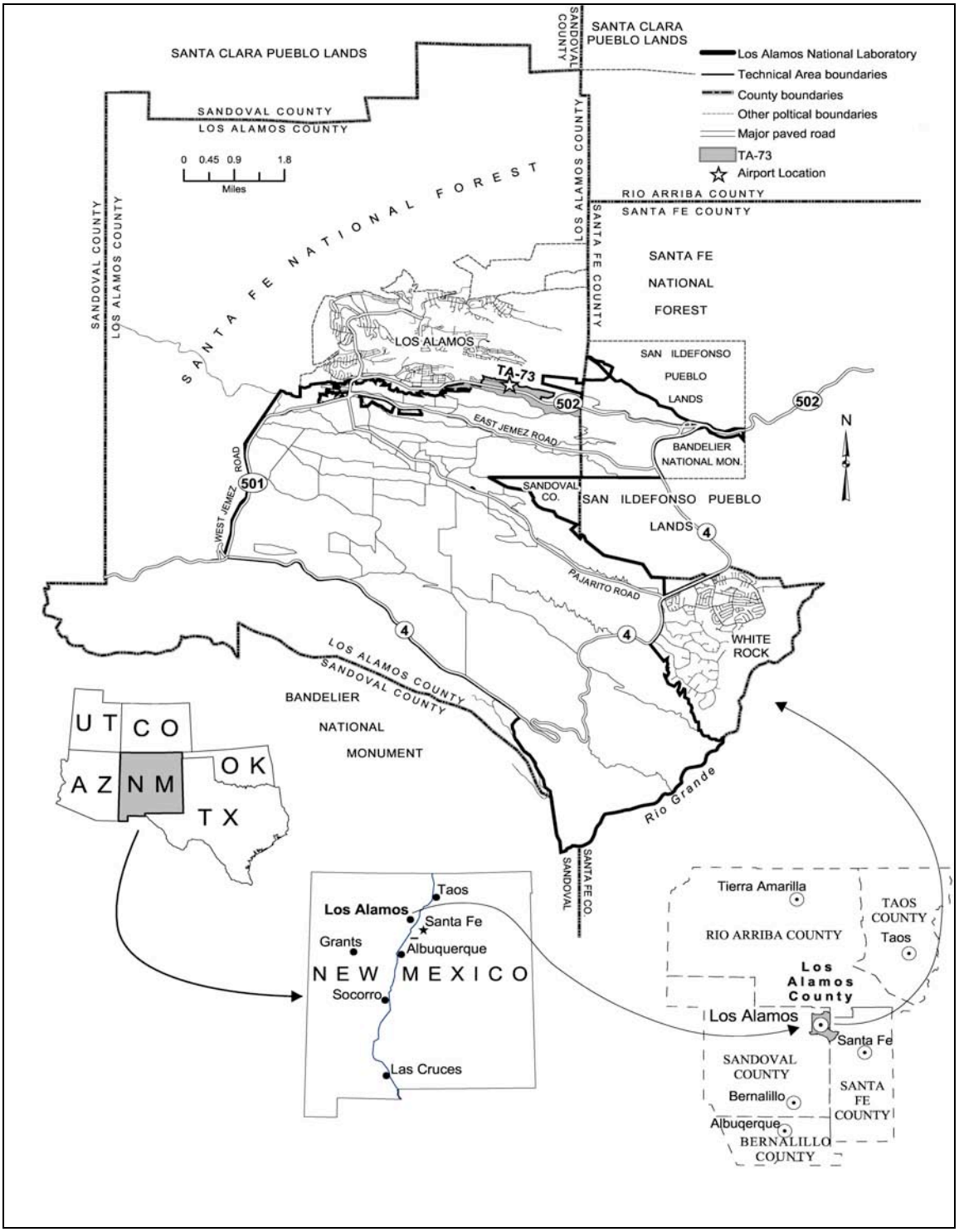


Figure 1. Location of Los Alamos National Laboratory.

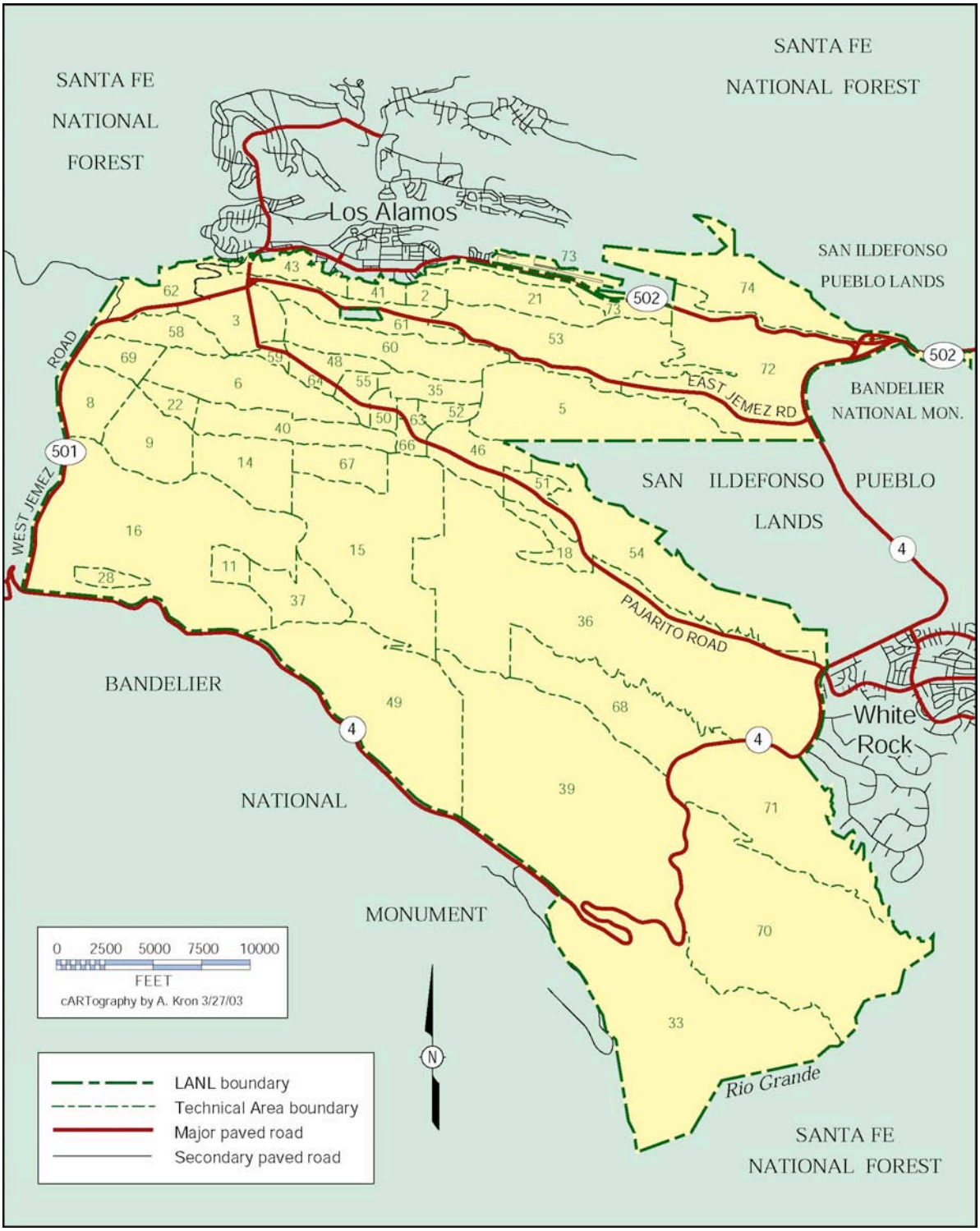


Figure 2. Los Alamos National Laboratory technical areas by number.

The radionuclides emitted from point sources at LANL in calendar year 2011 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

[Note – numerical superscript references in this and subsequent sections refer to external documents, listed at the end of this report.]

LANL technical areas and operations summaries are listed below. Additional descriptions of LANL technical areas can be found in the annual Environmental Report for LANL.[1] More thorough descriptions of LANL operations can be found in the Annual Site-Wide Environmental Impact Statement Yearbooks, the most recent being published in 2010.[2] 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 described earlier, 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.

TA-3-66: This facility is used for a variety of nuclear materials work, primarily for dealing with metallic and ceramic items, including depleted uranium. The uranium foundry is in this building.

TA-3-102: This machine shop is used for the metalworking of radioactive materials, primarily depleted uranium. The facility only operated for less than one month of 2011, and operations are planning to move to TA-3-141 over the next several years. Currently, TA-3-141 is a non-radiological facility. No moves from TA-3-102 to TA-3-141 took place in 2011.

TA-3-1698: This facility is designated as 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: Dual-Axis Radiographic Hydrodynamic Test (DARHT) Facility: This facility 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 testing, vessels undergo cleanout in building 15-534 and at times, 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: 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 2011 are measured with the 16-205 duct monitor, but exhausted through and modeled from the 16-450 ES-05 stack.

TA-21: Many of the facilities at this decommissioned radiochemistry site are undergoing decontamination and demolition. Some of these operations may contribute to diffuse emissions of uranium and plutonium into the air. The Executive Summary details the current operational state of TA-21. 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. The MDA-B legacy waste disposal site is also considered part of TA-21. Final remediation of building foundations, subsurface structures, and legacy disposal areas will take place in coming years, as described in the Executive Summary.

