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National Emission Standards for Hazardous Air Pollutants – Radionuclide Emissions Calendar Year 2012

June 2013

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Nevada National Security Site
&
North Las Vegas Facility

National Security Technologies LLC
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National Nuclear Security Administration
Nevada Field Office

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EXECUTIVE SUMMARY

2012 RADIOLOGICAL DOSE TO THE PUBLIC BELOW FEDERAL STANDARD

The U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) operates the Nevada National Security Site (NNSS) and North Las Vegas Facility (NLVF). From 1951 through 1992, the NNSS was the continental testing location for U.S. nuclear weapons. The release of radionuclides from NNSS activities has been monitored since the initiation of atmospheric testing. Limitation to underground detonations after 1962 greatly reduced radiation exposure to the public surrounding the NNSS. After nuclear testing ended in 1992, NNSS radiation monitoring focused on detecting airborne radionuclides from historically contaminated soils. These radionuclides are derived from re-suspension of soil (primarily by wind) and emission of tritium-contaminated soil moisture through evapotranspiration. Low amounts of legacy-related tritium are also emitted to air at the NLVF, an NNSS support complex in North Las Vegas.

To protect the public from harmful levels of man-made radiation, the Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAP) (Title 40 Code of Federal Regulations [CFR] Part 61 Subpart H) (CFR 2010a) limits the release of radioactivity from a U.S. Department of Energy (DOE) facility to that which would cause 10 millirem per year (mrem/yr) effective dose equivalent to any member of the public. This limit does not include radiation unrelated to NNSS activities. Unrelated doses could come from naturally occurring radioactive elements, from sources such as medically or commercially used radionuclides, or from sources outside of the United States, such as the damaged Fukushima nuclear power plant in Japan in 2011.

NNSA/NFO demonstrates compliance with the NESHAP limit by using environmental measurements of radionuclide air concentrations at critical receptor locations on the NNSS (U.S. Environmental Protection Agency [EPA] and DOE 1995). This method was approved by the EPA for use on the NNSS in 2001 (EPA 2001a) and has been the sole method used since 2005. Six locations on the NNSS have been established to act as critical receptor locations to demonstrate compliance with the NESHAP limit. These locations are actually pseudo-critical receptor stations, because no member of the public actually resides at these onsite locations. Compliance is demonstrated if the measured annual average concentration is less than the NESHAP Concentration Levels (CLs) for Environmental Compliance listed in 40 CFR 61, Appendix E, Table 2 (CFR 2010a). For multiple radionuclides, compliance is demonstrated when the sum of the fractions (determined by dividing each radionuclide's concentration by its CL and then adding the fractions together) is less than 1.0.

In 2012, the potential dose from radiological emissions to air, resulting from both current and past NNSS activities, was well below the 10 mrem/yr dose limit. Air sampling data collected at all air monitoring stations had average concentrations of radioactivity that were a fraction of the CL values. Concentrations ranged from less than 0.5% to a maximum of 11.1% of the allowed NESHAP limit. Because the nearest member of the public resides about 9 kilometers from potential release points on the NNSS, dose to the public would be only a small fraction of the value measured on the NNSS. The potential dose to the public from NLVF emissions was also very low at 0.000024 mrem/yr, more than 400,000 times lower than the 10 mrem/yr limit.

NESHAP Compliance for 2012

NNSS: Compliance Demonstrated by the Sum of Fractions at Each Critical Receptor Sampler Being Less Than 1.0			
Included Radio-nuclides	**NNSS Operations Area**	**Critical Receptor Location**	**Sum of Fractions of CLs**
	6	Yucca	0.005
^{3}H	10	Gate 700 S	0.006
^{238}Pu	16	Substation 3545	0.004
$^{239+240}Pu$	20	Schooner	0.111
^{241}Am	23	Mercury	0.005
	25	Gate 510	0.017
NLVF: Compliance Demonstrated by the Highest Potential Offsite Dose Being Less Than 10 mrem/yr			
Estimated offsite dose from NLVF = 0.000024 mrem/yr			

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List of Acronyms and Abbreviations

Am	americium
Ar	argon
ARL/SORD	Air Resources Laboratory, Special Operations and Research Division
Be	beryllium
BEEF	Big Explosives Experimental Facility
C	carbon
°C	degrees Celsius
CAP88-PC	Clean Air Package 1988 (EPA software program for estimating doses)
CFR	Code of Federal Regulations
Ci	curie(s)
Cl	chlorine
CL	Concentration Level
cm	centimeter(s)
Co	cobalt
Cs	cesium
CY	calendar year
DAF	Device Assembly Facility
DOE	U.S. Department of Energy
DPF	Dense Plasma Focus
DRA	Desert Rock Meteorological Observatory
DU	depleted uranium
E	east
EDE	effective dose equivalent
EPA	U.S. Environmental Protection Agency
Eu	europium
ft^3/min	cubic feet per minute
^3H	tritium
HTO	tritiated water
JASPER	Joint Actinide Shock Physics Experimental Research
km	kilometer(s)
km^2	square kilometer(s)
L	liter(s)
LINAC	linear accelerator
LATF	Los Alamos Technical Facility
LLW	low-level waste
m	meter(s)
mCi	millicurie(s)
mCi/yr	millicurie(s)/year
MEDA	Meteorological Data Acquisition
MEI	maximally exposed individual
MIDNET	Meteorological Integrated Data Network
mrem/yr	millirem per year
µrem/yr	microrem per year
m/s	meter(s) per second
^{13}N	nitrogen-13
N	north
NCERC	National Criticality Experiments Research Center
NESHAP	National Emission Standards for Hazardous Air Pollutants

List of Acronyms and Abbreviations (continued)

NLVF	North Las Vegas Facility
NNSA/NFO	U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office
NNSS	Nevada National Security Site
NOAA	National Oceanic and Atmospheric Administration
NPTEC	Nonproliferation Test and Evaluation Complex
O	oxygen
Ops	Operations
pCi	picocurie(s)
pCi/L	picocurie(s) per liter
pCi/m^3	picocurie(s) per cubic meter
PTC	primary target chamber
Pu	plutonium
rem	roentgen equivalent man
RNCTEC	Radiological/Nuclear Countermeasures Test and Evaluation Complex
RWMC	Radioactive Waste Management Complex
RWMS	Radioactive Waste Management Site
s	second(s)
S	south
SCC	secondary containment chamber
SNM	special nuclear material
Sr	strontium
STAR	Stability Array (grouping of meteorological data)
Tc	technetium
TRU	transuranic (nuclides with atomic numbers greater than uranium)
U	uranium
UCC	Yucca Flat Meteorological Observatory
UGTA	Underground Test Area
W	west
yr	year(s)

Report Information

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National Nuclear Security Administration
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SECTION I
FACILITY INFORMATION

SITE DESCRIPTION

The Nevada National Security Site (NNSS) is operated by the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) as the site for maintaining and enhancing the safety, security, reliability, and performance of the U.S. nuclear weapons stockpile without nuclear testing; reducing global danger from weapons of mass destruction; and responding to nuclear and radiological emergencies in the U.S. and abroad. The NNSS is also an operational site for environmental restoration, low-level radioactive waste management, and groundwater characterization activities. Located in Nye County, Nevada, the site's southeast corner is about 105 kilometers (km) northwest of the major population center, Las Vegas, Nevada. The NNSS covers about 3,523 square kilometers (km^2), an area larger than Rhode Island. Its size is 46 to 56 km east to west and 64 to 88 km north to south. The NNSS is surrounded, except on the south side, by the Nevada Test and Training Range, a public exclusion area that provides another 24 to 104 km between the NNSS and public lands (Figure 1). The NNSS is characterized by desert valley and Great Basin mountain topography, with climate, flora, and fauna typical of the southwest deserts. Based on 2010 census data, there were 438,544 people residing within 80 km (50 miles) of the NNSS boundary. The distribution of this population, as demonstrated with the most recent (2011) LandScan data (Geographic Information Science & Technology Group, Oak Ridge National Laboratory 2012), are concentrated in the metropolitan areas of Las Vegas and North Las Vegas to the southeast and in the town of Pahrump to the south (Figure 1). These more populated areas drive the overall average population density up to about 1.2 person/km^2, but the vast majority of the area within 80 km of the NNSS is uninhabited. The nearest populated location to the NNSS boundary is Amargosa Valley, 3.4 km south of the southwest corner of the NNSS. Two mines are also relatively near the boundaries of the NNSS: the American Silica mine, 2.7 km east from the southeast edge of the NNSS, and the Cinder Cone Pit mine, 5.5 km west of the southwest corner of the NNSS. The American Silica mine was not in operation during 2012 but was still considered a populated location because of the potential for operations to resume. Three dairies operated within 80 km of the NNSS during 2012. Two are located in Amargosa Center (center of Amargosa Valley, which is labeled Amargosa Center on maps in this report) at a distance of about 16.1 km from the boundary, and one is in Pahrump, 41.8 km south of the NNSS. The Pahrump Dairy closed in August 2012. Agriculture around the NNSS is sparse and consists primarily of alfalfa fields, which are found primarily in Amargosa Center, Pahrump, Penoyer Farm, Reed's Ranch, and locations between Alamo and Hiko.

The North Las Vegas Facility (NLVF) is an 80-acre complex composed of buildings that house much of the NNSS project management, diagnostic development and testing, design, engineering, and procurement operations. This facility is located along Losee Road in the city of North Las Vegas and is surrounded on the north, south, and east by general industrial zoning. The western border separates the property from fully developed, single-family residential-zoned property.

SOURCE DESCRIPTION

In 1950, the now-called NNSS was established as the primary location for testing the nation's nuclear explosive devices. Such testing took place from 1951 to 1992. Historical testing included (1) atmospheric testing in the 1950s and early 1960s, (2) underground testing between 1951 and 1992, and (3) open-air nuclear reactor and rocket engine testing between 1959 and 1973 (U.S. Department of Energy [DOE] 2013). No nuclear tests have been conducted since September 23, 1992 (DOE 2013). The environmental legacy of nuclear weapons and other testing on the NNSS is the predominant source of radionuclides that are released into the air. They are characterized as non-point (diffuse) sources and include (1) areas of radioactively contaminated surface soils, (2) contaminated groundwater that is pumped or flows naturally to the surface, (3) radioactive waste storage and burial sites, and (4) radiologically contaminated structures and materials being decommissioned, demolished, and/or managed.

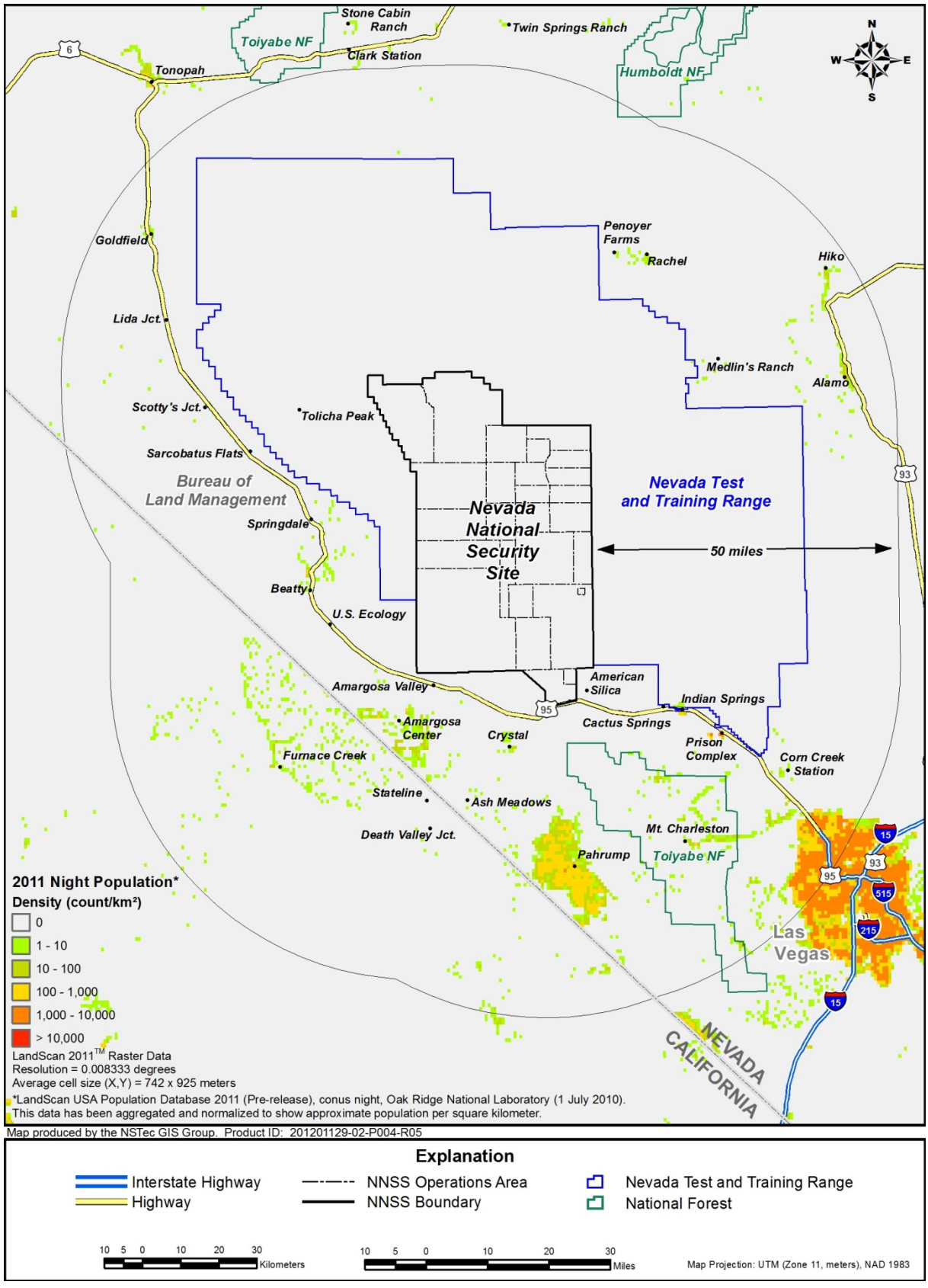

Figure 1. NNSS and Surrounding Populated Area

Surfaces contaminated with plutonium (Pu), americium (Am), tritium (^{3}H), and fission and activation products from past nuclear device safety, atmospheric, or cratering test activities could become sources of radionuclide exposure to the public if the radionuclides were to be re-suspended (e.g., through evaporation or transpiration of ^{3}H in water, by windy conditions, surface cleanup, construction, vehicular travel, or similar activities for radionuclides associated with particulates). In 1981, DOE began a project known as the Radionuclide Inventory and Distribution Program. After 5 years of field work and 3 years of data analysis, the result was a report that identified the inventory and described the distribution of radionuclides in the soil in parts of the NNSS affected by NNSS operations (DOE 1991) (Table 1). The inventory includes an estimate of the curies (Ci) of ^{241}Am, ^{238}Pu, and $^{239+240}Pu$ in surface soil within each NNSS Operations (Ops) Area. Other isotopes, such as cobalt-60 (^{60}Co), strontium-90 (^{90}Sr), cesium-137 (^{137}Cs), and the europium (Eu) isotopes ^{152}Eu, ^{154}Eu, and ^{155}Eu are also in the soil at various locations on the NNSS. However, their concentrations in air samples are generally below detection levels and collectively contribute less than 10% to the total dose from all radionuclide emissions calculated from re-suspension calculations. Therefore, they have not been included in evaluations for National Emission Standards for Hazardous Air Pollutants (NESHAP) compliance. Figure 2 shows areas of elevated exposure rates due to radionuclides in NNSS soils as measured by an aerial survey conducted in 1994 (Hendricks and Riedhauser 1999).

Table 1. Inventory of ^{241}Am, ^{238}Pu, and $^{239+240}Pu$ in Surface Soil[(a)] at the NNSS

NNSS Ops Area Studied	Study Site Area in square miles / Percent of Total NNSS Ops Area	Radionuclide Inventory (Ci)		
		^{241}Am	^{238}Pu	$^{239+240}Pu$
1	26.5 / 100	4.2	6.5	24[(b)]
2	19.7 / 100	2.9	8.6	22[(b)]
3	32.3 / 100	4.6	3.1	37
4	16.0 / 100	6.6	13	40[(b)]
5	2.9 / 3	0.6	0.1	4.8[(b)]
6	32.3 / 81	1.7	3.3	8.4[(b)]
7	19.3 / 100	2.2	0.6	16[(b)]
8	13.9 / 100	17	8.0	110
9	20.0 / 98	4.2	2.2	89
10	20.0 / 99	19	19	110
11	4.0 / 16	3.3	0.5	29
12	39.6 / 100	5.7	8.5	39[(b)]
15	35.3 / 100	8.0	7.8	63[(b)]
16	14.3 / 50	0.7	1.5	3.7[(b)]
17	31.4 / 100	2.8	4.5	18[(b)]
18	27.3 / 31	19	5.6	100
19	148.3 / 100	21	32	140[(b)]
20	6.2 / 6	23	30	41
25	0.9 / 0.004	0	0	0
26	0.2 / 0.009	0	0	0
30	0.3 / 0.0051	3.2	4.5	14[(b)]

Source: (DOE 1991)
(a) Soil within 0–30 centimeters (cm) of the surface with most activity in the top 5 cm.
(b) DOE (1991) indicated that these levels were probably the result of historical fallout from nuclear tests in surrounding areas.

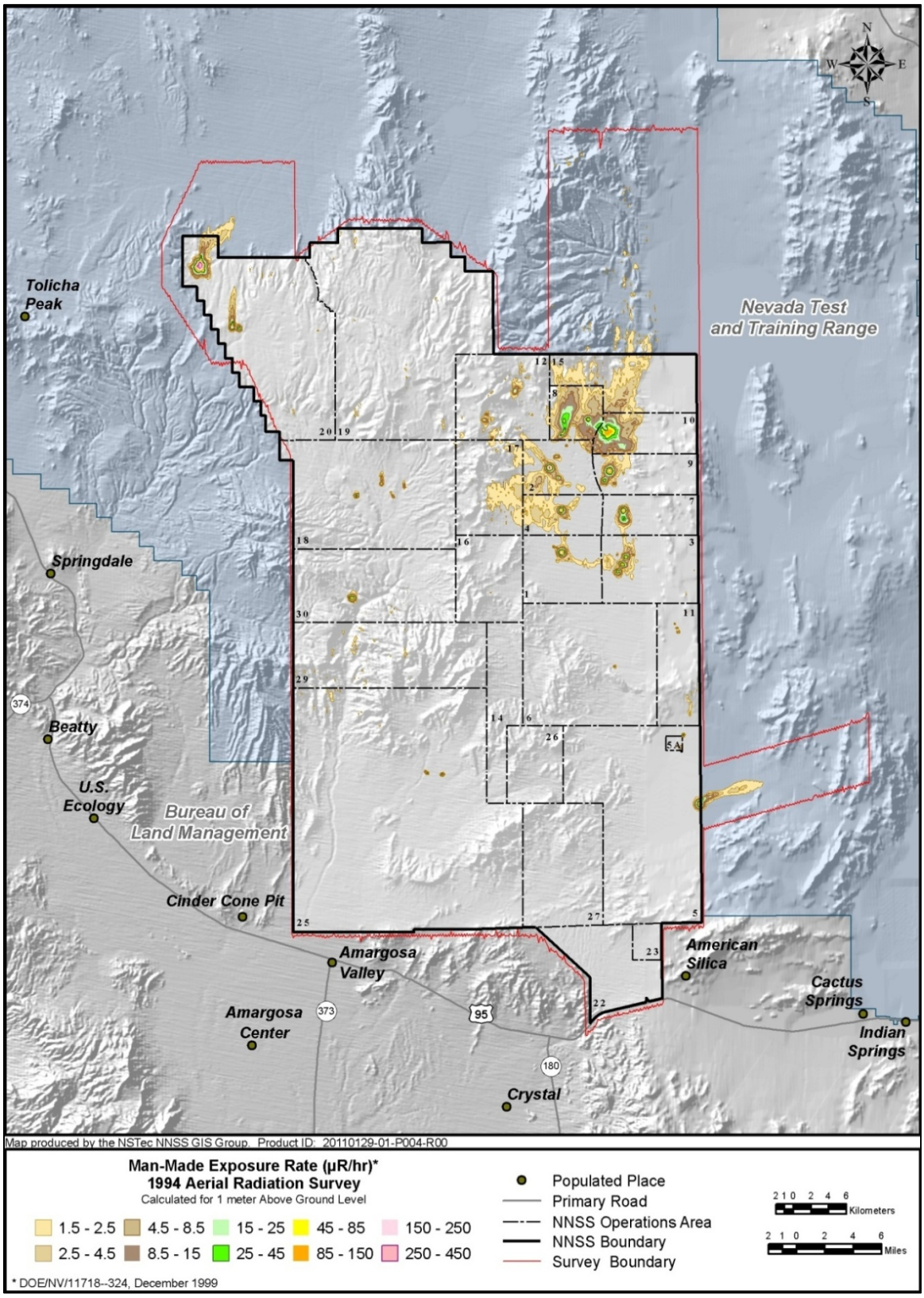

Figure 2. Distribution of Elevated Exposure Rates from Radionuclides in NNSS Soils

Current missions of the NNSS include (1) conducting high-hazard operations in support of defense-related nuclear and national security experiments; (2) providing support for homeland security activities, national security, and nonproliferation technology development and research; (3) characterizing and remediating the environmental legacy of past nuclear testing; and (4) managing and disposing radioactive wastes. A few programs and experiments at the NNSS use or handle radioactive materials in facilities. In all such facilities, radioactive materials are controlled in accordance with Title 10 Code of Federal Regulations (CFR) Part 835, "Occupational Radiation Protection" (CFR 2010b). The primary facilities that have key NNSA/NFO missions that have unsealed radioactive material and are potential sources for radiological air emissions are shown in Figure 3. Radionuclides potentially present at these facilities include various isotopes of Pu, Am, and uranium (U) as well as ^{3}H, ^{60}Co, ^{137}Cs, and various short-lived activation products. Radioactive emissions are not necessarily produced from these facilities in a given year, but all have the potential for radioactive emissions. These key facilities that are potential NNSS sources include the following:

- Big Explosives Experimental Facility (BEEF)
- T1 Training and Exercise Area
- Area 3 Radioactive Waste Management Site (RWMS)
- U1a Complex
- Los Alamos Technical Facility (LATF)
- Device Assembly Facility (DAF)
- National Criticality Experiments Research Center (NCERC), located inside the DAF
- Radiological/Nuclear Countermeasures Test and Evaluation Complex (RNCTEC)
- Tumbleweed Test Range
- Area 5 Radioactive Waste Management Complex (RWMC)
- Nonproliferation Test and Evaluation Complex (NPTEC)
- Joint Actinide Shock Physics Experimental Research (JASPER)

There are also facilities with laboratories where potentially contaminated environmental samples are processed or analyzed: Occupational Medicine and Radiological Control Building 23-650 and the Environmental Monitoring Building 23-652, both in Mercury in Area 23 (Figure 3). There is also handling and distillation of radioactive materials in the laboratory in Building 23-652. The amount of radioactive material in the environmental samples and laboratory standards are generally low; therefore, the potential emissions are negligible, but they are still considered a potential source.

All facilities and activities from which radionuclides were known to be released to air in calendar year (CY) 2012 are listed in Section II, Table 2, and their source information is listed in Appendix A.

The JASPER facility in Area 27 is the only continuously monitored point source on the NNSS. However, an updated assessment of potential dose from this facility (Appendix B) showed that the dose to the public from potential emissions from this facility are well below 0.1 millirem per year (mrem/yr) and do not necessitate continuous monitoring. Therefore, continuous monitoring of the JASPER stack emissions will be terminated in CY 2013. There were no man-made radionuclides detected in emissions from the JASPER facility during CY 2012.

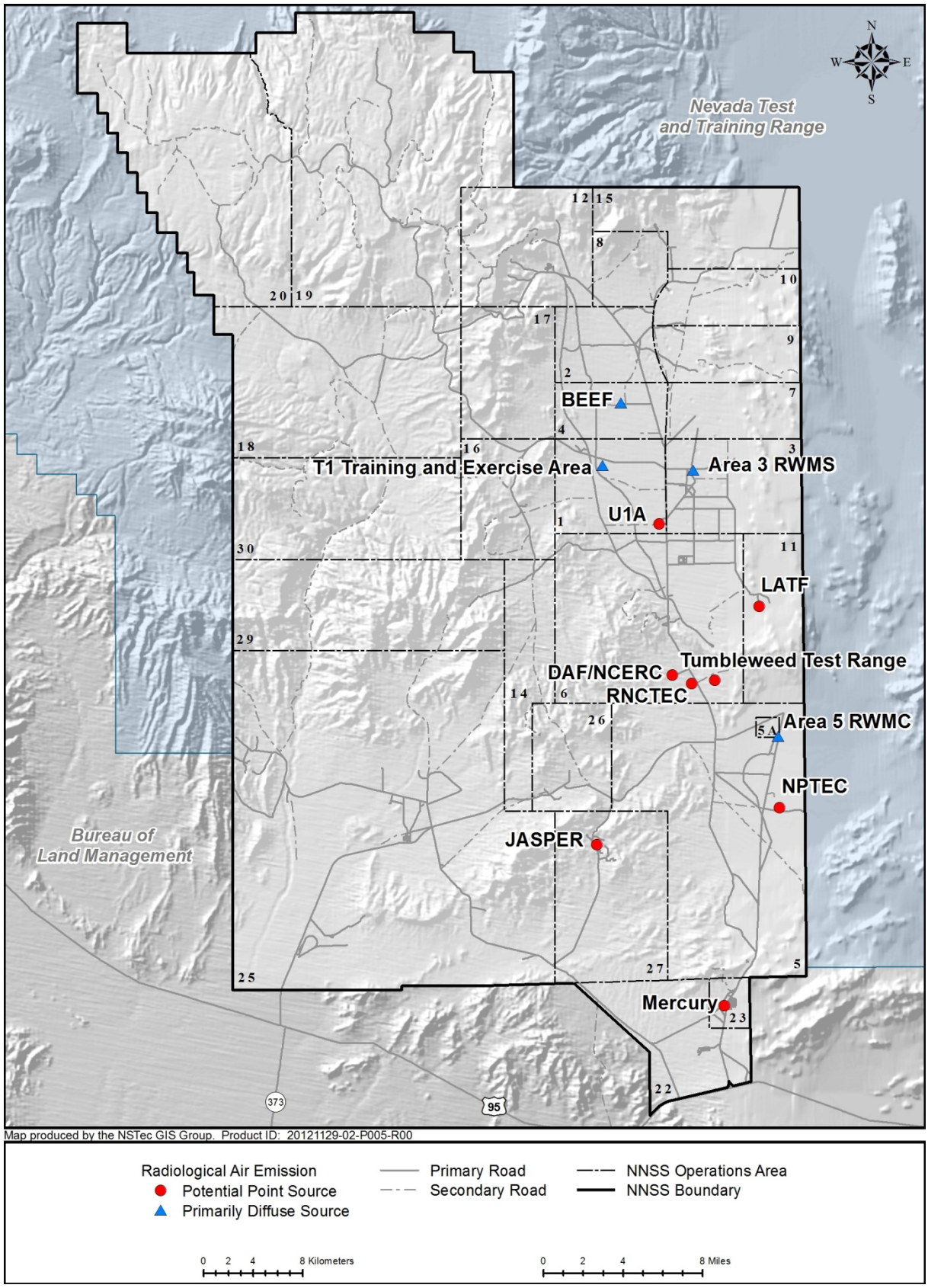

Figure 3. Primary Facilities for Key NNSA/NFO Missions

SECTION II
AIR EMISSIONS DATA

Facilities and operations from which radionuclides were released to the atmosphere during CY 2012 are listed in Table 2, and their source information is listed in Table A.1 of Appendix A. Their locations are displayed in Figure 4. Releases for the year are grouped into four general source categories: (1) legacy contamination sites; (2) defense, security, and stockpile stewardship; (3) radioactive waste management; and (4) support facility operations. Descriptions of CY 2012 emission sources by category are described below.

Legacy Contamination Sites

The environmental legacy of nuclear weapons and other testing on the NNSS is the predominant source of radionuclides that are released into the air. They are generally characterized as non-point (diffuse) sources and include:

Weapon Test and Plowshare Soil Contamination Sites

Three general soil contamination locations are listed for emission sources in this category. Two of them, Sedan and Schooner, are craters from the Plowshare program, which used nuclear devices to demonstrate their ability to excavate large amounts of earth. They are specifically listed separately from other test locations because they dominate the NNSS for ^{3}H emissions. The derivation of ^{3}H emission estimates from these locations is described in Appendix C. The third general location, referred to as "Grouped Area Sources," is a grouping of all large areas impacted by past nuclear testing on the NNSS. This grouping is used to report ^{238}Pu, $^{239+240}Pu$, and ^{241}Am emissions, the derivation of which is described in Appendix D.