TA-41-4: This building was formerly used as a tritium-handling facility. The tritium sources were removed in 2002. 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 supporting the medical radioisotope production program, the Yucca Mountain program, nuclear chemistry experiments, and geochemical and environmental research. These separations involve nCi to Ci (hot cell) 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.

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 did not operate in 2011, and that practice has been discontinued. The new evaporator mentioned in Section IV, Construction and Modifications 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.

TA-50-69: This waste management site consists of a waste characterization, reduction, and repackaging facility. 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 an energy 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.

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.

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.[3] 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.

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, 55 unmonitored ("minor") release points in 40 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/yr 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*.[4] 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.

The distance between each of the release points and the nearest receptor is provided in Table 1. The nearest receptor can be a residence, school, business, or office. In this report, the nearest receptor is defined as the public receptor most impacted by a given release point; that is, the air dispersion pattern is taken into account to determine the nearest or most critical receptor location.

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 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.[5]

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, a building is considered 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 summarizes the potential impacts of non-point sources by analyzing and reporting air concentration measurements of significant radionuclides (other than activation products) collected at ambient air-sampling (Airnet) sites around the Laboratory and at locations of public receptors surrounding the Laboratory. The LANL Airnet system was approved for use in monitoring LANL's non-point radioactive air emission sources in 1996.[6] 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.[7,8]

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.

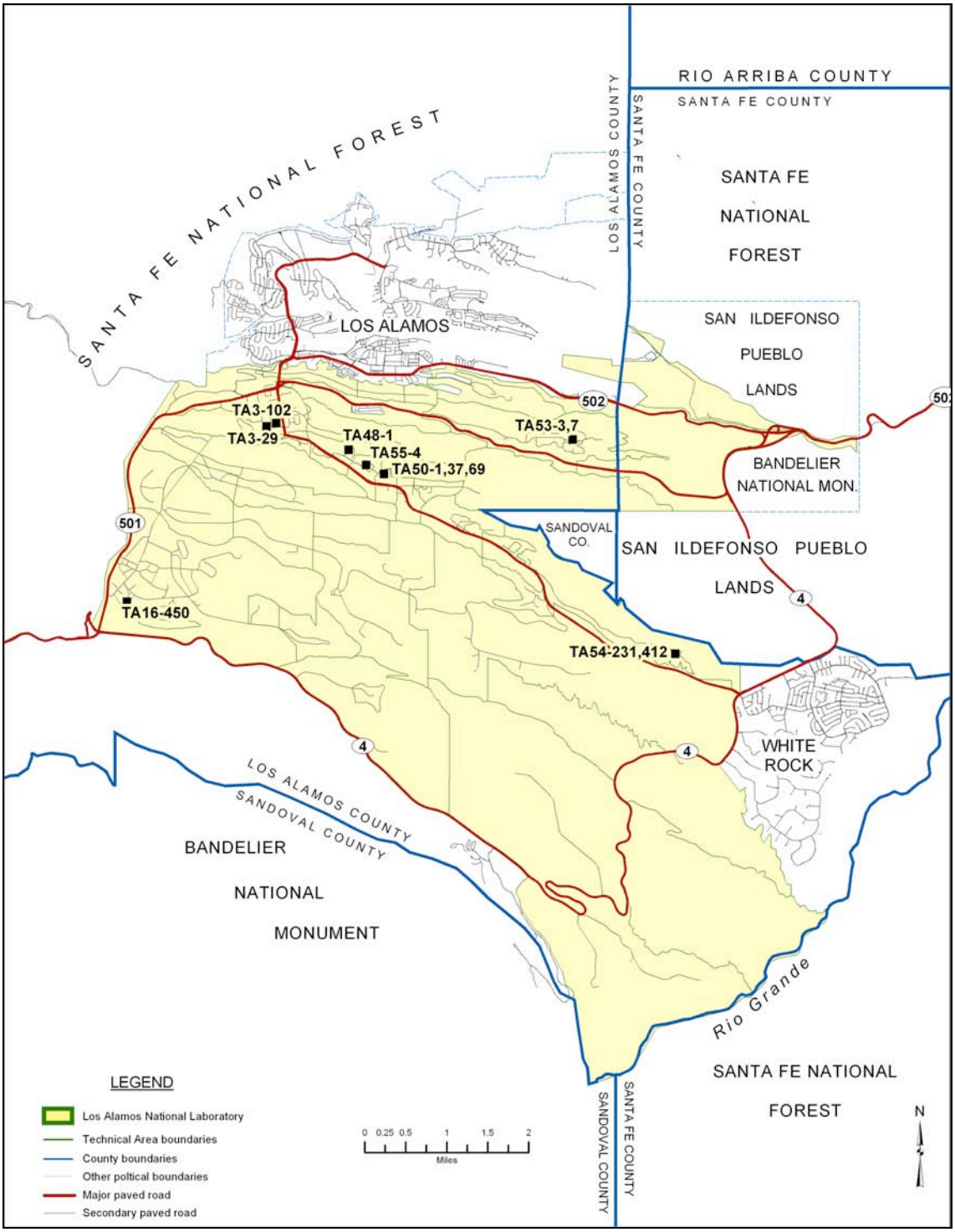


Figure 3. Location of facilities with continuously operated stack-sampling systems for airborne radionuclide emissions.

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 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.

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 loops) 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 2011, 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. Three of the monitored stacks do not meet Subpart H requirements for "major" sources and did not have inspections performed on them. This accounts for the 28 monitored stacks at LANL

Of the inspections performed in 2011, seven stack sample systems required cleaning. These systems will be addressed as part of the 2012 sampler inspection cycle. In 2011, 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. Starting with the 2006 annual emissions report, LANL uses CAP88-PC version 3 to demonstrate compliance. 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 version 3. For conservatism, however, all tritium is modeled as vapor phase HTO.

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 2011 can be calculated based on the rate of generation measured in 2001, using representative parameters.

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. Interviews with experimenters at ES-15 areas have established an upper bound on the potential emissions and chemical form of these emissions, and they are reported in Table 2.

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 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. This information is then used 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 2011 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 2011, 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. Copies of the meteorological data files used for the annual 2011 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. The population arrays used at LANL were updated in late 2011, and various files were developed for population dose assessment; different files are used depending on where the dominant LANL source is located in a given year. For 2012, LANL's dominant emitter was at MDA-B, so the "TA-21" 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,[9] 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 3 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 includes all radionuclides for which there are dose conversion factors in the EPA's Federal Guidance Reports.[10, 11, 12] In 2011, only three monitored radionuclides were not included in CAP88 for the monitored stacks source term: ^{10}C, ^{14}O,

and ^{16}N. These nuclides are all very short-lived accelerator activation & spallation products. For ^{10}C and ^{14}O, ^{11}C was used as a surrogate, as described in the Laboratory procedure ENV-EAQ-512.[13] CAP88 was used to calculate the ^{11}C dose, which was then adjusted for the number of curies emitted, the gamma energy emitted per decay, and the half life of the radionuclides. For ^{16}N, ^{28}Al was used as the surrogate nuclide and the resulting dose was adjusted accordingly. The maximum dose from emissions of radionuclides not included in the CAP88 library was 7.19 E-06 mrem (see Tables 12 and 13). This dose contribution is well below the criteria for individual nuclide monitoring, which is 10% of a source's PEDE. Updates of "non-CAP88 nuclides" for monitored and non-monitored point sources will be described in an upcoming memo to EPA Region 6 later this summer.

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 2011, approximately 14 Ci of ^{11}C and 0.6 Ci of ^{41}Ar were released from LANSCE as fugitive emissions.[14] These sources were modeled as area sources using CAP88, 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 37 air sampling stations (Figure 4) is calculated by subtracting an appropriate background concentration value.[15] 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/yr from all appropriate exposure pathways (100% occupancy assumed at the respective location).[16] 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 2011, 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. This includes all stations along DP Road at MDA-B. These stations have the notation "No H-3" in the tritium dose or analytical completeness column. Station 317 represents our highest compliance dose for 2011. While tritium is not measured at Station 317, it is apparent from review of nearby stations (stations 114, 169, 212, and 290) that the dose contribution from tritium at these locations is less than 0.01 mrem for 2011. MDA-B itself contained no tritium; the age of the landfill means all remaining tritium would have long decayed away.