Emanation from Building Materials

At the NLVF, parts of the Building A-01 basement were contaminated with ^{3}H in 1995. Emanation of tritiated water (HTO) from these building materials has persisted at continually decreasing levels. These emissions are exhausted from the building through the ventilation system. A description of the incident and the potential effective dose equivalent (EDE) for offsite exposure during CY 2012 are presented in Appendix E.

Groundwater Characterization/Control and Remediation Activities

Groundwater containing radionuclides associated with legacy contamination can be brought to the surface through either groundwater flow through fissures and man-made tunnels or through active pumping.

Environmental Restoration Corrective Action Site 12-59-01, E-Tunnels, has a component consisting of water contaminated from historical nuclear weapons testing flowing into collection ponds (E-Tunnel Ponds). The only radiological contaminant that produces a measurable air emission is ^{3}H evaporating as HTO. Calculation of this emission source for CY 2012 is described in Appendix F.

The Underground Test Area (UGTA) project has the task of characterizing the aquifers at sites of past underground nuclear tests. To characterize the groundwater regime, suitable wells are drilled and existing wells re-completed and sampled as determined by hydrologists. During these drilling and sampling operations, water is pumped to the surface. This water is then available for evaporation. Again, the only contaminant producing a measurable air emission from this evaporating water is ^{3}H as HTO. During CY 2012, water containing ^{3}H was pumped into sumps from the following wells:

- UE-20n #1
- ER-20-11

These well locations are displayed in Figure 4. Calculation of the ^{3}H emission from water pumped from them is described in Appendix F.

The 1995 ^{3}H contamination of the NLVF Building A-01 basement mentioned above also affected an inactive radiation source well that had since been filling with water due to the soil bottom in the well and a rise in groundwater. This source well was sealed in 2001 and a pump was installed to remove the residual ^{3}H contaminated water. The State of Nevada approved disposing of the contaminated water in the Area 23 Sewage Lagoons at the NNSS. Calculation of the ^{3}H emission from NLVF water disposed of at the NNSS sewage lagoons during CY 2012 is described in Appendix F.

There were no Environmental Restoration demolitions or cleanup projects conducted during CY 2012 that resulted in radionuclide emissions to air.

Defense, Security, and Stockpile Stewardship

This category consists of activities that make up the bulk of the current mission for the NNSS.

The Defense Experimentation and Stockpile Stewardship Directorate has a vital mission for national defense to maintain the integrity of the United States nuclear weapons stockpile. Certain experiments conducted under the Missions and Projects program have potential for radioactive emissions. Primary facilities for this are U1a, BEEF, JASPER, DAF, NCERC (located within the DAF), Dense Plasma Focus (DPF) located at the LATF, and tunnel facilities.

The Global Security Directorate conducts work to strengthen national security by providing real-world testing, evaluation, and training venues. Certain activities conducted by the National Center for Nuclear Security and the Test and Evaluation program have potential for radioactive emissions. The primary facilities for this are the T1 Training and Exercise Area, RNCTEC, NPTEC, and the Tumbleweed Test Range.

Of facilities in this category, radionuclides were released during CY 2012 from BEEF, DPF, NPTEC, Tumbleweed Test Range, and the T1 Training and Exercise Area. The T1 Training and Exercise Area and BEEF also include wide area soil contamination associated with historical testing. This is included in the "Grouped Area Sources" within the Legacy Weapon Test and Plowshare Soil Contamination Sites category mentioned above.

Radioactive Waste Management

The Area 3 RWMS and the Area 5 RWMC are used for the disposal of packaged, dry, low-level waste in pits and trenches. The Area 5 RWMC also has facilities for waste examination and repackaging activities, the accumulation of mixed waste, and the storage of transuranic (TRU) and mixed TRU wastes. Concrete pads are used for temporary storage of these wastes. The only radioactive emission detected by the various types of samplers located downwind of these sites and attributed to waste operations was ^{3}H as HTO in atmospheric moisture. The calculation of the ^{3}H source term for these emissions in CY 2012 is described in Appendix C.

Support Facility Operations

Facilities with laboratories as described at the end of Section I have the potential to emit low quantities of radionuclides from handling contaminated environmental samples or from the preparation of ^{3}H standards that are used for quality assurance purposes. Also, the Radiological Control Department has the responsibility of conducting receipt surveys of any radioactive materials arriving at the NNSS. If packaging is damaged, materials must be handled during repackaging, which creates the potential for low levels of air emissions. These activities generally take place at Radioactive Materials Control, Building 23-180. Of these support facilities, only the laboratory in Building 23-652 was known to use

unsealed radioactive materials (standard solutions) regularly in CY 2012; therefore, it is the only facility in this category listed as being an emission source in CY 2012.

Each potential source of NNSS emissions for CY 2012 was characterized by one of the following methods:

- Measuring the radionuclide inventory and identifying losses of radionuclides that were released to the environment
- Measuring the HTO concentrations in liquid effluents discharged and proceeding as if all the effluent evaporates over the course of the year to become an air emission
- Using re-suspension calculations
- Using a combination of environmental measurements and the Clean Air Package 1988 (CAP88-PC) air dispersion model (EPA 2006) to calculate the emissions

Distances and directions from all CY 2012 emission sources to the nearest offsite locations of interest are listed in Table 2. Distances ranged from 6 to 80 km from NNSS emission sources and from 0.1 to 0.85 km from the NLVF emission source.

Radionuclide emissions by source for CY 2012 are shown in Table 3. NNSS total emissions by radionuclide are shown in Table 4, and the NLVF emission is provided in Table 5. The source type, emission control, and description of the nature of each emission are listed in Table A.1 of Appendix A. Appendices C through F describe the methods used to determine the CY 2012 emissions.

A number of radionuclides that have not been emitted in recent history (post 1992) from the NNSS were introduced during 2012. These are beryllium-7 (^{7}Be), carbon-11 (^{11}C), nitrogen-13 (^{13}N), oxygen-15 (^{15}O), chlorine-38 (^{38}Cl), chlorine-39 (^{39}Cl), argon-41 (^{41}Ar), and metastable technetium-99 (^{99m}Tc). All but one of these activation products (^{7}Be) have short half-lives ranging from 10 minutes (^{13}N) to 6 hours (^{99m}Tc). This means that they decay away very quickly so are not available to contribute dose to the public at the 31 to 62 km distances over which they have to travel (from the Tumbleweed Test Range and T1 Training and Exercise Area) (Table 2). ^{7}Be has a 54-day half-life but is emitted in quantities much lower than the concentrations of ^{7}Be produced in the atmosphere by naturally occurring cosmic radiation. Section IV shows potential public dose from these emissions.

Table 2. CY 2012 Radionuclide Emission Sources and Distance to Offsite Locations

Emission Source	Distance[a] and Direction[b] to Nearest Offsite Locations		
	Offsite Residence	Offsite Business/Office	Offsite School
Legacy Contamination Sites			
Weapon Test and Plowshare Soil Contamination Sites			
Sedan, Area 10	52 km ENE (Medlin's Ranch)	59 km NNE (Rachel)	80 km ENE (Alamo)
Schooner, Area 20	37 km WSW (Sarcobatus Flat)	21 km WSW (Tolicha Peak)	56 km SSW (Beatty)
Grouped Area Sources – All NNSS	Various locations ranging from 20 to 60 km		
Emanation from Building Materials			
Building A-01, basement ventilation, NLVF	0.6 km W (N Las Vegas)[c]	0.1 km (at north fence of NLVF)	0.85 km W (N Las Vegas)[c]
Groundwater Characterization/Control or Remediation Activities			
Environmental Restoration Projects			
E-Tunnel Ponds, Area 12	53 km WSW (Springdale)	55 km WNW (Tolicha Peak)	62 km SW (Beatty)
UGTA Well Sumps			
UE-20n #1, Area 20	38 km SW (Springdale)	33 km W (Tolicha Peak)	51 km SW (Beatty)
ER-20-11, Area 20	45 km SW (Springdale)	38 km W (Tolicha Peak)	58 km SW (Beatty)
NLVF Building A-01 Source Well Water			
Area 23 Sewage Lagoons	23 km SW (Crystal)	7 km ESE (American Silica)	32 km ESE (Indian Springs)
Defense, Security, and Stockpile Stewardship			
BEEF, Area 4	57 km SSW (Amargosa Valley)	54 km SSE (American Silica)	57 km SSW (Amargosa Valley)
DPF (at LATF in Figure 4), Area 11	46 km SSE (Cactus Springs)	36 km S (American Silica)	49 km SSE (Indian Springs)
NPTEC, Area 5	34 km SE (Cactus Springs)	23 km S (American Silica)	38 km SE (Indian Springs)
Tumbleweed Test Range, Area 6	43 km SE (Cactus Springs)	31 km SSE (American Silica)	47 km SE (Indian Springs)
T1 Training and Exercise Area (labeled T1 in Figure 4)	53 km SSW (Amargosa Valley)	50 km SSE (American Silica)	62 km WSW (Beatty)
Radioactive Waste Management			
Area 3 RWMS	56 km SW (Amargosa Valley)	48 km S (American Silica)	61 km SSE (Indian Springs)
Area 5 RWMC	36 km SE (Cactus Springs)	26 km S (American Silica)	40 km SE (Indian Springs)
Support Facility Operations			
Building 23-652 (labeled 23-652 in Figure 4), Area 23	24 km SW (Crystal)	6 km SE (American Silica)	30 km ESE (Indian Springs)

(a) Distance is shown in km. For miles, multiply by 0.62.
(b) N=north, S=south, E=east, W=west in all direction combinations shown
(c) City of North Las Vegas

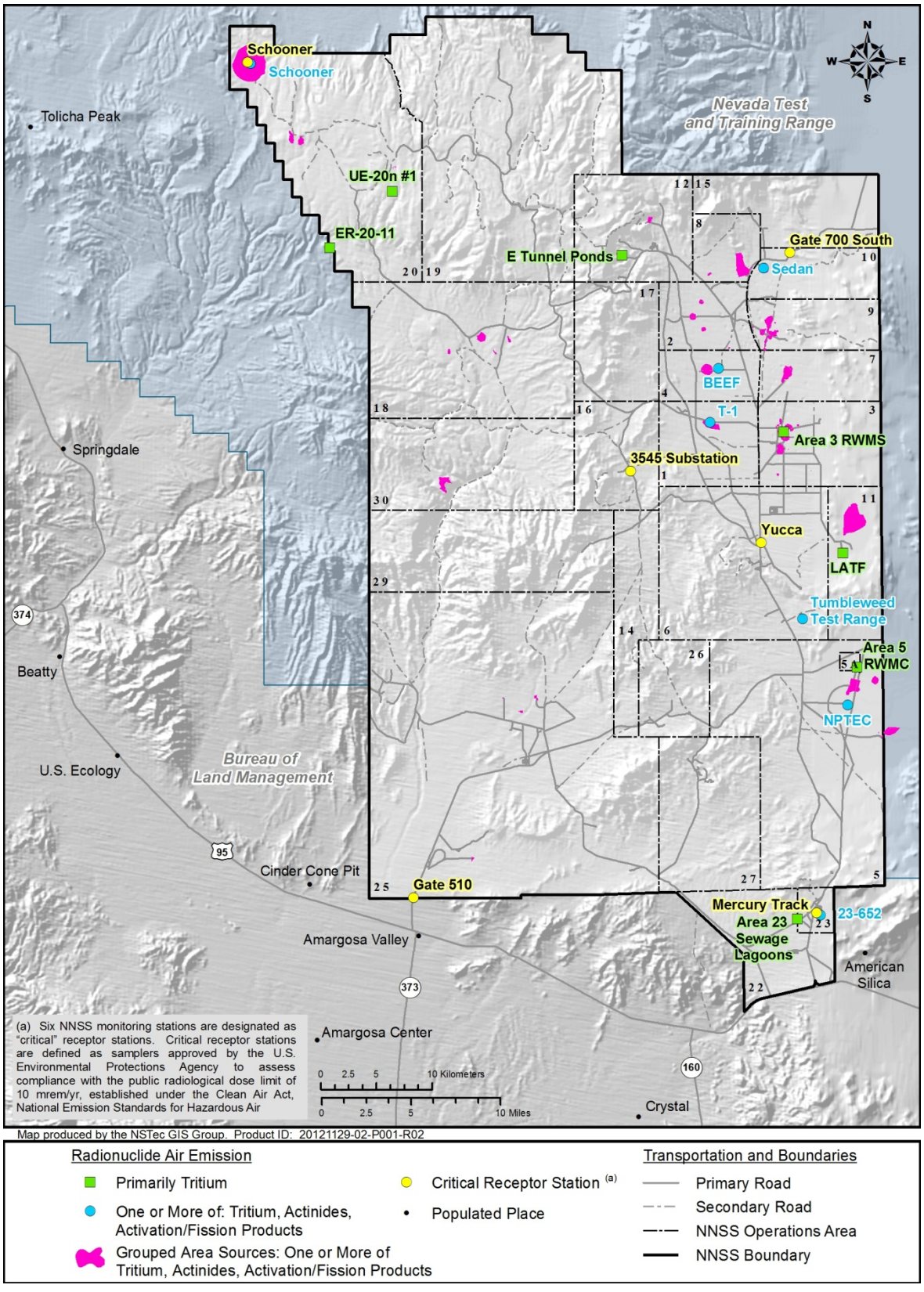

Figure 4. Sources of Radiological Air Emissions on the NNSS in CY 2012

Table 3. Summary of CY 2012 Air Emissions Data by Source

Emission Source[a]	Type of Emissions Control	Radionuclide	Annual Quantity (Ci)
Legacy Contamination Sites			
Weapon Test and Plowshare Soil Contamination Sites			
Sedan	None	^{3}H[b]	24.4
Schooner	None	^{3}H[b]	92
Grouped Area Sources – All NNSS Ops Areas	None	^{241}Am[c]	0.047
	None	^{238}Pu[c]	0.050
	None	$^{239+240}Pu$[c]	0.29
Emanation from Building Materials			
Building A-01, basement ventilation, NLVF	None	^{3}H[d]	0.0047
Groundwater Characterization/Control or Remediation Activities			
Environmental Restoration Projects			
E-Tunnel Ponds	None	^{3}H[e]	6.7
UGTA Well Sumps			
UE-20n #1	None	^{3}H[e]	2.6
ER-20-11	None	^{3}H[e]	0.12
NLVF Groundwater Control			
Area 23 Sewage Lagoons	None	^{3}H[e]	0.00045
Defense, Security, and Stockpile Stewardship			
BEEF	None	depleted uranium (DU)[d]	0.06
DPF	None	^{3}H[f]	95
NPTEC	None	DU[g]	0.00082
Tumbleweed Test Range	None	^{7}Be[g]	0.0006
	None	^{11}C[g]	51
	None	^{13}N[g]	1808
	None	^{15}O[g]	2866
	None	^{38}Cl[g]	2
	None	^{39}Cl[g]	22
	None	^{41}Ar [g]	177
T1 Training and Exercise Area	None	^{99m}Tc[g]	0.0002
Radioactive Waste Management			
Area 3 RWMS	Soil cover over waste	^{3}H[b]	5.7
Area 5 RWMC	Soil cover over waste	^{3}H[b]	1.8
Support Facility Operations			
Building 23-652	None	^{3}H	0.000042

(a) All locations are on the NNSS except for Building A-01.
(b) Emission based on sample results and CAP88-PC software; see Appendix C.
(c) Sum of emissions estimated from re-suspension model; see Table D.1 for individual area estimates.
(d) Based on air concentrations and ventilation system flow rate; see Appendix E.
(e) Emission based on HTO discharged into containment pond(s) or onto the ground; see Appendix F.
(f) Emission reported by DPF project personnel.
(g) Emission based on potential release used in dose estimate (see Section IV).