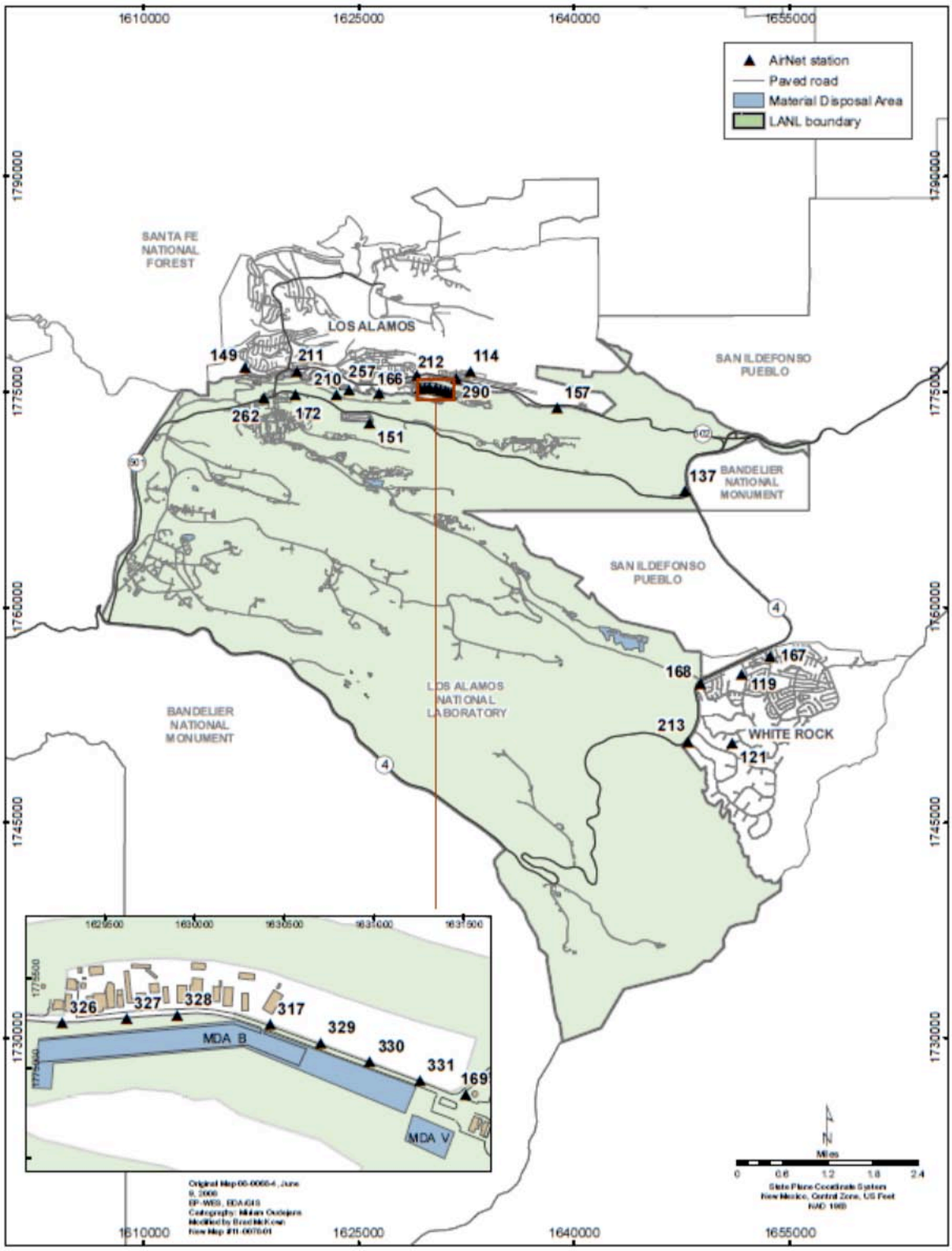


Figure 4. Locations of air sampling stations used for non-point source emissions compliance.

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 2011 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. The sum of monthly doses resulted in a dose of 0.0396 mrem, while the annual total single analysis resulted in a total of 0.0387 mrem. The values differ by under 3%. This difference is likely due to the annual meteorological file including windy spring season, while the monthly files (starting in June of each year) do not include this season. This issue is made moot by using the maximum value of either the annual evaluation or the sum of the monthly doses for EPA reported doses.

All doses were evaluated at the East Gate receptor location initially; additional receptors were added in later. For later receptors (278 DP Road), annual runs were performed and compared with sum of monthly runs as well. The difference between the annual evaluation and the sum of the monthly evaluations was about 10% for these other receptors. In all cases, the maximum of either the annual GMAP run or the sum of monthly GMAP runs was used for reporting purposes at each analyzed receptor location.

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 2011, the MDA-B cleanup resulted in relatively high measurements of ambient air concentrations. Airnet Station 317 measured over three millirem, based on summed biweekly measurements. We knew that this level of dose would dominate anything emitted by LANSCE in 2011. Therefore, the business adjacent to Station 317, address 278 DP Road, was clearly the MEI location for 2011 operations. For Station 317, we compared the air concentration measurements as measured by the biweekly "operational trending" analysis and the normal quarterly analysis. The biweekly measurements measured plutonium only, as this was the primary pollutant of concern from MDA-B. The sum of biweekly analyses were higher than the quarterly sums for plutonium, so the more conservative biweekly sum value for plutonium isotopes was used for compliance calculations. Quarterly Airnet measurements were used for other nuclides and added to the plutonium value to determine the final ambient air dose measured at Station 317.

To get the total MEI dose at 278 DP Road, we start with the Airnet measured dose at Station 317 and then add (1) the doses modeled by CAP88 dose from all LANL monitored stacks to this 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 3.53 mrem for radionuclides released by LANL in 2011. 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 0.148 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 off-site point of highest EDE for 2011 is 278 DP Road, the eastern-most business on DP Road across from the MDA-B cleanup site.

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 2011 for which the requirement to apply for approval to construct or modify was waived under section 61.96 is given below:

Sample Loading at TA-53-17

A new HEPA filtered glovebox was installed in 2011 at TA-53-17. The new glovebox will be used for handling radioactive material that is contained on target foils. These foils are used in irradiation experiments at the LANSCE facility's Weapons Neutron Research (WNR) beam line. In the glovebox, these foils are sealed into irradiation experiment systems. The glovebox is exhausted back into the room at TA-53-17, making this building a diffuse source of emissions. Irradiation of the foils takes place at the WNR experiment lines at TA-53. The WNR target is exhausted out of the monitored stack at TA-53-7, ES-2.

Initial emissions estimates for the sample loading were based on maximum operating scope, particulate reduction factor of 1E-3, and assuming a ground level release. Based on these conservative assumptions, CAP88 calculated a worst-case off-site dose of less than 2.1E-3 mrem/yr. Based on the actual amount of radioactive material loaded in 2011, the potential off-site dose was 3.6E-5 mrem. These experiments will continue in 2012. Radioactive air emissions from this source and other diffuse sources are measured by existing Airnet stations at off-site receptor locations.

Combustion Experiments at TA-9

Combustion chamber experiments were conducted at TA-9 buildings. Sample preparation was performed at TA-9 Building 21, and the combustion experiments conducted at TA-9 Building 34. Follow-up radiochemical analyses took place back at Building 21. Combustion chamber experiments and depleted uranium (DU) experiments are ongoing at the Laboratory, but this represents the first-time usage of radioactive material (DU) in Building 34. Building 21 housed radiological experiments many years ago.

Combustion chamber experiments in Building 34 are conducted on a bench top and exhausted to outside air via a snorkel system, making this a point source release. Associated activities in Building 21

are performed inside a standard chemical fume hood, which is also considered a point source of emissions. Potential radioactive air emissions from these buildings will be tracked through RMUS.

Initial estimates of emissions and off-site doses were based on an operating envelope of processing up to 500 g per year of DU. Assuming 100% release of DU, off-site dose consequence of this corresponds to less than 2E-4 mrem/year. Actual operations in 2011 resulted in emissions less than 1.37E-07 mrem/year.

Vessel Repair Work at TA-15-285

Explosive experiments at LANL take place in vessels at the Dual Axis Radiological Hydrodynamic Test (DARHT) facility. Vessel surface repair work now takes place in TA-15-285. Although post shot vessels are cleaned out and decontaminated prior to being brought to this facility, trace amounts of depleted uranium may be present in dents on the interior vessel surface. These dents are gouged out using plasma arc or carbon arc welding. The work takes place inside the post shot vessel using a containment tent. Exhaust air is pulled from the vessel, through the tent, through a HEPA filter and vented outside the building. Vessel clean-out and repair work are existing ongoing activities at LANL, but this represents first time use of radioactive material at TA-15-285. Potential radioactive air emissions from these buildings will be tracked through RMUS.

For pre-job planning purposes, initial estimates of potential off-site dose from TA-15-285 assumed a maximum usage equal to 5% of the total nuclear material authorized for DARHT's confined vessel shots, and that all of that inventory would be released from ground level. Using CAP88 and these conservative assumptions, the maximum potential uncontrolled off-site dose was 1.5E-2 mrem/yr. Subsequent analytical work done by DARHT personnel indicate that over 99% of the radioactive throughput is removed from vessels prior to their arrival at TA-15-285. Based on actual throughput for 2011, assuming that 1% of radioactive material remains in the vessel, and that all of this radioactive material is released at ground level, CAP88 calculates the worst-case uncontrolled off-site dose for 2011 to be less than 8E-8 mrem/yr. This vessel repair work will continue in 2012.

Evaporator for RLWTF at TA-50

A new evaporator, designated as TA-50-257, was installed to evaporate treated influent from the Radioactive Liquid Waste Treatment Facility at TA-50. Initial estimates of potential off-site dose assumed the maximum gallons/minute processing capability of the RLWTF and 24/7 operations for the entire year. Concentrations of radionuclides present in the treated effluent were assumed to be the

maximum allowable under the existing NPDES (discharge) permit, and all radioactive material was assumed to be released to the air. Using these conservative assumptions, CAP88 calculated the potential off-site uncontrolled dose to be 0.05 mrem/yr. Based on the actual volume of treated effluent sent to the evaporator in 2011 and on the actual concentration of radionuclides present in the effluent, and assuming 100% release, CAP88 calculated the potential off-site dose for 2011 to be 1.91E-05 mrem/yr. Use of the evaporator will continue in 2012. Potential radioactive air emissions from the evaporator will continue to be tracked through RMUS.

Section V. Additional Information

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

Unplanned Releases

During 2011, the only instances of increased airborne emissions of radionuclides at the Laboratory were those at MDA-B. Such instances were addressed according to the MDA-B emissions management plan and communicated to EPA Region 6. No other instances of elevated emissions required reporting to the EPA. There were no instances of an unplanned event.