Table 4. Total Estimated NNSS Emissions for CY 2012

Radionuclide[(a)]	Total Quantity (Ci)
^{3}H	228
^{7}Be	0.0006
^{11}C	51
^{13}N	1808
^{15}O	2866
^{38}Cl	2
^{39}Cl	22
^{41}Ar	177
^{99m}Tc	0.0002
^{238}Pu	0.050
$^{239+240}Pu$	0.29
DU	0.061
^{241}Am	0.047

Note: This table includes conservative point and diffuse source release estimates.

(a) Includes all radionuclides with reasonable emission estimates available. Not all of these radionuclides would contribute ≥ 10% of the potential EDE.

Table 5. Total Estimated NLVF Emissions for CY 2012

Radionuclide	Total Quantity (Ci)
^{3}H	0.0047

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SECTION III
DOSE ASSESSMENTS

DOSE ASSESSMENT METHOD

The NNSS demonstrates compliance with dose limits using environmental measurements of radionuclide air concentrations near the NNSS borders and near areas of known potential sources of radionuclide emissions. This critical receptor method (40 CFR 61.93.g) was approved by EPA Region IX for use on the NNSS in 2001 (EPA 2001a) and has been the sole method used to demonstrate compliance since 2005. The six approved critical receptor locations are listed below and displayed in Figure 4 with NNSS emission locations and in Figure 5 along with the entire NNSS air sampling network.

- Area 6, Yucca
- Area 10, Gate 700
- Area 16, Substation 3545
- Area 20, Schooner
- Area 23, Mercury Track
- Area 25, Gate 510

These can be thought of as worst case for an offsite receptor because these samplers are much closer to emissions sources. Table 6 displays the distances between the critical receptor monitoring stations and points where members of the public potentially live, work, and/or go to school. The distance between the sampling location and the closest onsite emission location is also listed. The shortest distance between where a member of the public resides and a critical receptor monitoring station is 4 km. This is between the Gate 510 sampler, in the SW corner of the NNSS, and Amargosa Valley. Because it is the closest, the results from the Gate 510 sampler are believed to be most representative of air concentrations to which the public is continuously exposed. The shortest distance between an NNSS radionuclide emission source and a critical receptor monitoring station is 0.2 km. This is between the Schooner sampler, in the NW corner of the NNSS, and the Schooner Crater. Because this sampler is actually within the area physically affected by the nuclear test (Figure 6), it generally has the highest radionuclide concentrations of all of the six critical receptor stations. It also, therefore, represents the most extreme potential dose to a (pseudo) member of the public. The distance from the Schooner sampler to the closest member of the public (Tolicha Peak) is 20 km, which is 100 times farther than it is from the emission source.

Compliance with the NESHAP public air pathway dose limit of 10 mrem/yr is demonstrated if the measured annual average concentration of each detected radionuclide at each of these six critical receptor locations is less than the NESHAP Concentration Levels (CLs) for Environmental Compliance (40 CFR 61, Appendix E, Table 2). The CLs represent the annual average concentration of each radionuclide that would result in an EDE of 10 mrem/yr (see Table 7). For multiple radionuclides, compliance with NESHAP is demonstrated when the sum of the fractions (determined by dividing each radionuclide's concentration by its CL and then adding the fractions together) is less than 1.0. The CY 2012 air sampling results from the six compliance stations are presented in Table 7.

COMPLIANCE ASSESSMENT

Table 7 lists the annual average concentrations of detected radionuclides and their fraction of the NESHAP compliance level for each of the six NNSS critical receptor stations. The concentration average for each detected man-made radionuclide was below 2% of the CLs except for the ^{3}H average at the Schooner sampler station, which was about 11% of the CL. The average concentration of ^{3}H is high at Schooner because the air sampler is so close to the emission source, as discussed above. The highest sum

of the fractions, which was also measured at the Schooner sampler, was 0.111. This is well below 1.0 and therefore in compliance with the NESHAP standard. Scaling the 0.111 sum of fractions to the 10 mrem/yr limit gives an estimated EDE of 1.11 mrem/yr from the air pathway for a hypothetical individual living year-round at this station. This can be thought of as a highly conservative hypothetical maximally exposed individual (MEI). The more representative dose to the public would be from the Gate 510 station. Scaling the 0.017 sum of fractions for the Gate 510 station to the 10 mrem/yr limit gives an estimated EDE of about 0.17 mrem/yr from air emissions. For comparison, the fractions of the 10 mrem/yr air pathway dose limit from CAP-88 modeled MEI dose estimates from CY 1992 to CY 2004 are displayed in Figure 7 along with the highest critical receptor station monitoring results (Schooner) from CY 2005 to CY 2012.

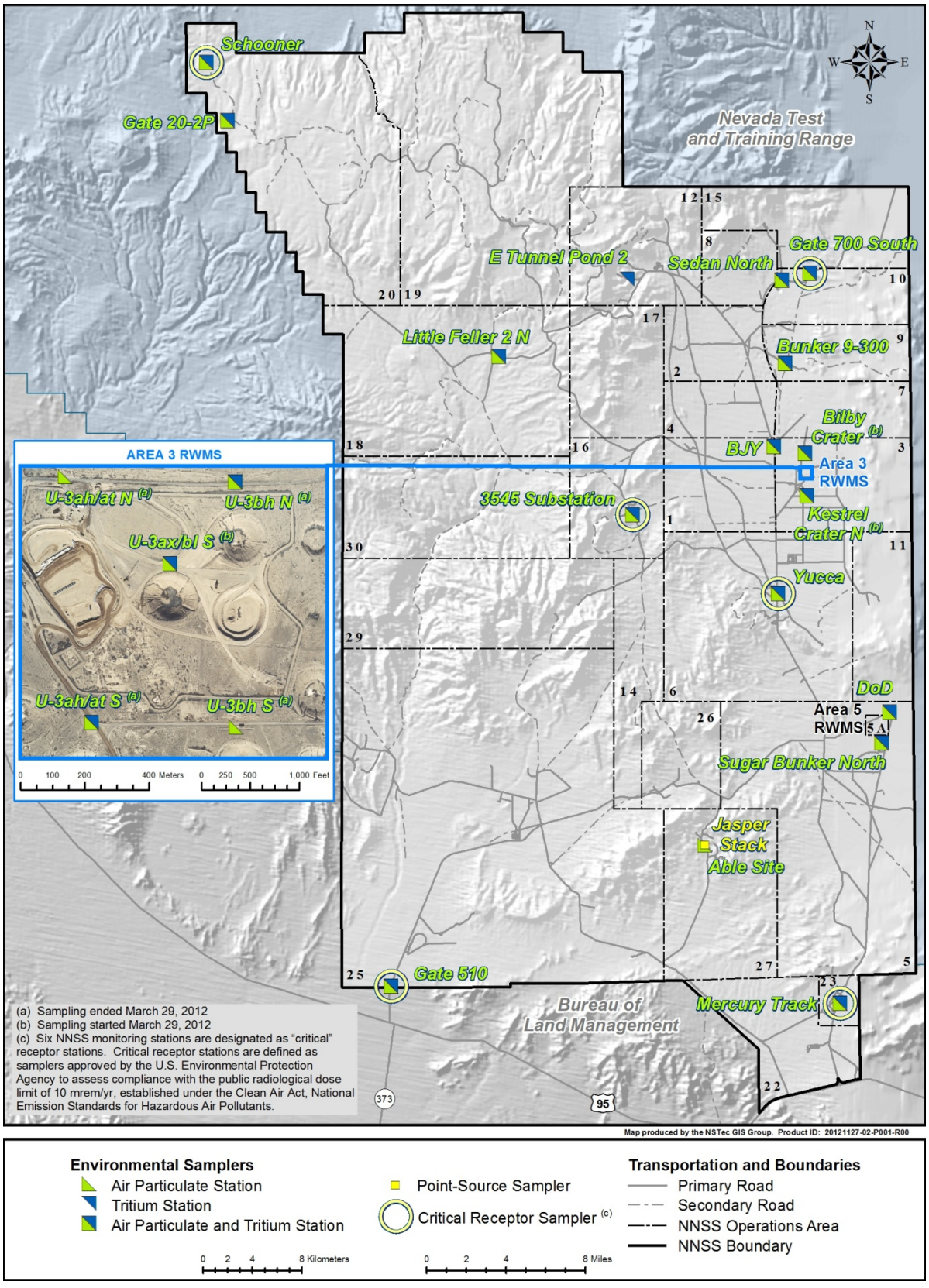

Figure 5. Air Sampling Network on the NNSS

Table 6. Distance Between Critical Receptor Air Monitoring Stations and Nearest Points of Interest

Critical Receptor Station	Distance[a] and Direction[b] to Nearest Offsite Locations and Onsite Emission Location			
	Offsite Residence	Offsite Business/ Office	Offsite School	NNSS Emission Source
Area 6, Yucca	47 km SW (Amargosa Valley)	38 km SSE (American Silica)	54 km SE (Indian Springs)	10 km N (Area 3 Radioactive Waste Management Site)
Area 10, Gate 700	49 km ENE (Medlin's Ranch)	56 km NNE (Rachel)	77 km ENE (Alamo)	2.4 km WSW (Area 10, Sedan Crater)
Area 16, Substation 3545	46 km SSW (Amargosa Valley)	46 km SSW (Amargosa Valley)	58 km SSW (Amargosa)	14 km ENE (Area 3 Radioactive Waste Management Site)
Area 20, Schooner	36 km WSW (Sarcobatus Flat)	20 km WSW (Tolicha Peak)	56 km SSW (Beatty)	0.2 km SE (Area 20, Schooner Crater)
Area 23, Mercury Track	24 km SW (Crystal)	6.0 km SE (American Silica)	31 km SSW (Indian Springs)	1.0 km WSW (Area 23 Sewage Lagoons)
Area 25, Gate 510	4 km S (Amargosa Valley)	3.5 km S (Amargosa Valley)	15 km SW (Amargosa)	5.1 km NE (Area 25, nearest portion of the Grouped Area Sources)

(a) Distance is shown in km. For miles, multiply by 0.62.
(b) N=north, S=south, E=east, W=west in all direction combinations shown

Table 7. Average Radionuclide Concentrations at NNSS Critical Receptor Stations and Fraction of Concentration Level (CL) for CY 2012

Location	Radionuclide	Average Concentration in Air (pCi/m^3)[(a)]	CL[(b)] (pCi/m^3)	Average Concentration as Fraction of CL
Yucca	^{3}H	0.22×10^{0}	1500	0.0001
Gate 700 S		0.26×10^{0}		0.0002
Substation 3545		0.18×10^{0}		0.0001
Schooner		157.57×10^{0}		0.1050
Mercury Track		0.24×10^{0}		0.0002
Gate 510		0.21×10^{0}		0.0001
Yucca	^{241}Am	2.15×10^{-6}	0.0019	0.0011
Gate 700 S		1.22×10^{-6}		0.0006
Substation 3545		2.86×10^{-6}		0.0015
Schooner		4.99×10^{-6}		0.0026
Mercury Track		3.26×10^{-6}		0.0017
Gate 510		3.66×10^{-6}		0.0019
Yucca	^{238}Pu	0.32×10^{-6}	0.0021	0.0002
Gate 700 S		1.52×10^{-6}		0.0007
Substation 3545		1.99×10^{-6}		0.0009
Schooner		2.39×10^{-6}		0.0011
Mercury Track		1.35×10^{-6}		0.0006
Gate 510		1.06×10^{-6}		0.0005
Yucca	$^{239+240}Pu$	7.01×10^{-6}	0.002	0.0035
Gate 700 S		8.22×10^{-6}		0.0041
Substation 3545		3.31×10^{-6}		0.0017
Schooner		3.73×10^{-6}		0.0019
Mercury Track		3.94×10^{-6}		0.0020
Gate 510		27.87×10^{-6}		0.0139
Yucca	Sum of Fractions by Location			0.005
Gate 700 S				0.006
Substation 3545				0.004
Schooner				0.111
Mercury Track				0.004
Gate 510				0.017

(a) picocuries per cubic meter (pCi/m^3)

(b) Source: Table 2 in Title 40 CFR 61, Appendix E (Compliance Procedures Methods for Determining Compliance with Subpart I) (CFR 2010a)

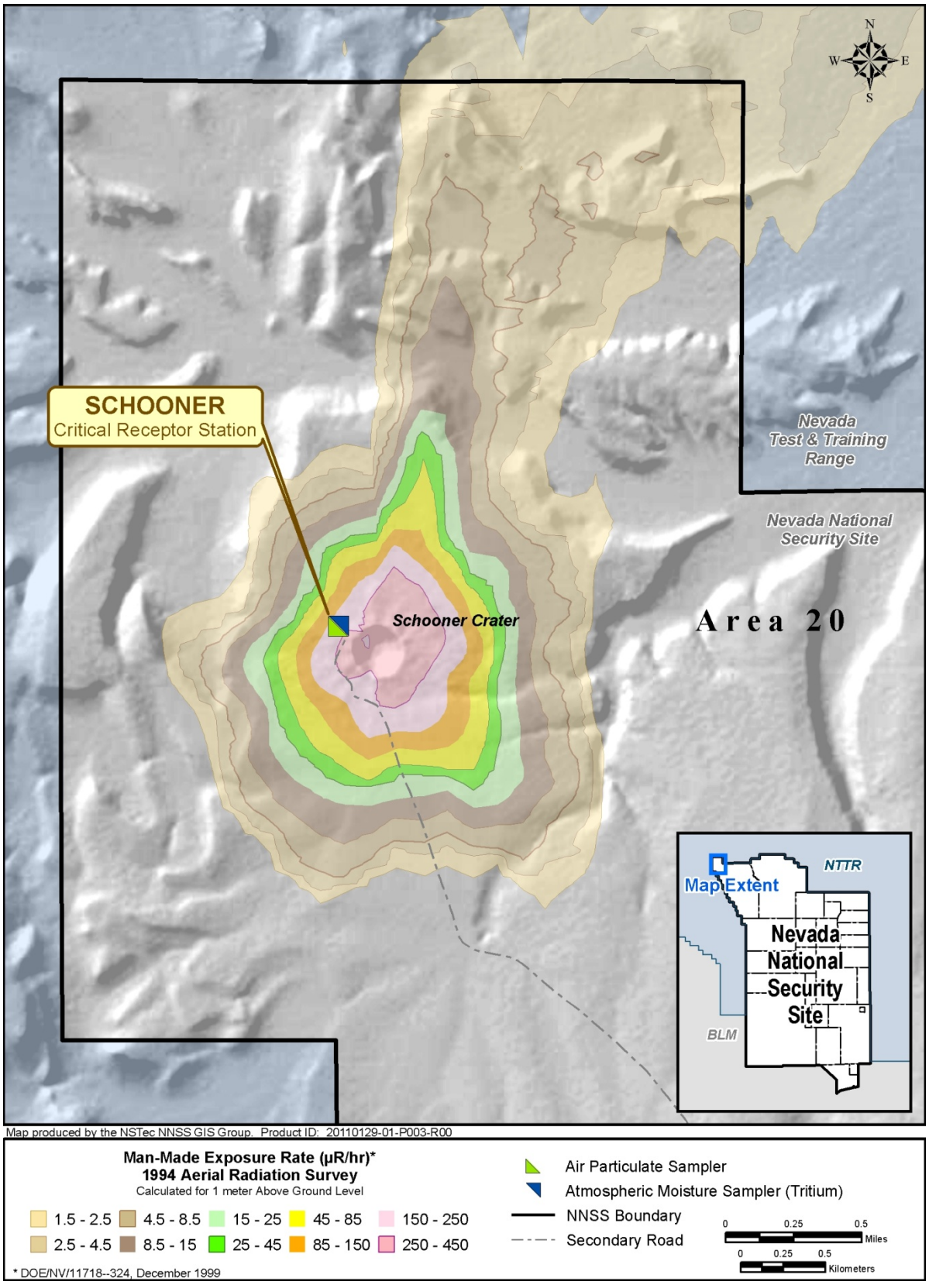

Figure 6. Schooner Critical Receptor Air Sampling Station

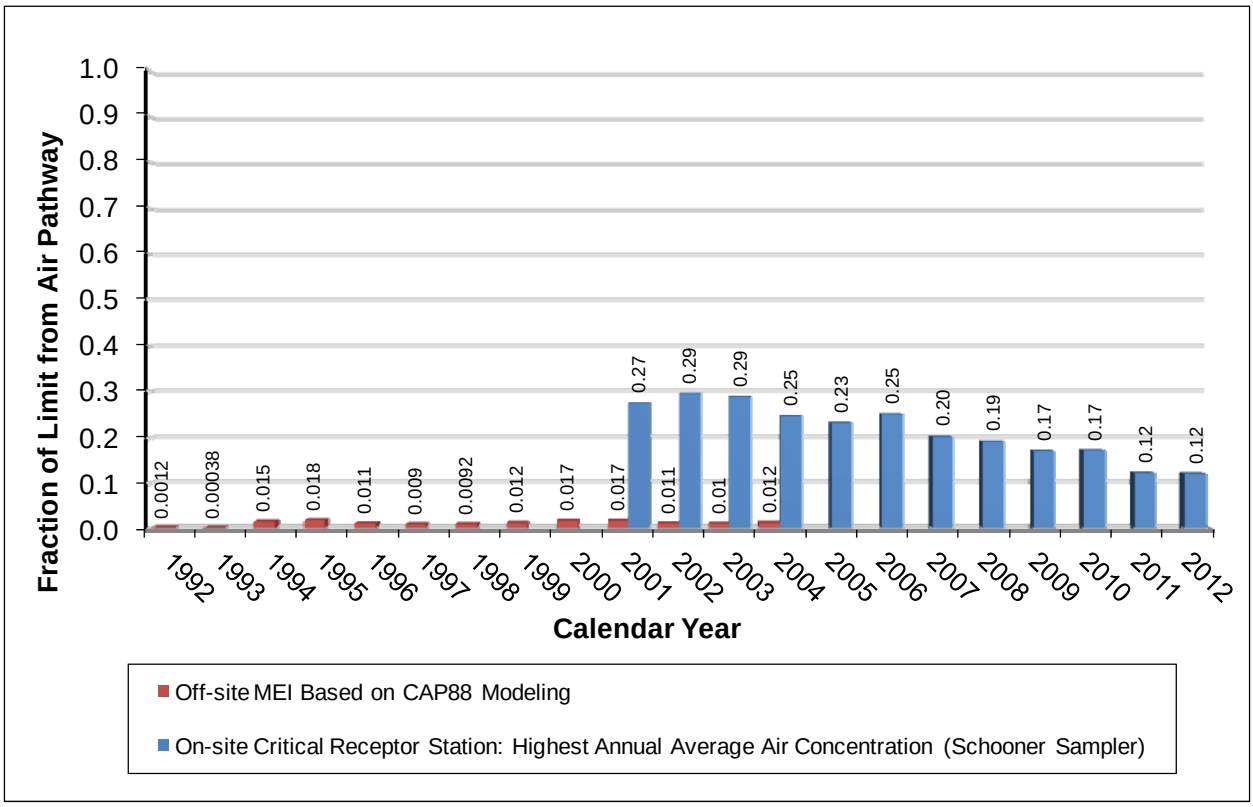

Figure 7. Fraction of the 10 mrem/yr Air Pathway Dose Limit for CAP88-PC modeled MEI Dose and Highest Critical Receptor Station Monitoring Results

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SECTION IV
ADDITIONAL INFORMATION

DOSE EVALUATIONS CONDUCTED DURING CY 2012

This section summarizes radionuclide NESHAP evaluations conducted during CY 2012 for potential radionuclide releases and radiation dose estimates from new projects, construction, modifications, or periodic confirmatory measurements of existing activities. These evaluations were performed in accordance with 40 CFR 61, Subpart H, and are separated into the following general categories: Environmental Restoration Projects, Waste Management Projects, Construction Projects, Research Projects, and Periodic Confirmatory Assessments. Sources classified as Category III or IV (see right-most column of Table 8) have a potential dose to the offsite MEI of less than 0.1 mrem/yr and do not require monitoring; they only require periodic confirmatory evaluations to confirm low emissions. All of the radiation dose assessments performed during CY 2012 were performed with CAP88-PC modeling software, in accordance with 40 CFR 61.93, using conservative assumptions in the software input parameters to maximize dose estimates.

ENVIRONMENTAL RESTORATION PROJECTS

Under the *Federal Facility Agreement and Consent Order*, as amended (March 2010) between DOE, the U.S. Department of Defense, and the State of Nevada, radioactive soil contamination generated by historical NNSS activities is addressed. NNSS Environmental Restoration projects that involve the removal and haulage of materials and soil containing low concentrations of radioactivity are evaluated for potential radionuclide emissions to air and potential dose offsite. No environmental restoration activities with potential for radionuclide air emissions were conducted during CY 2012; therefore, no radiation dose assessments were performed in this category.

WASTE MANAGEMENT PROJECTS

No construction/modification activities took place at waste management facilities during CY 2012. Radionuclide emission from waste management sites are discussed in Appendix C.

CONSTRUCTION PROJECTS

No construction projects with potential for radionuclide emissions were initiated during CY 2012.

RESEARCH PROJECTS

NESHAP dose evaluations were conducted for four research projects during CY 2012. Some of these projects were conducted during CY 2012 and some are for future work. A summary of each evaluation is listed in Table 8. All projects evaluated were determined to be Category III or Category IV emission sources.

Table 8. NESHAP dose evaluations conducted during CY 2012

Project Description	NNSS Operational Area	Emission Year	Radionuclide Emissions	MEI Dose (mrem/yr) and Location	Emission Category[(a)]
A photon flux created by an electron linear accelerator (LINAC) is used to irradiate materials in closed containers. Activation products in air are produced in the vicinity of the LINAC and along its beam path during LINAC operations.	Area 6 Tumbleweed Test Range	CY 2012, ongoing	^{3}H, ^{7}Be, ^{11}C, ^{13}N, ^{15}O, ^{38}Cl, ^{39}Cl, ^{39}Ar, and ^{41}Ar	0.018 Cold Creek, 59 km SSE	III
Potential radionuclides in soil resuspended by the use of explosives at two locations in the southwest portion of the NNSS. This is only re-suspension of soil with background levels of fallout. No radionuclides are used in the explosives.	Area 25	CY 2012, ongoing	^{60}Co, ^{90}Sr, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{155}Eu, ^{238}Pu, $^{239+240}$Pu, ^{241}Am, ^{234}U, ^{238}U (conservative estimate of background levels of fallout)	1.4×10^{-5} Amargosa Valley, 9.4 km SW	IV
National Center for Nuclear Security particle dispersal and deposition study simulating a small-scale vent from an underground test. Particle sizes are 38 to 75 microns so they will not move far and are not respirable but were modeled as 1 micron particles for a conservative dose estimate.	Area 6	CY 2013	Lanthamum-140 and Gold-198	0.001 American Silica, 42 km S	IV
Global Security, Test and Evaluation, began a program called Testing Radiation and Contamination in Emergency Response .The purpose of this program is for various emergency response organizations to practice procedures and techniques for detecting radioactive material and contamination.	Area 1 T1 Training and Exercise Area	CY 2012 ongoing	^{99m}Tc	2×10^{-7} American Silica, 50 km, SSE	IV

(a) Based on ANSI/HPS 13.1-1999 potential impact categories (American National Standards Institute 1999): Category I refers to annual dose > 5 mrem; Category II refers to annual dose > 0.1 mrem and ≤ 5 mrem; Category III refers to annual dose > 0.001 mrem and ≤ 0.1 mrem; and Category IV refers to annual dose ≤ 0.001 mrem.

PERIODIC CONFIRMATORY MEASUREMENTS

NESHAP regulations require periodic confirmatory measurements for minor release sources (Category III or IV sources) to verify low emissions [40 CFR 61.93 (e)]. Furthermore, a Memorandum of Understanding between the EPA and DOE states that "engineering calculations and/or representative measurements may be used to comply with periodic confirmatory measurement requirements" (EPA and DOE 1995). This section lists the periodic confirmatory measurements that were conducted during CY 2012.

North Las Vegas Facility (NLVF), Building A-01

Biannual measurements of ^{3}H concentrations in air in Building A-01 are made as a best management practice. The potential dose from Building A-01 emissions is calculated each year based on this monitoring information. The emissions during CY 2012, and the resultant dose (0.000024 mrem/yr), were at the same low levels as were calculated for the previous year. These are over 4000 times lower than the 0.1 mrem/yr level specified in 40 CFR 61.96. A summary of this is presented in Appendix E.

Joint Actinide Shock Physics Experimental Research (JASPER)

No manmade radionuclides were detected in stack samples from the JASPER facility as has been the case for previous years. A periodic confirmatory assessment of the potential radionuclide emissions and dose from those emissions was conducted. The results (summarized in Appendix B) show the potential dose at the nearest boundary (0.021 mrem/yr) is 4.76 times lower than the 0.1 mrem/yr level specified in 40 CFR 61.96 for requiring monitoring, and the dose at the nearest offsite residence is 20 times lower. It is therefore concluded that the emission of radioactive material to air from operations at the JASPER Facility is minor (Category III emission) and does not require continuous monitoring from a NESHAP perspective.

Nonproliferation Test and Evaluation Complex (NPTEC)

Certain experiments conducted at the NPTEC involve the handling of radioactive material (natural and depleted uranium) in particulate form. The CAP88-PC predicted dose at the nearest boundary (0.043 mrem/yr) is 2.3 times lower than the 0.1 mrem/yr level specified in 40 CFR 61.96. The predicted dose at the nearest offsite residence (Cactus Springs) is over 43 times lower than at the nearest boundary. It is therefore concluded that the emission of radioactive materials to air from NPTEC is minor (Category III) and does not require continuous monitoring.

UNPLANNED RELEASES

There were no unplanned radionuclide releases during CY 2012. Multiple wildland fires did occur on the NNSS during CY 2012 (Figure 8), but the routine air monitoring results did not indicate increased emissions. Radionuclide emissions from these fires were therefore considered negligible.