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 Environmental Report for DOE Order compliance. This can be found on the web at the following URL: http://www.lanl.gov/environment/air/reports.shtml

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 equivalent for 2011 airborne releases: 0.576 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/m^2 s of ^{222}Rn. In 1993 and 1994, LANL conducted a study to characterize emissions from the MDA G disposal site.[17] This study showed an average emission rate of 0.14 pCi/m^2 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.[18]
- 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.

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
03002937	TA-03-29-V	HEPA	2*	99.95% each*	X	872	NE
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
03010222	TA-03-102	HEPA	1	99.95%	X	792	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				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
36000104	TA-36-1	unknown	0	0%		5379	SE
39006999	TA-39-69	unknown				??	??
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%	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%	X	756	NNE
48000160	TA-48-1	HEPA	1	99.95%	X	769	NNE
48000166	TA-48-1	HEPA	2*	99.95%		867	NNE
48000167	TA-48-1	HEPA	2*	99.95%		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
54023199	TA-54-231	HEPA	1	99.95%	X	1480	SE
54028101	TA-54-281	HEPA	1	99.95%		1922	ESE
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

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	Emission (Ci)
03002914	Pu-238	1.40E-08
03002914	Pu-239	6.48E-09
03002915	Pu-238	4.60E-09
03002915	Pu-239	4.02E-09
03002915	U-238	7.21E-08
03002915	Pa-234m (p)	7.21E-08
03002915	Th-234 (p)	7.21E-08
03002919	Am-241	2.49E-06
03002919	Pu-238	2.24E-06
03002919	Pu-239	9.41E-06
03002919	Sr-90	7.08E-08
03002919	Y-90 (p)	7.08E-08
03002919	Th-228	5.84E-08
03002919	Th-232	2.06E-08
03002920	Am-241	3.59E-08
03002920	Pu-238	1.13E-08
03002920	Pu-239	1.06E-07
03002920	Sr-90	1.19E-07
03002920	Th-228	3.60E-08
03002920	Y-90 (p)	1.19E-07
03002923	Pa-234m (p)	6.40E-08
03002923	Pu-238	4.84E-09
03002923	Sr-90	6.83E-08
03002923	Th-234 (p)	6.40E-08
03002923	U-234	5.44E-07
03002923	U-238	6.40E-08
03002923	Y-90 (p)	6.83E-08
03002924	Am-241	4.47E-09
03002924	Pu-238	7.23E-08
03002924	Pu-239	2.58E-08
03002924	Sr-90	6.20E-08
03002924	Y-90 (p)	6.20E-08
03002924	Th-228	5.93E-08
03002924	Th-232	1.98E-08
03002924	U-234	1.67E-06
03002924	U-238	3.81E-08
03002924	Th-234 (p)	3.81E-08
03002924	Pa-234m (p)	3.81E-08
03002928	Am-241	4.13E-08
03002928	Pu-238	1.37E-06
03002928	Pu-239	1.72E-07
03002928	Th-228	3.72E-08
03002928	U-234	4.55E-08
03002928	U-238	3.81E-08
03002928	Pa-234m (p)	3.81E-08
03002928	Th-234 (p)	3.81E-08
03002929	Pu-238	6.70E-08
03002929	Pu-239	2.71E-08
03002929	Sr-90	1.84E-07
03002929	Y-90 (p)	1.84E-07
03002932	Pu-238	5.57E-08
03002932	Pu-239	9.37E-09
03002932	Th-232	3.15E-08
03002932	U-234	4.96E-08
03002933	Am-241	6.86E-08
03002933	Pu-238	4.77E-06
03002933	Pu-239	3.42E-07
03002933	Th-228	2.41E-08
03002933	U-234	5.34E-08
03002937	None	0.00E+00
03002944	U-238	7.05E-08
03002944	Pa-234m (p)	7.05E-08
03002944	Th-234 (p)	7.05E-08
03002945	None	0.00E+00
03002946	Th-230	4.44E-08
03010222	Th-228	3.14E-10
03010222	Th-230	9.31E-10
03010222	U-234	8.65E-08
03010222	U-235	1.69E-09
16045005	H-3(Gas)	2.22E+01
16045005	H-3(HTO)	4.05E+01
48000107	As-73	7.16E-06
48000107	As-74	6.10E-06
48000107	Br-76	2.99E-05
48000107	Br-77	1.41E-05
48000107	Ge-68	7.08E-03
48000107	Ga-68 (p)	7.08E-03
48000107	Hg-197m	1.15E-04
48000107	Hg-197 (p)	1.15E-04
48000107	Se-75	9.56E-05
48000154	U-238	4.66E-09
48000154	Pa-234m (p)	4.66E-09
48000154	Th-234 (p)	4.66E-09
48000160	As-72	6.37E-05
48000160	As-73	4.63E-07
48000160	As-74	7.72E-08
48000160	Br-76	1.20E-04
48000160	Ge-68	1.02E-06
48000160	Ga-68 (p)	1.02E-06
48000160	Mn-54	1.70E-08
48000160	Se-75	4.93E-05
50000102	Pu-238	6.18E-09

StackID	Nuclide	Emission (Ci)
50000102	Sr-90	8.17E-08
50000102	Y-90 (p)	8.17E-08
50000102	Th-230	4.52E-08
50000102	Th-232	2.68E-08
50003701	None	0.00E+00
50006903	Am-241	7.92E-10
50006903	Pu-238	4.12E-09
50006903	Pu-239	1.69E-09
50006903	U-234	9.59E-10
53000303	Ar-41	2.33E+00
53000303	As-73	1.96E-06
53000303	Be-7	3.76E-05
53000303	Br-76	5.00E-06
53000303	Br-77	1.19E-06
53000303	Br-82	6.06E-05
53000303	C-11	5.60E+01
53000303	H-3(HTO)	2.00E+01
53000702	Ar-41	1.49E+01
53000702	As-73	1.66E-05
53000702	Br-76	3.01E-04
53000702	Br-77	1.66E-05
53000702	Br-82	2.38E-03
53000702	C-10	2.88E-01
53000702	C-11	7.15E+01
53000702	H-3(HTO)	4.45E+00
53000702	Hg-197m	7.34E-04
53000702	Hg-197 (p)	7.34E-04
53000702	N-13	3.48E+01
53000702	N-16	6.21E-01
53000702	Na-24	2.18E-06
53000702	O-14	7.40E-01
53000702	O-15	4.67E+01
53000702	Os-191	6.56E-06
53000702	Se-75	2.61E-06
54023199	Pu-238	3.51E-10
54023199	Th-232	9.14E-10
54041299	Pu-238	1.23E-10
54041299	Th-230	9.70E-10
55000415	H-3(Gas)	5.00E-01
55000415	H-3(HTO)	5.00E-01
55000415	Pu-238	9.30E-10
55000415	Th-228	5.07E-09
55000415	Th-230	5.20E-09
55000415	U-238	1.69E-08
55000415	Pa-234m (p)	1.69E-08
55000415	Th-234 (p)	1.69E-08
55000416	H-3(Gas)	1.09E+01
55000416	H-3(HTO)	1.53E+00
55000416	Pu-239	3.21E-09
55000416	Th-228	2.02E-08
55000416	Th-232	4.58E-09
55000416	U-238	1.62E-08
55000416	Pa-234m (p)	1.62E-08
55000416	Th-234 (p)	1.62E-08

Non-Point (Diffuse) Sources		
StackID	**Nuclide**	**Emission (Ci)**
53DIF1LS	Ar-41	3.37E-01
53DIF1LS	C-11	8.08E+00
53DIF3SY	Ar-41	2.64E-01
53DIF3SY	C-11	6.33E+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.

Notes continued next page

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).

The term "None" in the Nuclide column indicates that there were no detectable emissions from this source this calendar year.

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.

Emissions of H-3 from 55000415 represent potential emissions, based on user estimation. This stack is not monitored for tritium due to the very low contribution of tritium to off-site dose from this stack.

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	17.3	TA-6
03002915	15.9	1.05	9.2	TA-6
03002919	15.9	1.07	16.3	TA-6
03002920	15.9	1.07	19.2	TA-6
03002923	15.9	1.07	17.1	TA-6
03002924	15.9	1.06	14.8	TA-6
03002928	15.9	1.05	30.0	TA-6
03002929	15.9	1.07	27.9	TA-6
03002932	15.9	1.07	22.3	TA-6
03002933	15.9	1.06	25.9	TA-6
03002937	16.8	0.20	4.5	TA-6
03002944	16.5	1.52	9.4	TA-6
03002945	16.5	1.52	6.9	TA-6
03002946	16.5	1.88	7.1	TA-6
03010222	13.4	0.91	0.4	TA-6
16045005	18.3	1.18	16.0	TA-6
48000107	13.4	0.30	20.2	TA-6
48000154	13.1	0.91	5.6	TA-6
48000160	12.4	0.38	10.6	TA-6
50000102	15.5	1.82	11.3	TA-6
50003701	12.4	0.91	4.4	TA-6
50006903	10.5	0.31	6.2	TA-6
53000303	33.5	0.91	10.5	TA-53
53000702	13.1	0.91	8.1	TA-53
540023199	0.61	0.61	0 vertical 6.0 horizontal	TA-54
540041299	0.61	0.61	0 vertical 4.6 horizontal	TA-54
55000415	9.5	0.93	7.5	TA-6
55000416	9.5	0.94	10.4	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
03010222	1,618,354	1,772,074
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
54041299	1,644,568	1,757,946
55000415	1,624,870	1,769,742
55000416	1,624,675	1,769,550