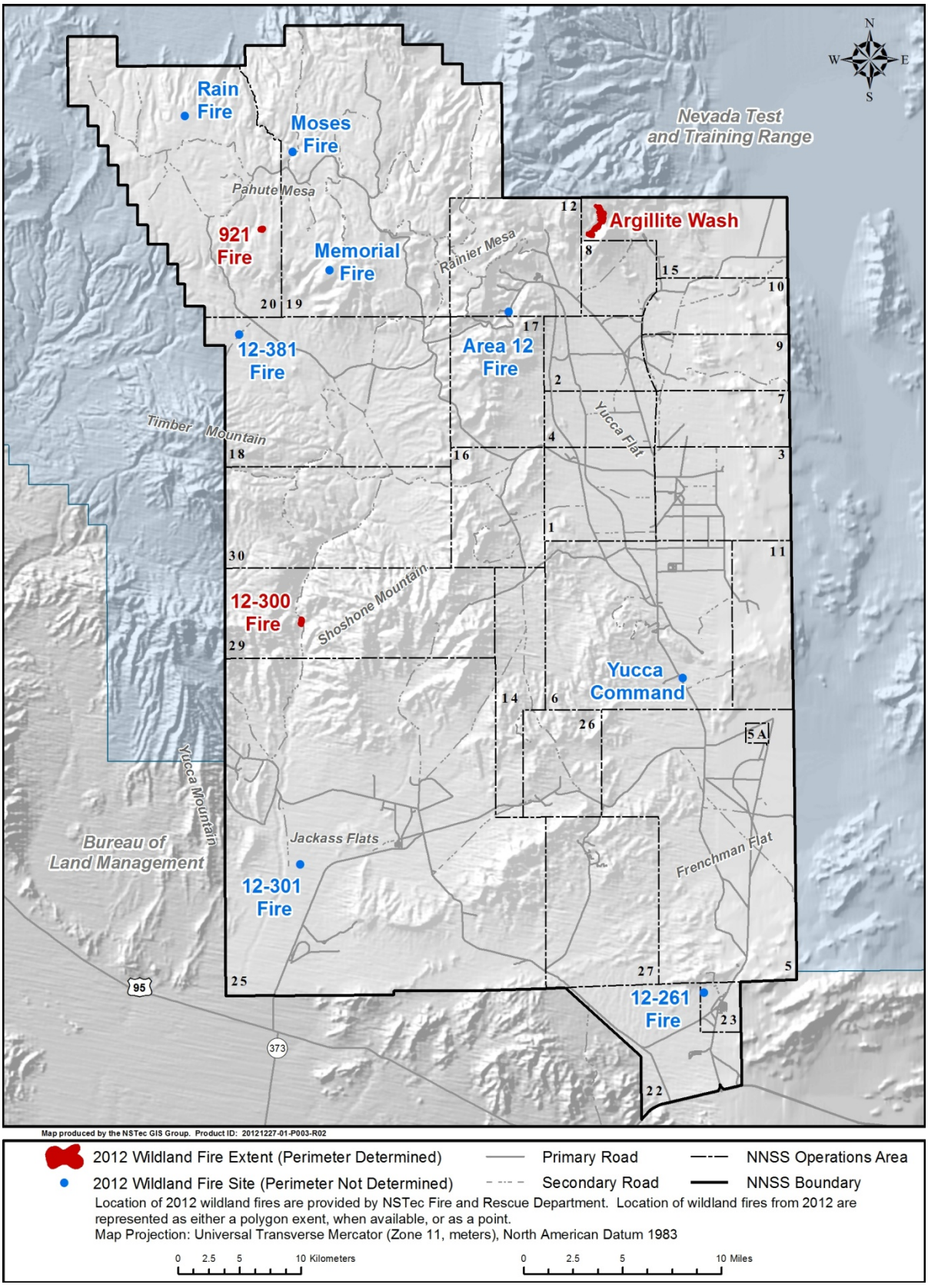

Figure 8. Wildland fires on the NNSS, CY 2012

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.

Name: Steven J. Lawrence,
Acting Manager, NNSA/NFO

Signature: Steven J. Lawrence Date: 6.13.13

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REFERENCES

American National Standards Institute, 1999. *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities.* ANSI N13.1-1999. American National Standards Institute, Inc., Washington, D.C.

CFR, see Code of Federal Regulations.

Code of Federal Regulations, 2010a. National Emission Standards for Hazardous Air Pollutants: Radionuclides, Title 40, Part 61, U.S. Environmental Protection Agency, Washington, D.C.

Code of Federal Regulations, 2010b. Occupational Radiation Protection, Title 10, Part 835, U.S. Environmental Protection Agency, Washington, D.C.

DOE, see U.S. Department of Energy.

EPA, see U.S. Environmental Protection Agency.

Geographic Information Science & Technology Group, Oak Ridge National Laboratory, 2012. LandScan USA Population Database 2011 (conus night pre-release). Oak Ridge National Laboratory, Oak Ridge, TN.

Hendricks, T. J., and S. R. Riedhauser, 1999. *An Aerial Radiological Survey of the Nevada Test Site*, DOE/NV/11718--324, U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV.

National Security Technologies, LLC, 2012. *Nevada National Security Site 2011 Waste Management Monitoring Report, Area 3 and Area 5 Radioactive Waste Management Sites*, DOE/NV/25946--1572, U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, Las Vegas, NV.

Shott, G. J., L. E. Barker, S. E. Rawlinson, M. J. Sully, and B. A. Moore, 1998. *Performance Assessment for the Area 5 Radioactive Waste Management Site at the Nevada Test Site, Nye County, Nevada, Revision 2.1*, DOE/NV/11718--176, Bechtel Nevada, Las Vegas, NV.

U.S. Department of Energy, 1991. *Radionuclides in Surface Soil at the Nevada Test Site*, DOE/NV/10845--02, Water Resources Center, Desert Research Institute, University of Nevada System, Las Vegas, NV.

U.S. Department of Energy, 1992. *Summary of the Nevada Applied Ecology Group and Correlative Programs*, DOE/NV--357, Raytheon Services Nevada, Las Vegas, NV.

U.S. Department of Energy, 1996. *National Emission Standards for Hazardous Air Pollutants Submittal - 1995*, DOE/NV/11718--032, U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV.

U.S. Department of Energy, 1999a. Radioactive Waste Management, DOE O 435.1, Office of Environmental Management, Washington, D.C.

U.S. Department of Energy, 1999b. Radioactive Waste Management Manual, DOE M 435.1-1, Office of Environmental Management, Washington, D.C.

U.S. Department of Energy, 2003. *Routine Radiological Environmental Monitoring Plan*, DOE/NV/11718--804, U.S. Department of Energy, Nevada Operations Office, Las Vegas, NV.

U.S. Department of Energy, 2004. Email from Gustavo Vazquez, DOE/EH-41, to Bruce W. Hurley, NNSA/NSO, dated April 1, 2004.

U.S. Department of Energy, 2013. *Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada*. DOE/EIS-0426, U.S. Department of Energy, Nevada Site Office, Las Vegas, NV.

U.S. Department of Energy, 2011. Quality Assurance, DOE O 414.1D, April 25, 2011, Washington, D.C.

U.S. Environmental Protection Agency, 2001a. Approval Letter for the NNSS Use of Critical Receptor Monitoring. Letter from Jack P. Broadbent, EPA Region IX Director, Air Division, to Kenneth A. Hoar, DOE Nevada Field Office, Environmental, Safety & Health Division, July 23, 2001.

U.S. Environmental Protection Agency, 2001b. Test Methods for Measuring Radionuclide Emissions from Stationary Sources, Title 40 Code of Regulations, Part 61, Appendix B, Method 114, July 1, 2001 Edition.

U.S. Environmental Protection Agency, 2006. Updated User's Guide for CAP88-PC, Version 3.0, Office of Radiation and Indoor Air, Washington, D.C.

U.S. Environmental Protection Agency and U.S. Department of Energy, 1995. U.S. Memorandum of Understanding Between the U.S. Environmental Protection Agency and the U.S. Department of Energy Concerning the Clean Air Act Emission Standards for Radionuclides 40 CFR Part 61, Including Subparts H, I, Q & T. Signed by Mary D. Nichols, EPA Assistant Administrator for Air and Radiation, September 29, 1994. Signed by Tara O'Toole, DOE Assistant Secretary for Environment, Safety, and Health, April 5, 1995.

U.S. Nuclear Regulatory Commission, 1983. *Radiological Assessment*, NUREG/CR-3332, Till, J. E., and H. R. Meyer, Editors, Office of Nuclear Reactor Regulation, Washington, D.C.

APPENDICES

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Appendix A

Radionuclide Air Emission Sources

Table A.1 Facilities or Areas from which Radionuclides were Released to Air in Calendar Year (CY) 2012

Facility or Area	Emission Type	Radionuclide(s) Emitted	Handling/ Processing	Nature of Emissions	Effluent Controls	Emission Category[(a)]	Distance and Direction to Nearest Air Sampler(s)
Legacy Contamination Sites							
Weapon Test and Plowshare Soil Contamination Sites							
Sedan Crater (Plowshare), Area 10	Diffuse	Tritium (^{3}H) as tritiated water (HTO), americium (Am), plutonium (Pu), activation and fission products	None	^{3}H as HTO through evaporation from soil or transpiration from plants and suspension of contaminated soil by wind	None	III (2004, annual emission estimates)	• Sedan North: 0.8 kilometers (km) to the north • Critical receptor sampler (Gate 700 S): 2.4 km to the east-northeast (ENE)
Schooner Crater (Plowshare), Area 20	Diffuse	^{3}H as HTO, Am, Pu, activation and fission products	None	^{3}H as HTO through evaporation from soil or transpiration from plants and suspension of contaminated soil by wind	None	III (2004, annual emission estimates)	• Critical receptor sampler (Schooner): 0.2 km to the northwest (NW)
Grouped Area Sources – All Nevada National Security Site (NNSS) Areas	Diffuse	Am, Pu, activation and fission products (^{3}H as HTO as well, but the vast majority is emitted from Sedan and Schooner—see above)	None	Wind causing suspension of soil containing small amounts of historical fallout/legacy radioactive materials	None	II (2012, continuous Critical Receptor monitoring)	• See Section III, Table 6

Table A.1 Facilities or Areas from which Radionuclides were Released to Air in Calendar Year (CY) 2012 (continued)

Facility or Area	Emission Type	Radionuclide(s) Emitted	Handling/ Processing	Nature of Emissions	Effluent Controls	Emission Category[(a)]	Distance and Direction to Nearest Air Sampler(s)
Legacy Contamination Sites (continued)							
Emanation from Building Materials							
NLVF, Building A-01	Point	Parts of the basement were contaminated with ^{3}H in 1995 including a vacant radiation source well	Air flow through building ventilation system	^{3}H as HTO through emanation from building materials into the air and exhausted from the building through the ventilation system	None	IV (2012, annual emission estimates)	• Biannual sampling inside room that was contaminated
Groundwater Characterization/Control or Remediation Activities							
Environmental Restoration Projects							
E-Tunnel Ponds, Area 12	Diffuse	^{3}H in groundwater flowing from fissures in historical nuclear tests tunnel system	Controlled drainage and containment of groundwater from the tunnel in a series of earthen ponds	^{3}H as HTO through evaporation or transpiration from plants	None	IV (2004, annual emission estimates)	• E-Tunnel Pond #2: 0.4 km to the southeast (SE) • Critical receptor sampler (Gate 700 S): 15 km to the east
Underground Test Area (UGTA) Wells							
UE-20n #1, Area 20	Diffuse	^{3}H as HTO	Groundwater pumped to the surface	Evaporation of ^{3}H as HTO	None	IV (2012, based on 2012 emission)	• Gate 20-2P: 14.1 km to the NW • Critical receptor sampler (Schooner): 17.4 km to the NW
ER-20-11, Area 20	Diffuse	^{3}H as HTO	Groundwater pumped to the surface	Evaporation of ^{3}H as HTO	None	IV (2012, based on 2012 emission)	• Gate 20-2P: 13.5 km to the north-northwest (NNW) • Critical receptor sampler (Schooner): 18.1 km to the NNW

Table A.1 Facilities or Areas from which Radionuclides were Released to Air in Calendar Year (CY) 2012 (continued)

Facility or Area	Emission Type	Radionuclide(s) Emitted	Handling/ Processing	Nature of Emissions	Effluent Controls	Emission Category[(a)]	Distance and Direction to Nearest Air Sampler(s)
Legacy Contamination Sites (continued)							
Groundwater Characterization/Control or Remediation Activities (continued)							
NLVF Groundwater Control							
Area 23 Sewage Lagoons	Diffuse	^{3}H in groundwater pumped from NLVF Building A-01 source well	Groundwater is transported via truck and released into the sewage lagoons, as approved by the State	^{3}H as HTO through evaporation	None	IV (2012, based on 2012 emission)	• Critical receptor sampler (Mercury Track): 1.0 km to the ENE
Defense, Security, and Stockpile Stewardship							
Big Explosives Experimental Facility (BEEF), Area 4	Point and Diffuse	Depleted uranium (DU)	Hydrodynamic testing facility	Explosives and diffuse emissions from areas of past experiments	None	III (2011, dose evaluation based on source-term)	• Bunker 9-300: 5.5 km northeast (NE) • Critical receptor sampler (Gate 700 S): 12.2 km to the NE
Dense Plasma Focus (DPF) at the Los Alamos Technical Facility (LATF), Area 11	Point	^{3}H	Production of neutron flux using a deuterium-^{3}H reaction	^{3}H gas released through a stack exhaust	None	III (2006, annual emission estimates)	• Critical receptor sampler (Yucca): 7.4 km to the west-northwest
Nonproliferation Test and Evaluation Complex (NPTEC), Area 5	Diffuse	Natural uranium and DU	Handling of powder compounds	Suspension of particulates	None	III (2012, dose evaluation based on source-term)	• Sugar Bunker North: 2.5 km north-northeast • Critical Receptor sampler (Yucca): 16.4 km to the NNW

Table A.1 Facilities or Areas from which Radionuclides were Released to Air in Calendar Year (CY) 2012 (continued)

Facility or Area	Emission Type	Radionuclide(s) Emitted	Handling/ Processing	Nature of Emissions	Effluent Controls	Emission Category[(a)]	Distance and Direction to Nearest Air Sampler(s)
Defense, Security, and Stockpile Stewardship (continued)							
Tumbleweed Test Range, Area 6	Point and Diffuse	^{3}H, ^{7}Be, ^{11}C, ^{13}N, ^{15}O, ^{38}Cl, ^{39}Cl, and ^{41}Ar	None; activation products resulting from operations	Activation products in air are produced in the vicinity of an electron linear accelerator	None	III (2012, dose evaluation based on source-term)	• DOD: 7.1 km SE • Critical Receptor sampler (Yucca): 7.3 km to the NNW
T1 Training and Exercise Area	Diffuse	^{99m}Tc	Applied to surfaces as a liquid for emergency response training	Potential aerosolization during application and re-suspension of soil	None	IV (2012, dose evaluation based on source-term)	• BJY: 4.6 km ENE • Critical Receptor sample (3545 Substation); 8.2 km southwest
Radioactive Waste Management							
Area 3 Radioactive Waste Management Site (RWMS)	Diffuse	Bulk low-level waste (LLW)	Subsurface burial of waste (no active burial during CY 2012)	^{3}H as HTO through evaporation from soil or transpiration from plants	Soil cover	III (2004, annual emission estimates)	• U-3ax/bl South: < 0.3 km in multiple directions; located near the center of the Area 3 RWMS • Critical receptor sampler (Yucca): 10 km south-southwest
Area 5 Radioactive Waste Management Complex (RWMC)	Diffuse	LLW, mixed low-level waste, and transuranic waste	Subsurface burial of waste	Evaporation from soil or transpiration from plants of ^{3}H as HTO	Soil cover	IV (2004, annual emission estimates)	• DoD: 0.4 km from NE edge of the Area 5 RWMC. • Critical receptor sampler (Yucca): 14 km to the NNW

Table A.1 Facilities or Areas from which Radionuclides were Released to Air in Calendar Year (CY) 2012 (continued)

Facility or Area	Emission Type	Radionuclide(s) Emitted	Handling/ Processing	Nature of Emissions	Effluent Controls	Emission Category[(a)]	Distance and Direction to Nearest Air Sampler(s)
Support Facility Operations							
Environmental Monitoring Building 23-652	Point	^{3}H as HTO, fission products, Am and Pu in environmental samples	Distilling or handling samples to prepare for submission to analytical laboratories	^{3}H emission during distillation or enrichment of samples and preparation of standards	None	IV	• Critical receptor sampler (Mercury Track): 0.2 km to the east-southeast

(a) Based on ANSI/HPS 13.1-1999 potential impact categories (American National Standards Institute 1999): Category II refers to annual dose > 0.1 mrem and ≤ 5 mrem, Category III refers to annual dose > 0.001 mrem and ≤ 0.1 mrem, and Category IV refers to annual dose ≤ 0.001 mrem. The year refers to the most recent dose evaluation with description of frequency of emission estimates used to verify continued low/decreasing emissions.

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Appendix B

Periodic Confirmatory Assessment of the Joint Actinide Shock Physics Experimental Research (JASPER) and Justification to Halt Stack Monitoring

During calendar year (CY) 2012 a periodic confirmatory assessment of the potential radiation dose to the maximally exposed individual (MEI) offsite resulting from the operation of the gas gun device used by the JASPER project was conducted. JASPER is located in Area 27 of the Nevada National Security Site (NNSS) and uses both special nuclear materials (SNM) and non-radioactive surrogate materials in its research. Potential radioactive emissions from the use of SNM are assessed. The general steps for conducting an experiment using SNM at the JASPER Facility are the following:

- Receipt of an SNM target at the JASPER Facility
- Installation of the target assembly in the primary target chamber (PTC)
- Installation of the PTC inside the secondary containment chamber (SCC)
- Evacuation of air from the PTC and SCC in preparation of the experiment. This air is released to the atmosphere.
- Firing a projectile at the target. At the time of impact the PTC is sealed, keeping most of the target material inside the PTC.
- Exhausting air out of the system post-shot. The PTC remains sealed and the gases in the SCC are not exhausted until the material has cooled and the particulates settle. Post-shot air is exhausted from the system after passing through a series of metal frits and high-efficiency particulate air filters in series before being emitted to the atmosphere.

For this assessment, no credit is taken for the filtration of air exhausted from the system in order to evaluate potential radioactive emissions per 40 CFR 61.93(b)(4)(ii). The meaning of the word "potential" as used in this assessment is "worst case under normal operating conditions." It should not be interpreted as "probable" or "likely."

In accordance with 40 CFR 61.93, the Clean Air Package – 1988 computer model, specifically CAP88-PC version 3.0 (CAP88-PC), was used to determine the dose to a member of the public from JASPER operations. Inputs to the CAP88-PC model are described below.

CAP88-PC Input

Potential Radionuclide Emission

Radioactive emissions may come from two general sources: (1) solid radioactive material handled at the JASPER Facility, excluding materials in sealed packages that remain unopened and (2) radioactive material in the SCC that escapes from the PTC during testing. The potential emissions from these situations were calculated by multiplying the radionuclide inventory of each by the emission factors, 10^{-6} for solid materials, and 10^{-3} for particulate solids, specified by 40 CFR 61, Appendix D.

Radioactive material is potentially available for emissions from three locations: (1) the building where the target assembly is installed in the PTC, (2) the vacuum pumps that exhaust air from the SCC and PTC prior to a test, and (3) an 8.9 meter (m) high stack that exhausts air from the system during and after tests.

From 2003, when the first test using SNM was conducted at the JASPER Facility, through December 2012, there have been 42 gas gun shots using SNM targets. There have never been more than

eight SNM shots in one year. However, in order to account for increased testing in the future, this assessment conservatively presumed 18 SNM shots will be conducted annually.

Potential Emission from Solid Radioactive Material

After SNM targets are built at Lawrence Livermore National Laboratory, they are installed in the PTCs at the JASPER Facility. To obtain the potential emission from this process, the maximum weight of a SNM target was multiplied by the number of targets used in a year (18) and then by the 40 CFR 61, Appendix D, emission factor of 10^{-6}. The same emission factor was also applied to the same amount of material for the process of evacuating air from the SCC and PTC prior to a test.

Potential Emission from Material Escaping from the PTC

Of the 42 SNM shots conducted at the JASPER Facility through CY 2012, only two, Shot 82 (2008) and Shot 86 (2009), had elevated amounts of radioactive material escape from the PTC during the experiment. In each case, the material was contained by the SCC as designed. Though these events do not represent typical operations, they do represent the worst case for potential release from the system under normal operations. It is important to point out that after Shot 86, the JASPER gas gun system was reconfigured to inhibit material from escaping the PTC. However, this evaluation still used the amount of radioactivity that escaped from the PTC during Shot 86 for a conservative estimate of source term for potential emissions to air. An assessment of the surface contamination conservatively calculated the total activity to be 0.0004 curies or 0.003 grams of one particular isotope. From this, the other radionuclide constituents were calculated by multiplying by the respective weight percentages.

Total Annual Potential Emission

The potential emissions from the sources listed above were summed to obtain an estimate of the total annual radioactive emission for each radionuclide. This was used as the source term for the CAP88-PC calculation of public dose.

Distances to Potential Receptors

The distance to the nearest NNSS boundary (11.3 kilometers [km]) was determined using ArcMap version 10.0 (ESRI, Inc.) software. Nobody resides, or is stationed full-time, at the nearest NNSS boundary. It is only used as a reference. The nearest offsite member of the public resides in Amargosa Valley, 29.3 km west-southwest of the JASPER Facility.

Meteorological Data

Meteorological data were obtained from the National Oceanic and Atmospheric Administration, Air Resources Laboratory, Special Operations and Research Division Meteorological Data Acquisition (MEDA) station number 27, located 1.2 km southeast of the JASPER Facility in Area 27. The annual average wind speed, 1988–1995, at MEDA 27 is 11.3 knots. However, because it is impossible to predict the exact conditions during the testing and it is undesirable to under-predict, the estimated potential offsite dose was maximized by using a lower wind speed range of 4–6 knots (4.6–6.9 miles per hour) for the CAP88-PC model with a calm stability (class G). It was also conservatively modeled that the wind was blowing 100% of the time directly towards a populated location.

The annual precipitation value used in CAP88-PC was the annual average (1965–2011) precipitation at the Cane Springs rain gauge station located 4.2 km northeast of the JASPER Facility (7.74 inches [19.7 centimeters]).

The average temperature used in CAP88-PC was the average 24-hour temperature for MEDA 27, 1981–2001 (16.4 degrees Celsius [61.5 degrees Fahrenheit]).

The mixing height (Height of Lid parameter) was set to be 1000 m.

The absolute humidity value used in CAP88-PC was the average absolute humidity at the BJY and Little Feller routine air monitoring stations, 2001–2007 (3.5 grams per cubic meter).

Food Source Scenario

The food intake scenario was set to Rural. This is conservative because it presumes all food is derived regionally (none imported).

Results and Conclusion

The effective dose equivalent (EDE) for each offsite location is listed in Table B.1 with each location's distance from the JASPER Facility. These dose estimates are believed to be biased high due to the conservatism of the assessment (e.g. radionuclide daughter buildup time of 100 years, 18 SNM shots per year, maximum amount of material ever observed escaping from the PTC used for every shot, wind blowing 100% of the time toward receptors, and the rural food scenario). More realistic selections of any of these parameters would result in a lower dose estimates.

The CAP88-PC predicted dose at the nearest boundary (0.021 millirem per year [mrem/yr]) is 4.76 times lower than the 0.1 mrem/yr level specified in 40 CFR 61.96 for requiring monitoring, and 476 times lower than the 10 mrem/yr limit specified in 40 CFR 61.92. The MEI would be at the nearest offsite residence (Amargosa Valley), which has a predicted dose (0.0048 mrem/yr) over four times lower than at the nearest boundary. It is therefore concluded that potential emissions of radioactive material to air from operations at the JASPER Facility are minor (Category III source).

From a review of the original dose assessment conducted for the JASPER gas gun that was sent to the U.S. Environmental Protection Agency for approval, it appears that the dose estimates were overly conservative for normal operation due to the completely volatized SNM targets used to model the emission. However, the operating history of the gas gun has shown that practically the entire vaporized target is contained in the PTC, with relatively small amounts released into the SCC. Therefore, the source-term for the operation of the JASPER gas gun is more realistically as described above. The EDE to the MEI based on this emission was 0.0048 mrem/yr, which is well below the limit at which continuous monitoring is required. In addition, the NNSS demonstrates compliance with the 10 mrem/yr standard established by the National Emission Standard for Hazardous Air Pollutants by using onsite critical receptor location monitoring. There are two critical receptor monitoring stations (Gate 510 and Mercury Track) located between the nearest offsite populated locations and the JASPER Facility (Figure 5). Also, ambient air monitoring has been conducted 250 m south-southwest (a predominant down-wind location) from the JASPER stack at the Able Site sampler since the start of JASPER operations to measure ambient conditions in order to distinguish from stack exhaust in the event radionuclides were detected on the stack sample, and as a backup in case the stack sampling system failed (Figure 5). For these reasons, monitoring of the JASPER Facility stack is not required per 40 CFR 61.93(b)(4)(i) and will be halted in CY 2013. However, the Able Site ambient air sampler will remain operating as a best management practice to detect unlikely off-normal events.

Table B.1 Dose (mrem/yr) predicted by CAP88-PC for radionuclide releases from the JASPER Facility

Location	Distance (km)	CAP88-PC predicted dose (mrem/yr)
Nearest NNSS Boundary	11.3	0.0210
Amargosa Valley	29.3	0.0085
Crystal	31.7	0.0048
Cinder Lite Mine	36.4	0.0044
Johnnie	39.5	0.0037
Cactus Springs	41.0	0.0034
Amargosa Center	42.0	0.0032
Indian Springs	45.7	0.0031
Ash Meadows	48.1	0.0028
U.S. Ecology	52.2	0.0026
Cold Creek	52.3	0.0023
Stateline Area	52.7	0.0023
SNV Prison	57.7	0.0023
Beatty	58.2	0.0019
Death Valley Junction	58.7	0.0018
Springdale	63.8	0.0018
Pahrump	63.8	0.0008
Mt. Charleston	69.5	0.0008
Furnace Creek	74.9	0.0007
Corn Creek Station	77.7	0.0006

Appendix C

Tritium Emissions Estimated from Air Sampling Data

BACKGROUND INFORMATION

Diffuse emissions of tritiated water (HTO) from the Nevada National Security Site (NNSS) include evaporation from containment ponds, evapotranspiration of soil moisture diffusing through waste covers at the Area 3 Radioactive Waste Management Site (RWMS), the Area 5 Radioactive Waste Management Complex (RWMC), and evapotranspiration of HTO from soil contaminated by atmospheric, or near surface, nuclear weapon testing conducted in the past. Locations that make up the majority of diffuse tritium (^{3}H) emissions on the NNSS are the Schooner and Sedan nuclear test areas, the Area 3 RWMS, the Area 5 RWMC, and the containment ponds at E-Tunnel. Emissions from the E-Tunnel ponds were not estimated from air sampling data because the total volume of water and ^{3}H concentration of the water was known, allowing for an estimate described in Appendix F. For the remaining sites listed, emissions were estimated by scaling concentrations of ^{3}H in air predicted by a modeled 1 curie (Ci) release to concentrations measured at nearby sampling stations. Figure 5 of this report shows the current NNSS air sampling station locations, and Table C.1 lists the samplers near the major diffuse ^{3}H emission locations.

SOURCE TERM ESTIMATES

For each major ^{3}H emission location, the Clean Air Package 1988 (CAP88-PC) model was used to estimate the ^{3}H concentration that would be expected at nearby air samplers if 1 Ci of ^{3}H were released from the center of the source location. The total annual emission from each source was then calculated by dividing the annual average concentration of ^{3}H measured at each sampling location by the predicted CAP88-PC concentration for a 1 Ci release. Table C.1 lists the estimated emissions for each source location.

Table C.1 Tritium Emissions from Airborne Tritium Sampling Results during CY 2012

Emission Source	Air Sampler	Annual Average Tritium Concentration (pCi/m^3)[(a)]	CAP88-PC Concentration for 1 Ci Emission (pCi/m^3)	Tritium Emission (Ci)	Emission Source Average (Ci)[(b)]
Area 3 RWMS	Bilby Crater	0.218	0.0459	4.7	5.7
	Kestrel Crater N	0.443	0.0667	6.6	
Area 5 RWMC	DOD	0.173	0.0803	2.15	1.8
	Sugar Bunker	0.627	0.464	1.35	
Area 10, Sedan	Gate 700 South[(c)]	0.259	0.00889	29.1	24.4
	Sedan North	3.383	0.173	19.6	
Area 20, Schooner	Gate 20-2p	0.187	0.0325	5.8	92.0
	Schooner[(c)]	194.38	1.09	178.3[(d)]	

(a) pCi/m^3 = picocuries per cubic meter
(b) Average of emissions predicted by samplers for an emission source. This value is used as the emission for each emission source.
(c) Critical Receptor Station
(d) Emission estimate likely biased high due to sampler being within the diffuse emission source (see Figure 6)

Appendix D

Emissions of Americium and Plutonium from Diffuse Legacy Sites Based on Historical Soil Survey Data and Soil Re-suspension Model

BACKGROUND INFORMATION

Operations (Ops) Areas 1 through 12 and 15 through 30 on the Nevada National Security Site (NNSS) contain diffuse sources of radionuclides. Historical soil surveys have identified the location of these sources on the NNSS and provided estimates of the amounts of radionuclides that remain in the surface soils (U.S. Department of Energy [DOE] 1991; see Table 1 of this report). Due to occasional high winds, some contaminated soil becomes airborne. Results from the air samplers in these areas indicate that americium-241 (^{241}Am) and plutonium-239+240 ($^{239+240}$Pu) are routinely detected but only in concentrations slightly above the minimum detectable concentration. The total emissions (in curies [Ci]) produced each year from all known soil legacy sites on the NNSS is estimated with a mathematical re-suspension model. This appendix describes all the calculations involved in producing the emission estimates.