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	3517	ENE
03002915	TA-06	3520	ENE
03002919	TA-06	3529	ENE
03002920	TA-06	3526	ENE
03002923	TA-06	3669	ENE
03002924	TA-06	3670	ENE
03002928	TA-06	3676	ENE
03002929	TA-06	3677	ENE
03002932	TA-06	3530	ENE
03002933	TA-06	3530	ENE
03002937	TA-06	3609	ENE
03002944	TA-06	3625	ENE
03002945	TA-06	3628	ENE
03002946	TA-06	3626	ENE
03010222	TA-06	3814	ENE
16045005	TA-06	7767	NE
48000107	TA-06	7763	NE
48000154	TA-06	2522	NE
48000160	TA-06	2491	NE
50000102	TA-06	2526	NE
50003701	TA-06	2311	NE
50006903	TA-06	2375	NE
53000303	TA-53	2419	NE
53000702	TA-53	2609	WNW
54023199	TA-54	2659	WNW
54041299	TA-54	2144	NW
55000415	TA-06	2082	NW
55000416	TA-06	2407	NE

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 Arrays

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 TA-21 (distances in kilometers)												
Direction (sector)	**0.0-0.8**	**0.8-1.0**	**1.0-2.0**	**2.0-3.0**	**3.0-4.0**	**4.0-5.0**	**5.0-10**	**10-20**	**20-30**	**30-40**	**40-50**	**50-60**	**60-80**
N	100	0	400	666	0	0	0	16	103	1077	0	945	641
NNW	100	200	400	666	400	0	0	7	22	291	0	0	528
NW	100	200	400	666	800	400	0	2	27	56	821	0	1153
WNW	100	200	400	666	800	457	0	0	35	41	0	0	3305
W	0	100	400	333	400	0	0	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	0	333	0	0	0	1915	5002	511	588	1	598
ENE	0	0	0	0	0	0	0	2600	5419	4317	194	1128	1752
NE	100	0	400	666	0	0	0	1314	17067	2878	1604	1597	3527
NNE	100	0	400	666	0	0	0	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^3)	Radionuclide	Emission (Ci)
TA-53 Beam Switchyard StackID = 53DIF3SY	484	^{41}Ar	2.64-01
		^{11}C	6.33E+00
TA-53-1L Service Area Stack ID = 53DIF1LS	1.0	^{41}Ar	3.37E-01
		^{11}C	8.08+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	2564	WNW
TA-53-1L Service Area Stack ID = 53DIF1LS	2669	WNW

Table 10. Environmental Data—Compliance Stations

2011 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	LA Airport Terminal Bldg	0.006	0.004	0.002	0.019	0.007	0.000	0.004	0.043
119	Rocket Park	0.015	0.000	0.004	0.000	0.005	0.001	0.002	0.027
121	Pajarito Acres	0.010	-0.002	-0.003	-0.002	0.001	0.000	0.002	0.005
133	Bandelier Fire Lookout	0.002	-0.002	-0.004	0.005	0.004	0.001	0.004	0.011
137	Well PM-1	0.005	-0.002	-0.003	0.002	0.005	0.000	0.000	0.007
149	48th Street	0.002	-0.003	-0.005	0.002	0.000	0.001	0.000	-0.003
151	Royal Crest Trailer Court	0.001	0.001	0.000	0.001	0.009	0.001	0.012	0.025
157	Eastgate	0.003	-0.002	0.001	0.001	0.008	0.000	0.010	0.020
166	McDonalds	0.006	-0.004	-0.002	0.005	0.003	0.001	0.007	0.017
167	White Rock Fire Station	0.008	-0.006	0.001	0.002	0.004	0.001	0.003	0.014
168	WR Nazarene Church	0.014	-0.001	-0.004	0.002	0.004	0.002	0.003	0.019
169	TA-21 Area B	0.009	0.011	0.010	0.230	0.022	0.002	0.017	0.301
172	LA County Landfill	0.008	-0.005	0.002	0.000	0.041	0.004	0.039	0.088
206	Eastgate – Backup	-0.001	0.000	-0.001	0.067	0.006	0.001	0.006	0.078
210	LA Canyon	0.000	-0.001	-0.002	0.008	0.007	0.001	0.007	0.020
211	Los Alamos Medical Center	0.000	-0.005	-0.001	-0.001	0.005	0.001	0.005	0.004
212	Crossroads Bible Church	0.000	0.000	0.000	0.016	0.009	0.002	0.007	0.034
213	Monte Rey South	0.011	-0.003	-0.003	-0.001	0.008	0.002	0.009	0.023
257	Los Alamos Inn - South	0.004	0.008	-0.002	0.783	0.009	0.002	0.010	0.813
262	TA-3 Research Park	0.004	-0.004	-0.003	0.004	0.005	0.001	0.005	0.012
290	Los Alamos Airport Road	-0.001	0.007	0.000	0.087	0.004	0.000	0.006	0.104
291	DP Rd - West Entrance	*No H-3*	0.000	-0.003	0.010	0.012	0.001	0.010	0.029
307	TA-16	0.006	-0.001	-0.001	-0.002	0.007	0.001	0.005	0.015
317	A15 - West End	*No H-3*	0.040	0.020	3.240	0.038	0.003	0.031	3.372
318	East Road Fire Station	*No H-3*	0.005	0.000	0.262	0.014	0.002	0.015	0.297
319	New Beginnings Church	*No H-3*	-0.004	-0.002	0.015	0.013	0.002	0.013	0.038
320	HedgeRow East Rd.	*No H-3*	0.003	-0.003	0.214	0.008	0.002	0.010	0.235
326	DP - Fire Station	*No H-3*	0.000	0.000	0.130	0.018	0.002	0.015	0.164
327	DP - Ace	*No H-3*	0.004	0.002	0.280	0.013	0.001	0.012	0.312
328	DP - Monitor	*No H-3*	0.009	0.003	0.596	0.022	0.001	0.022	0.653
329	A15 - West Center	*No H-3*	0.042	0.014	2.960	0.030	0.003	0.025	3.073
330	A15 - East Center	*No H-3*	0.013	0.100	0.490	0.029	0.002	0.023	0.657
331	A15 - East End	*No H-3*	0.026	0.020	0.689	0.038	0.003	0.036	0.813
344	Hilltop House	*No H-3*	0.000	0.003	0.009	0.008	0.001	0.011	0.032
345	Canyon School	*No H-3*	-0.004	0.002	0.010	0.005	0.002	0.007	0.022
347	Airport Hangers	-0.003	-0.003	0.002	0.018	0.007	0.001	0.007	0.033
348	State Rd 502/Mid-Runway	-0.002	-0.002	0.003	0.010	0.013	0.002	0.011	0.038

Note 1: This table uses the three-digit "Master Site ID" value. A cross reference to the older 2-digit numbers appeared in the 2010 report in this table.

Note 2: Stations 326, 327, 328, 317, 329, 330, 331, and 169 are analyzed for Pu isotopes on a biweekly basis and the normal quarterly basis. The maximum value was used for Pu; the sum of the quarterly data or the sum of the biweekly Pu analyses.

Note 3: The note "No H-3" indicates that tritium is not sampled at that location. Tritium is not a pollutant of concern at this location.

Table 11. Environmental Data—Compliance Stations

2011 Analytical Completeness and Air Sampler Operation Summary									
Site	Site Name	H-3	Am-241	Pu-238	Pu-239	U-234	U-235	U-238	Percent run time
114	LA Airport Terminal Bldg	96.15	100	100	100	100	100	100	99.79
119	Rocket Park	100	100	100	100	100	100	100	99.74
121	Pajarito Acres	100	100	100	100	100	100	100	99.91
133	Bandelier Fire Lookout	100	100	100	100	100	100	100	94.90
137	Well PM-1	100	100	100	100	100	100	100	99.45
149	48th Street	100	100	100	100	100	100	100	99.75
151	Royal Crest Trailer Court	92.31	100	100	100	100	100	100	99.82
157	Eastgate	96.15	100	100	100	100	100	100	99.73
166	McDonalds	100	100	100	100	100	100	100	99.83
167	White Rock Fire Station	100	100	100	100	100	100	100	99.69
168	WR Nazarene Church	100	100	100	100	100	100	100	98.23
169	TA-21 Area B	100	100	96.67	96.67	100	100	100	99.69
172	LA County Landfill	100	100	100	100	100	100	100	99.89
206	Eastgate - Backup	100	100	100	100	100	100	100	99.70
210	LA Canyon	96.15	100	100	100	100	100	100	99.83
211	Los Alamos Medical Center	96.15	100	100	100	100	100	100	99.84
212	Crossroads Bible Church	100	100	100	100	100	100	100	97.00
213	Monte Rey South	100	100	100	100	100	100	100	99.74
257	Los Alamos Inn - South	100	100	100	100	100	100	100	99.76
262	TA-3 Research Park	100	100	100	100	100	100	100	99.61
290	Los Alamos Airport Road	96.15	100	100	100	100	100	100	99.75
291	DP Rd - West Entrance	*No H-3*	100	100	100	100	100	100	99.38
307	TA-16	100	100	100	100	100	100	100	99.61
317	A15 - West End	*No H-3*	100	96.67	96.67	100	100	100	99.84
318	East Road Fire Station	100	100	100	100	100	100	100	99.45
319	New Beginnings Church	*No H-3*	100	100	100	100	100	100	99.42
320	Hedge Row East Rd.	*No H-3*	100	100	100	100	100	100	99.83
326	DP - Fire Station	*No H-3*	100	96.67	96.67	100	100	100	99.79
327	DP - Ace	*No H-3*	100	96.67	96.67	100	100	100	99.81
328	DP - Monitor	*No H-3*	100	96.67	96.67	100	100	100	99.78
329	A15 - West Center	*No H-3*	100	95.65	95.65	100	100	100	99.35
330	A15 - East Center	*No H-3*	100	95.65	95.65	100	100	100	99.85
331	A15 - East End	*No H-3*	100	95.65	95.65	100	100	100	99.02
344	Hilltop House	*No H-3*	100	100	100	100	100	100	99.42
345	Canyon School	*No H-3*	100	100	100	100	100	100	99.41
347	Airport Hangers	100	100	100	100	100	100	100	99.50
348	State Rd 502/Mid-Runway	100	100	100	100	100	100	100	99.81
Average Analytical Completeness:		98.88% for tritium, H-3		99.73% for particulate nuclides					

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

Description	StackID	Dose at East Gate Receptor (mrem)	Dose at 278 DP Road Receptor (mrem)
LANSCE stack January GMAP	53000702	None	None
LANSCE stack February GMAP	53000702	None	None
LANSCE stack March GMAP	53000702	None	None
LANSCE stack April GMAP	53000702	None	None
LANSCE stack May GMAP	53000702	2.96E-04	2.59E-05
LANSCE stack June GMAP	53000702	4.05E-03	2.77E-04
LANSCE stack July GMAP	53000702	3.64E-03	2.49E-04
LANSCE stack August GMAP	53000702	4.36E-03	3.44E-04
LANSCE stack September GMAP	53000702	5.93E-03	6.91E-04
LANSCE stack October GMAP	53000702	8.67E-03	1.01E-03
LANSCE stack November GMAP	53000702	6.16E-03	9.01E-04
LANSCE stack December GMAP	53000702	6.48E-03	6.02E-04
Sum of monthly GMAP runs for this stack	53000702	3.96E-02	4.10E-03
GMAP single annual analysis for this stack	53000702	3.87E-02	3.70E-03
Difference, sum of monthly vs. annual analyses:		*2.3%*	*10.8%*

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 East Gate Receptor (mrem)	Dose at 278 DP Road Receptor (mrem)
LANSCE stack GMAP	53000303	8.10E-03	1.06E-03
LANSCE stack PVAP	53000303	5.12E-03	6.68E-04
LANSCE Non-CAP88 Radionuclides	53000303	None	None
LANSCE stack GMAP (see above)	53000702	3.96E-02	4.10E-03
LANSCE stack PVAP	53000702	2.62E-03	2.50E-04
LANSCE Non-CAP88 Radionuclides	53000702	7.19E-06	6.86E-07
LANSCE Diffuse/Fugitive Emissions – Beam Switchyard	53DIF3SY	4.95E-03	2.79E-04
LANSCE Diffuse/Fugitive Emissions – 1L Service Area	53DIF1LS	4.38E-03	3.33E-04
2011 LANSCE facility summary:		6.48E-02	6.69E-03

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 East Gate receptor and the LA Inn South receptor.

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

Description	StackID	Dose for Release Site Receptor (mrem)	Dose at 278 DP Road Receptor (mrem)
CMR Stack – Wing 2	03002914	1.50E-06	3.59E-07
CMR Stack – Wing 2	03002915	1.22E-06	2.58E-07
CMR Stack – Wing 3	03002919	1.05E-03	2.60E-04
CMR Stack – Wing 3	03002920	1.26E-05	3.13E-06
CMR Stack – Wing 4	03002923	4.10E-06	8.58E-07
CMR Stack – Wing 4	03002924	2.47E-05	5.11E-06
CMR Stack – Wing 5	03002928	7.52E-05	2.18E-05
CMR Stack – Wing 5	03002929	4.48E-06	1.30E-06
CMR Stack – Wing 7	03002932	5.31E-06	1.35E-06
CMR Stack – Wing 7	03002933	3.10E-04	7.85E-05
CMR Stack	03002937	None	None
CMR Stack – Wing 9	03002944	2.80E-07	7.54E-08
CMR Stack – Wing 9	03002945	None	None
CMR Stack – Wing 9	03002946	8.75E-07	2.35E-07
Shops Addition Stack	03010222	7.72E-07	1.28E-07
WETF Stack – new	16045005	1.12E-02	1.58E-03
Radiochemistry Stack	48000107	1.47E-02	3.77E-03
Radiochemistry /non-CAP88 nuclides	48000107	None	None
Radiochemistry Stack	48000154	3.43E-08	8.52E-09
Radiochemistry Stack	48000160	1.91E-05	4.65E-06
Waste Management Stack	50000102	1.50E-06	8.16E-07
Waste Management Stack	50003701	None	None
Waste Management Stack	50006903	3.93E-07	1.96E-07
LANSCE-Stack – GMAP	53000303	8.10E-03	1.06E-03
LANSCE- Annual – Partic/Vapor	53000303	5.12E-03	6.68E-04
LANSCE Non-CAP88 radionuclides	53000303	None	None
LANSCE-Stack – GMAP (See Note below)	53000702	3.96E-02	4.10E-03
LANSCE- Annual – Partic/Vapor	53000702	2.62E-03	2.50E-04
LANSCE Non-CAP88 radionuclides	53000702	7.19E-06	6.86E-07
LANSCE Fugitive - Beam Switch Yard	53DIF3SY	4.95E-03	2.79E-04
LANSCE Fugitive - 1L Service Area	53DIF1LS	4.38E-03	3.33E-04
Waste Processing Stack	54023199	0.00E+00	0.00E+00
Waste Processing Stack	54041299	0.00E+00	0.00E+00
Plutonium Facility Stack	55000415	3.66E-04	1.38E-04
Plutonium Facility Stack	55000416	2.75E-03	1.12E-03
Unmonitored Stacks - No credit for controls	99000000	1.48E-01	1.48E-01
Air Sampler Net Dose @ this location	99000010	N/A	3.37E+00
Total maximally exposed individual dose (mrem)			**3.53**

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: *[signature on file]* Date: 6/25/2012

Kevin W. Smith, Owner
Manager
Los Alamos Site Office
National Nuclear Security Administration
U.S. Department of Energy

Signature: *[signature on file]* Date: 6/12/2012

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

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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 2011 TA-6 Meteorological Tower (97.6% Data Completeness)

```
   N A 0.000530.000200.000000.000000.000000.00000
 NNE A 0.000990.000320.000000.000000.000000.00000
  NE A 0.001730.000610.000030.000000.000000.00000
 ENE A 0.003010.001140.000000.000000.000000.00000
   E A 0.003600.001080.000000.000000.000000.00000
 ESE A 0.002750.001700.000000.000000.000000.00000
  SE A 0.001730.001490.000000.000000.000000.00000
 SSE A 0.001760.001640.000030.000000.000000.00000
   S A 0.000790.000970.000000.000000.000000.00000
 SSW A 0.000730.000470.000000.000000.000000.00000
  SW A 0.000440.000200.000030.000000.000000.00000
 WSW A 0.000530.000150.000000.000000.000000.00000
   W A 0.000290.000200.000000.000000.000000.00000
 WNW A 0.000380.000180.000000.000000.000000.00000
  NW A 0.000230.000200.000000.000000.000000.00000
 NNW A 0.000350.000200.000000.000000.000000.00000
   N B 0.000260.000150.000030.000000.000000.00000
 NNE B 0.000180.000440.000000.000000.000000.00000
  NE B 0.000670.000910.000000.000000.000000.00000
 ENE B 0.000970.001350.000000.000000.000000.00000
   E B 0.001580.001370.000030.000000.000000.00000
 ESE B 0.000790.001960.000000.000000.000000.00000
  SE B 0.000590.002600.000000.000000.000000.00000
 SSE B 0.000470.001780.000060.000000.000000.00000
   S B 0.000150.000940.000000.000000.000000.00000
 SSW B 0.000350.000350.000000.000000.000000.00000
  SW B 0.000060.000440.000000.000000.000000.00000
 WSW B 0.000150.000260.000030.000000.000000.00000
   W B 0.000090.000260.000060.000000.000000.00000
 WNW B 0.000120.000090.000000.000000.000000.00000
  NW B 0.000060.000180.000060.000000.000000.00000
 NNW B 0.000030.000180.000060.000000.000000.00000
   N C 0.000200.000410.000120.000000.000000.00000
 NNE C 0.000610.001780.000120.000000.000000.00000
  NE C 0.000850.003310.000200.000000.000000.00000
 ENE C 0.001760.004300.000060.000000.000000.00000
   E C 0.002340.004910.000090.000000.000000.00000
 ESE C 0.001290.006000.000230.000000.000000.00000
  SE C 0.001110.006760.000610.000000.000000.00000
 SSE C 0.000730.008540.000850.000000.000000.00000
   S C 0.000590.004650.001350.000090.000000.00000
 SSW C 0.000290.001670.001350.000030.000000.00000
  SW C 0.000150.000670.000730.000060.000000.00000
 WSW C 0.000060.000670.000410.000000.000000.00000
   W C 0.000120.000350.000380.000000.000000.00000
 WNW C 0.000150.000470.000670.000060.000000.00000
  NW C 0.000060.000730.000670.000120.000000.00000
 NNW C 0.000120.000560.000470.000000.000000.00000
   N D 0.003800.006460.003190.001290.000530.00000
```

Table 7a (continued)

NNE	D	0.00459	0.01100	0.00696	0.00114	0.00009	0.00000
NE	D	0.00442	0.00942	0.00421	0.00020	0.00000	0.00000
ENE	D	0.00448	0.00684	0.00149	0.00003	0.00000	0.00000
E	D	0.00489	0.00696	0.00059	0.00003	0.00000	0.00000
ESE	D	0.00371	0.00778	0.00126	0.00009	0.00000	0.00000
SE	D	0.00386	0.01094	0.00468	0.00020	0.00000	0.00000
SSE	D	0.00383	0.01688	0.01694	0.00366	0.00000	0.00000
S	D	0.00465	0.01784	0.02600	0.01050	0.00018	0.00000
SSW	D	0.00389	0.01454	0.02328	0.01264	0.00257	0.00009
SW	D	0.00374	0.00959	0.01556	0.01316	0.00266	0.00041
WSW	D	0.00348	0.00737	0.01240	0.01869	0.00515	0.00085
W	D	0.00325	0.00670	0.01664	0.02074	0.00462	0.00035
WNW	D	0.00345	0.00720	0.01536	0.01878	0.00421	0.00266
NW	D	0.00439	0.00919	0.01518	0.01120	0.00301	0.00099
NNW	D	0.00462	0.00603	0.00518	0.00170	0.00000	0.00000
N	E	0.00152	0.00430	0.00137	0.00000	0.00000	0.00000
NNE	E	0.00132	0.00298	0.00152	0.00000	0.00000	0.00000
NE	E	0.00108	0.00099	0.00018	0.00000	0.00000	0.00000
ENE	E	0.00099	0.00088	0.00009	0.00000	0.00000	0.00000
E	E	0.00085	0.00047	0.00000	0.00000	0.00000	0.00000
ESE	E	0.00053	0.00091	0.00003	0.00000	0.00000	0.00000
SE	E	0.00079	0.00111	0.00015	0.00000	0.00000	0.00000
SSE	E	0.00102	0.00178	0.00018	0.00000	0.00000	0.00000
S	E	0.00164	0.00705	0.00091	0.00000	0.00000	0.00000
SSW	E	0.00158	0.01223	0.00287	0.00000	0.00000	0.00000
SW	E	0.00155	0.01038	0.00933	0.00000	0.00000	0.00000
WSW	E	0.00164	0.00503	0.00456	0.00000	0.00000	0.00000
W	E	0.00146	0.00395	0.00371	0.00000	0.00000	0.00000
WNW	E	0.00164	0.00480	0.00512	0.00000	0.00000	0.00000
NW	E	0.00155	0.00799	0.00477	0.00000	0.00000	0.00000
NNW	E	0.00199	0.00486	0.00137	0.00000	0.00000	0.00000
N	F	0.00752	0.00807	0.00067	0.00000	0.00000	0.00000
NNE	F	0.00477	0.00295	0.00018	0.00000	0.00000	0.00000
NE	F	0.00260	0.00064	0.00000	0.00000	0.00000	0.00000
ENE	F	0.00222	0.00026	0.00000	0.00000	0.00000	0.00000
E	F	0.00181	0.00009	0.00000	0.00000	0.00000	0.00000
ESE	F	0.00140	0.00029	0.00003	0.00000	0.00000	0.00000
SE	F	0.00140	0.00035	0.00000	0.00000	0.00000	0.00000
SSE	F	0.00214	0.00041	0.00000	0.00000	0.00000	0.00000
S	F	0.00290	0.00184	0.00000	0.00000	0.00000	0.00000
SSW	F	0.00427	0.00512	0.00000	0.00000	0.00000	0.00000
SW	F	0.00693	0.01363	0.00120	0.00000	0.00000	0.00000
WSW	F	0.00746	0.02738	0.00319	0.00000	0.00000	0.00000
W	F	0.00825	0.02460	0.00196	0.00000	0.00000	0.00000
WNW	F	0.00699	0.01705	0.00161	0.00000	0.00000	0.00000
NW	F	0.00799	0.02404	0.00102	0.00000	0.00000	0.00000
NNW	F	0.00825	0.01243	0.00029	0.00000	0.00000	0.00000

Table 7 (continued)

Table 7b: CAP88 Input Data for 2011 TA-53 Meteorological Tower (99.8% Data Completeness)

```
   N A 0.000720.000230.000000.000000.000000.00000
 NNE A 0.001570.000630.000030.000000.000000.00000
  NE A 0.003170.000860.000030.000000.000000.00000
 ENE A 0.004180.002060.000000.000000.000000.00000
   E A 0.003720.002320.000000.000000.000000.00000
 ESE A 0.002920.002950.000000.000000.000000.00000
  SE A 0.002830.002460.000000.000000.000000.00000
 SSE A 0.001970.001890.000030.000000.000000.00000
   S A 0.001140.001340.000000.000000.000000.00000
 SSW A 0.000430.000630.000000.000000.000000.00000
  SW A 0.000490.000260.000000.000000.000000.00000
 WSW A 0.000430.000260.000030.000000.000000.00000
   W A 0.000170.000090.000000.000000.000000.00000
 WNW A 0.000400.000170.000000.000000.000000.00000
  NW A 0.000400.000140.000000.000000.000000.00000
 NNW A 0.000400.000200.000060.000030.000000.00000
   N B 0.000290.000090.000000.000000.000000.00000
 NNE B 0.000720.000600.000000.000000.000000.00000
  NE B 0.000860.001570.000060.000000.000000.00000
 ENE B 0.001460.002430.000030.000000.000000.00000
   E B 0.001060.002890.000000.000000.000000.00000
 ESE B 0.000770.002630.000000.000000.000000.00000
  SE B 0.000970.002120.000000.000000.000000.00000
 SSE B 0.000630.002200.000000.000000.000000.00000
   S B 0.000510.001800.000000.000000.000000.00000
 SSW B 0.000090.000720.000030.000000.000000.00000
  SW B 0.000060.000340.000030.000000.000000.00000
 WSW B 0.000060.000090.000060.000000.000000.00000
   W B 0.000060.000170.000060.000000.000000.00000
 WNW B 0.000090.000290.000030.000000.000000.00000
  NW B 0.000140.000170.000000.000000.000000.00000
 NNW B 0.000060.000200.000060.000000.000000.00000
   N C 0.000310.000570.000460.000000.000000.00000
 NNE C 0.000720.001320.000540.000000.000000.00000
  NE C 0.001230.004060.000830.000000.000000.00000
 ENE C 0.002000.007150.000370.000000.000000.00000
   E C 0.001630.007720.000170.000000.000000.00000
 ESE C 0.001200.005460.000260.000000.000000.00000
  SE C 0.000720.004200.000290.000000.000000.00000
 SSE C 0.000940.006290.000660.000000.000000.00000
   S C 0.000510.004980.000940.000000.000000.00000
 SSW C 0.000290.001600.000460.000030.000000.00000
  SW C 0.000170.000830.000490.000000.000000.00000
 WSW C 0.000140.000660.000630.000030.000000.00000
   W C 0.000090.000740.001320.000110.000000.00000
 WNW C 0.000200.000690.000740.000060.000000.00000
  NW C 0.000170.000490.000490.000030.000000.00000
 NNW C 0.000290.000430.000370.000000.000000.00000
```

Table 7b (continued)

N	D	0.00555	0.00738	0.00704	0.00192	0.00069	0.00006
NNE	D	0.00566	0.01181	0.00993	0.00306	0.00014	0.00000
NE	D	0.00558	0.01027	0.00655	0.00126	0.00003	0.00000
ENE	D	0.00449	0.00993	0.00315	0.00023	0.00000	0.00000
E	D	0.00360	0.00818	0.00217	0.00006	0.00000	0.00000
ESE	D	0.00286	0.00598	0.00117	0.00011	0.00000	0.00000
SE	D	0.00266	0.00558	0.00237	0.00029	0.00003	0.00000
SSE	D	0.00277	0.00998	0.00955	0.00486	0.00072	0.00000
S	D	0.00320	0.01696	0.02517	0.01716	0.00177	0.00000
SSW	D	0.00223	0.01316	0.03003	0.02431	0.00635	0.00183
SW	D	0.00252	0.00892	0.02071	0.01496	0.00483	0.00072
WSW	D	0.00152	0.00595	0.01422	0.01690	0.00461	0.00080
W	D	0.00174	0.00552	0.01467	0.01402	0.00220	0.00009
WNW	D	0.00186	0.00658	0.01379	0.01101	0.00286	0.00097
NW	D	0.00246	0.00380	0.00621	0.00678	0.00200	0.00063
NNW	D	0.00409	0.00466	0.00475	0.00323	0.00089	0.00014
N	E	0.00569	0.00818	0.00172	0.00000	0.00000	0.00000
NNE	E	0.00529	0.00844	0.00280	0.00000	0.00000	0.00000
NE	E	0.00315	0.00549	0.00103	0.00000	0.00000	0.00000
ENE	E	0.00203	0.00343	0.00040	0.00000	0.00000	0.00000
E	E	0.00229	0.00186	0.00011	0.00000	0.00000	0.00000
ESE	E	0.00146	0.00132	0.00003	0.00000	0.00000	0.00000
SE	E	0.00112	0.00123	0.00006	0.00000	0.00000	0.00000
SSE	E	0.00129	0.00192	0.00074	0.00000	0.00000	0.00000
S	E	0.00132	0.00463	0.00461	0.00000	0.00000	0.00000
SSW	E	0.00132	0.01010	0.02002	0.00000	0.00000	0.00000
SW	E	0.00152	0.01702	0.01407	0.00000	0.00000	0.00000
WSW	E	0.00143	0.00895	0.01284	0.00000	0.00000	0.00000
W	E	0.00140	0.00850	0.00758	0.00000	0.00000	0.00000
WNW	E	0.00166	0.00709	0.00538	0.00000	0.00000	0.00000
NW	E	0.00300	0.00532	0.00260	0.00000	0.00000	0.00000
NNW	E	0.00412	0.00626	0.00272	0.00000	0.00000	0.00000
N	F	0.00552	0.00172	0.00000	0.00000	0.00000	0.00000
NNE	F	0.00575	0.00195	0.00000	0.00000	0.00000	0.00000
NE	F	0.00566	0.00246	0.00003	0.00000	0.00000	0.00000
ENE	F	0.00503	0.00129	0.00000	0.00000	0.00000	0.00000
E	F	0.00352	0.00066	0.00000	0.00000	0.00000	0.00000
ESE	F	0.00380	0.00046	0.00000	0.00000	0.00000	0.00000
SE	F	0.00395	0.00123	0.00006	0.00000	0.00000	0.00000
SSE	F	0.00320	0.00186	0.00006	0.00000	0.00000	0.00000
S	F	0.00346	0.00346	0.00017	0.00000	0.00000	0.00000
SSW	F	0.00518	0.00741	0.00154	0.00000	0.00000	0.00000
SW	F	0.00455	0.00535	0.00037	0.00000	0.00000	0.00000
WSW	F	0.00380	0.00838	0.00237	0.00000	0.00000	0.00000
W	F	0.00446	0.00875	0.00320	0.00000	0.00000	0.00000
WNW	F	0.00406	0.00681	0.00060	0.00000	0.00000	0.00000
NW	F	0.00412	0.00346	0.00069	0.00000	0.00000	0.00000
NNW	F	0.00501	0.00280	0.00066	0.00000	0.00000	0.00000

Table 7 (continued)

Table 7c: CAP88 Input Data for 2011 TA-54 Meteorological Tower (99.6% Data Completeness)

N	A	0.00020	0.00017	0.00003	0.00000	0.00000	0.00000
NNE	A	0.00072	0.00072	0.00000	0.00000	0.00000	0.00000
NE	A	0.00155	0.00074	0.00000	0.00000	0.00000	0.00000
ENE	A	0.00370	0.00198	0.00000	0.00000	0.00000	0.00000
E	A	0.00539	0.00289	0.00000	0.00000	0.00000	0.00000
ESE	A	0.00433	0.00223	0.00000	0.00000	0.00000	0.00000
SE	A	0.00269	0.00201	0.00000	0.00000	0.00000	0.00000
SSE	A	0.00203	0.00172	0.00000	0.00000	0.00000	0.00000
S	A	0.00126	0.00123	0.00000	0.00000	0.00000	0.00000
SSW	A	0.00086	0.00095	0.00000	0.00000	0.00000	0.00000
SW	A	0.00074	0.00040	0.00000	0.00000	0.00000	0.00000
WSW	A	0.00037	0.00017	0.00000	0.00000	0.00000	0.00000
W	A	0.00037	0.00023	0.00003	0.00000	0.00000	0.00000
WNW	A	0.00017	0.00011	0.00003	0.00000	0.00000	0.00000
NW	A	0.00029	0.00020	0.00003	0.00000	0.00000	0.00000
NNW	A	0.00032	0.00023	0.00000	0.00000	0.00000	0.00000
N	B	0.00011	0.00026	0.00000	0.00000	0.00000	0.00000
NNE	B	0.00032	0.00077	0.00000	0.00000	0.00000	0.00000
NE	B	0.00034	0.00132	0.00003	0.00000	0.00000	0.00000
ENE	B	0.00095	0.00189	0.00003	0.00000	0.00000	0.00000
E	B	0.00123	0.00332	0.00003	0.00000	0.00000	0.00000
ESE	B	0.00080	0.00178	0.00000	0.00000	0.00000	0.00000
SE	B	0.00063	0.00140	0.00000	0.00000	0.00000	0.00000
SSE	B	0.00049	0.00172	0.00003	0.00000	0.00000	0.00000
S	B	0.00040	0.00146	0.00006	0.00000	0.00000	0.00000
SSW	B	0.00011	0.00069	0.00006	0.00000	0.00000	0.00000
SW	B	0.00006	0.00037	0.00006	0.00000	0.00000	0.00000
WSW	B	0.00014	0.00026	0.00009	0.00000	0.00000	0.00000
W	B	0.00006	0.00014	0.00006	0.00000	0.00000	0.00000
WNW	B	0.00009	0.00009	0.00006	0.00000	0.00000	0.00000
NW	B	0.00009	0.00026	0.00006	0.00000	0.00000	0.00000
NNW	B	0.00011	0.00034	0.00000	0.00000	0.00000	0.00000
N	C	0.00006	0.00054	0.00026	0.00000	0.00000	0.00000
NNE	C	0.00017	0.00166	0.00023	0.00000	0.00000	0.00000
NE	C	0.00089	0.00501	0.00029	0.00000	0.00000	0.00000
ENE	C	0.00126	0.00504	0.00026	0.00000	0.00000	0.00000
E	C	0.00097	0.00570	0.00006	0.00000	0.00000	0.00000
ESE	C	0.00089	0.00315	0.00003	0.00000	0.00000	0.00000
SE	C	0.00054	0.00278	0.00009	0.00000	0.00000	0.00000
SSE	C	0.00057	0.00298	0.00032	0.00000	0.00000	0.00000
S	C	0.00043	0.00415	0.00086	0.00000	0.00000	0.00000
SSW	C	0.00023	0.00272	0.00077	0.00000	0.00000	0.00000
SW	C	0.00029	0.00072	0.00052	0.00000	0.00000	0.00000
WSW	C	0.00017	0.00095	0.00052	0.00003	0.00000	0.00000
W	C	0.00000	0.00063	0.00172	0.00011	0.00000	0.00000
WNW	C	0.00009	0.00052	0.00095	0.00000	0.00000	0.00000
NW	C	0.00011	0.00034	0.00043	0.00006	0.00000	0.00000
NNW	C	0.00020	0.00020	0.00032	0.00000	0.00000	0.00000

Table 7c (continued)

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  N D 0.004070.005390.003640.001550.000520.00026
NNE D 0.004560.012920.013010.004470.000800.00000
 NE D 0.004840.017820.012460.001810.000060.00000
ENE D 0.004330.009170.002550.000090.000000.00000
  E D 0.002410.005270.001200.000110.000000.00000
ESE D 0.002120.003010.000340.000140.000000.00000
 SE D 0.001430.002460.001260.000370.000030.00000
SSE D 0.001830.004210.004470.004780.001150.00000
  S D 0.001430.007280.017740.017850.007110.00014
SSW D 0.002260.012230.032320.034300.013580.00298
 SW D 0.002490.010030.021170.017790.005160.00123
WSW D 0.002440.007740.011030.011720.001810.00032
  W D 0.003040.006760.011800.009030.000740.00000
WNW D 0.003670.004960.011060.005420.001350.00020
 NW D 0.004330.007310.006910.004530.000860.00000
NNW D 0.004440.005160.003810.001690.000170.00003
  N E 0.003700.004410.002690.000000.000000.00000
NNE E 0.002260.004530.002690.000000.000000.00000
 NE E 0.001290.003150.001460.000000.000000.00000
ENE E 0.001290.001780.000600.000000.000000.00000
  E E 0.000860.001030.000030.000000.000000.00000
ESE E 0.000630.000490.000030.000000.000000.00000
 SE E 0.000320.000570.000060.000000.000000.00000
SSE E 0.000430.001460.000720.000000.000000.00000
  S E 0.000630.002520.003180.000000.000000.00000
SSW E 0.000830.005640.010140.000000.000000.00000
 SW E 0.001090.008570.013610.000000.000000.00000
WSW E 0.001400.007680.002980.000000.000000.00000
  W E 0.002950.009080.003640.000000.000000.00000
WNW E 0.003150.011630.004530.000000.000000.00000
 NW E 0.004040.009600.002060.000000.000000.00000
NNW E 0.003870.006270.001260.000000.000000.00000
  N F 0.008450.012260.000830.000000.000000.00000
NNE F 0.007360.009000.000660.000000.000000.00000
 NE F 0.003640.004380.000290.000000.000000.00000
ENE F 0.002030.000950.000000.000000.000000.00000
  E F 0.001030.000230.000000.000000.000000.00000
ESE F 0.000950.000090.000000.000000.000000.00000
 SE F 0.000520.000340.000030.000000.000000.00000
SSE F 0.000540.000370.000000.000000.000000.00000
  S F 0.001000.001060.000230.000000.000000.00000
SSW F 0.001830.004560.000860.000000.000000.00000
 SW F 0.002350.013180.005670.000000.000000.00000
WSW F 0.003840.018740.004900.000000.000000.00000
  W F 0.005470.021920.004240.000000.000000.00000
WNW F 0.009110.017220.000370.000000.000000.00000
 NW F 0.010030.035790.001170.000000.000000.00000
NNW F 0.009250.018910.001780.000000.000000.00000
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