RE-SUSPENSION CALCULATIONS

These calculations are needed to estimate how much of the radionuclides in surface soils could actually become airborne (re-suspended) and therefore become an emission. A conservative estimate of americium and plutonium emissions from diffuse sources is obtained by the use of a re-suspension equation with parameters derived from actual studies at the NNSS. In NUREG/CR-3332 (U.S. Nuclear Regulatory Commission 1983), pages 5–30, an equation for calculating a suspension rate (fraction re-suspended per second [s]) is given as follows:

$$S = K \times V_g$$

where: S = fractional re-suspension rate (per s), or the fraction of the inventory re-suspended per s
K = re-suspension factor (per meter [m])
V_g = deposition velocity (meters per second [m/s])

The values of K and V_g used in this re-suspension equation are taken from DOE (1992), with values of K provided on page 75. An average of the values is 2×10^{-10}/m. Ranges in V_g of 0.01 to 0.05 m/s, presented in DOE (1992), are used as conservative estimates. When these values are used in the above equation, S is between 2×10^{-12} and 1×10^{-11} per s. To be conservative, the higher fractional re-suspension rate of 1×10^{-11}/s is used. For example, the emission rate in picocuries (pCi)/s for $^{239+240}$Pu from Area 3 is calculated from the product of the $^{239+240}$Pu inventory (37 Ci from Table 1) and S as shown below. The estimated total annual emission is expressed in millicuries per year (mCi/yr).

$$37\ Ci \times \frac{10^{-11}}{s} \times \frac{3600\ s}{hour} \times \frac{24\ hours}{day} \times \frac{366\ days}{yr} = \frac{1.17 \times 10^{-2} Ci}{yr}\ or\ \frac{11.7\ mCi}{yr}$$

Note that 2012 was a leap year so it had 366 days.

This method was used for calculating the ^{241}Am and $^{239+240}$Pu emissions from all other areas. The results are shown in Table D.1.

Table D.1 Emission Estimates from Inventories[(a)] of ^{238}Pu, $^{239+240}$Pu, and ^{241}Am

Inventory, Re-suspension Factors, and Calculated Emissions by NNSS Ops Area								
NNSS Ops Area	^{241}Am (Ci)	^{238}Pu (Ci)	$^{239+240}$Pu (Ci)	K (m^{-1})	Vg (m/s)	Emission of ^{241}Am (mCi/yr)	Emission of ^{238}Pu (mCi/yr)	Emission of $^{239+240}$Pu (mCi/yr)
1	4.2	6.5	24	2×10^{-10}	0.05	1.33	2.06	7.59
2	2.9	8.6	22	2×10^{-10}	0.05	0.92	2.72	6.96
3	4.6	3.1	37	2×10^{-10}	0.05	1.45	0.98	11.70
4	6.6	13	40	2×10^{-10}	0.05	2.09	4.11	12.65
5	0.6	0.1	4.8	2×10^{-10}	0.05	0.19	0.03	1.52
6	1.7	3.3	8.4	2×10^{-10}	0.05	0.54	1.04	2.66
7	2.2	0.6	16	2×10^{-10}	0.05	0.70	0.19	5.06
8	17	8	110	2×10^{-10}	0.05	5.38	2.53	34.78
9	4.2	2.2	89	2×10^{-10}	0.05	1.33	0.70	28.14
10	19	19	110	2×10^{-10}	0.05	6.01	6.01	34.78
11	3.3	0.5	29	2×10^{-10}	0.05	1.04	0.16	9.17
12	5.7	8.5	39	2×10^{-10}	0.05	1.80	2.69	12.33
15	8	7.8	63	2×10^{-10}	0.05	2.53	2.47	19.92
16	0.7	1.5	3.7	2×10^{-10}	0.05	0.22	0.47	1.17
17	2.8	4.5	18	2×10^{-10}	0.05	0.89	1.42	5.69
18	19	5.6	100	2×10^{-10}	0.05	6.01	1.77	31.62
19	21	32	140	2×10^{-10}	0.05	6.64	10.12	44.27
20	23	30	41	2×10^{-10}	0.05	7.27	9.49	12.97
30	3.2	4.5	14	2×10^{-10}	0.05	1.01	1.42	4.43
TOTAL	150	160	910			47	50	290

(a) Radioactive inventories from Table 5 in DOE/NV/10845--02 (DOE 1991)

As shown in Table D.1, the estimated total emissions of ^{241}Am, ^{238}Pu, and $^{239+240}$Pu from historical soil inventory data and from the re-suspension model were 47, 50, and 290 mCi/yr, respectively. These are shown in Table 3 of this report (as 0.047, 0.050 and 0.29 Ci/yr), which summarizes all measured or computed emissions from the NNSS in calendar year 2012. The spatial relation between these diffuse emission locations and the critical receptor stations can be seen in Figure 4.

OTHER ISOTOPES

The other isotopes that have been found in soil samples in the various areas on the NNSS are cobalt-60, strontium-90, cesium-137, europium-152, europium-154, and europium-155; however, their concentrations in air samples are below detection levels and collectively contribute less than 10% to the total dose from all radionuclide emissions determined from re-suspension calculations; therefore, they have not been included in evaluations for National Emission Standards for Hazardous Air Pollutants compliance.

Appendix E

Potential Radionuclide Emissions and Dose from the North Las Vegas Facility

As discussed in the 1995 National Emission Standard for Hazardous Air Pollutants (NESHAP) report (U.S. Department of Energy 1996), a container of tritium-aluminum foils was opened in Building A-01 at the North Las Vegas Facility (NLVF) and emitted at least 1 curie (Ci) of tritium into a basement area used as a fixed radiation source range. Environmental surveillance began on the day notification of the tritium leak occurred. Environmental tritiated water (HTO) samplers were installed at three locations outside the facility. Later, an HTO sampler was installed in the basement and operated continuously so that progress on cleanup of the spill could be monitored. After cleanup, the environmental samplers were removed, but the basement air sampler continued operation through January 5, 1998, at which time samples were collected one to four times annually. From 1995 to the present, results and the effective dose equivalent (EDE) to the maximally exposed individual (MEI) offsite at the perimeter fence have been reported in the annual NESHAP reports.

During the years 1999 through 2012, air sampling for HTO in the basement was conducted intermittently. For CY 2012, the results of two atmospheric moisture samples were 337 picocuries per cubic meter (pCi/m^3) for the sample collected March 27 to April 3, 2012, and 609 pCi/m^3 for the sample collected September 10 to September 17, 2012. The average of these sample results (473 pCi/m^3) was multiplied by the room ventilation rate (673 cubic feet per minute [ft^3/min]) to determine the total annual emission rate as shown below. The estimated total annual emission is expressed in millicuries per year (mCi/yr).

$$\frac{473\ pCi}{m^3} \times \frac{673\ ft^3}{min} \times \frac{0.02832\ m^3}{ft^3} \times \frac{525{,}600\ min}{yr} \times \frac{1\ \times 10^{-9}\ mCi}{pCi} = \frac{4.74\ mCi}{yr}$$

An additional 0.0005 mCi/yr of tritium was released from Building A-01 by the handling of water pumped from the sump well, resulting in a total emission of 4.74 mCi/yr.

The modeled dose to the MEI from NLVF tritium releases from 1995 to 2001, using the Clear Air Package 1988 computer program, gave a dose coefficient of 5.0×10^{-6} millirem per year per millicurie (mrem/yr/mCi) released. This coefficient multiplied by the tritium emission for CY 2012 gave the estimated EDE to the nearest member of the public outside the perimeter fence shown below in both mrem/yr and microrem per year (µrem/yr).

$$\frac{4.74\ mCi}{yr} \times \frac{5.0\ \times 10^{-6} mrem}{mCi} = \frac{0.0000237\ mrem}{yr}\ or\ \frac{0.0237\ \mu rem}{yr}$$

A comparison of the past and current emission rates and radiation dose to the MEI are presented in Table E.1.

Table E.1. Comparison of Tritium Emission Rates from Building A-01, NLVF from 1995 to 2012

Year	Tritium Emission Rate (mCi/yr)	EDE to MEI (µrem/yr)
1995	123	0.96
1996	52	0.25
1997	110	0.53
1998	16	0.08
1999	301	1.4
2000	370	1.8
2001	200	0.96
2002	(not sampled)	Not Estimated
2003	9.3	Not Estimated
2004	11	Not Estimated
2005	20	0.10
2006	13.2	0.07
2007	12.3	0.06
2008	11.1	0.06
2009	8.7	0.044
2010	6.45	0.032
2011	4.83	0.024
2012	4.74	0.024

Appendix F

Calculation of Tritium Emissions from Contaminated Groundwater Discharges

The calendar year (CY) 2012 air emissions (in curies [Ci]) of tritium, as tritiated water from contaminated groundwater sources, were conservatively estimated. They were computed as the product of the volume of water (in liters [L]) either pumped or naturally emerging to the surface and the tritium concentration (as picocuries per liter [pCi/L]) measured in that water using the following formula. It was assumed that all of the tritiated water evaporated.

$$Water\ Concentration\ \left(\frac{pCi}{L}\right)\ x\ Water\ Volume\ (L)\ x\ \frac{1\ x\ 10^{-12}\ Ci}{pCi}$$

Water flow from the E-Tunnel is measured monthly, and tritium concentration in the water is measured annually in support of Water Pollution Control Permit NEV 96021.

The volume of water discharged into the Area 23 Sewage Lagoons on the Nevada National Security Site is measured as it is removed from the basement of Building A-01 at the North Las Vegas Facility. Samples of the water were collected twice during CY 2012 to determine the tritium concentration.

Water from the wells listed in Table F.1 is purged water from Underground Test Area Activity sampling activities. The volume of water purged from the wells is calculated by pump rates multiplied by time, and the tritium concentrations of the well water are determined by either the Los Alamos National Laboratory or the Lawrence Livermore National Laboratory.

Table F.1 lists the values used to make emission estimates.

Table F.1 Tritium Concentrations, Water Volumes, and Estimated Tritium Emissions from Contaminated Groundwater Brought to the Surface

Location	Tritium Concentration (pCi/L)	Water Volume[(a)] (L)	Tritium Emission (Ci)
E-Tunnel Ponds	4.40×10^{5} [(b)]	1.51×10^{7}	6.7
Area 23 Sewage Lagoons	3.35×10^{2}	1.34×10^{6}	0.00045
Well UE-20n #1	4.28×10^{7} [(c)]	6.13×10^{4}	2.6
Well ER-20-11	1.23×10^{5} [(d)]	9.79×10^{5}	0.12

(a) All water was assumed to evaporate during CY 2012.
(b) Average of results from October 2011 and October 2012 samples.
(c) Average of multiple samples collected while purging the well.
(d) Average/composite of samples taken from the Well ER-20-11 sump.

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Appendix G

Identification and Justification for the Development of Meteorological Data used as Input to Clean Air Package 1988 (CAP88-PC)

Meteorological support, observations, and climatological services for the Nevada National Security Site (NNSS) are provided to the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) by the Air Resources Laboratory, Special Operations and Research Division (ARL/SORD). The ARL/SORD is a National Oceanic and Atmospheric Administration (NOAA) office and supports NNSA/NFO programs under the authority of an Interagency Agreement between NOAA and NNSA/NFO.

METEOROLOGICAL OBSERVATIONS

The ARL/SORD manages, operates, and maintains a meteorological monitoring program that is designed and used to support the NNSA/NFO-authorized activities on the NNSS. This vital program consists of many meteorological monitoring systems that have been brought together under the Meteorological Integrated Data Network (MIDNET). The MIDNET includes a Meteorological Data Acquisition (MEDA) network of 21 meteorological towers located on the NNSS (Figure G.1) and one on Yucca Mountain. The MIDNET consists of communications systems, local area networks, and surface-based instrumentation used to measure wind direction and speed, temperature, relative humidity, and pressure and precipitation at a subset of stations. The MIDNET has been operated on the NNSS for more than 40 years, has undergone several modernizations and upgrades, and serves as a solid basis for deriving climatological information.

Upper-air observations (radiosondes) were taken twice daily from Desert Rock Meteorological Observatory (DRA; elevation 1007 meters [m], located 4.8 kilometers southwest of Mercury, Nevada [Station 23 in Figure F.1]) but were discontinued in October 2010. Upper-air data are currently collected at the National Weather Service office in Las Vegas. DRA had been in operation since May 1978 and was built to replace a similar observatory that was located at the Yucca Flat Meteorological Observatory (UCC; elevation 1,196 m) from January 1962 through mid-May 1978. Consequently, surface and upper-air observations are also available from UCC for 1962–1978.

A key component of the MIDNET system is the MEDA station. A MEDA station consists of a 10 m tower, a microprocessor, meteorological sensors, and a radio transmitter. The 20 MEDA stations located on or near the NNSS (Figure G.1) provide surface weather data and weather data for weather forecasts and warnings for NNSS operations and emergency response activities. MEDA station locations were selected based on criteria to support NNSS consequence assessment activities, compliance reporting requirements, and general weather and forecasting needs.

Wind and temperature data have been collected on the NNSS for more than 40 years. These and other meteorological data have been compiled into a comprehensive climatological database for the NNSS. The MEDA data are especially useful in assessing boundary layer flow regimes on the NNSS.

The wind speed and direction sensor is located 10 m above the ground. Wind direction is measured to ±5 degrees of azimuth, and wind speed is accurate to 0.5 knots. Wind data are collected as 10 or 15 minute averages and are transmitted via radio and sent over the NNSS intranet to a central processor every 10 or 15 minutes. These data are checked by ARL/SORD and are stored and archived for climatological purposes.

Ambient temperature and relative humidity sensors are located approximately 1.5 m above ground level. MEDA temperature data are accurate to ±0.2 degrees Celsius (°C) (absolute range for the NNSS is −29°C to 46°C). Temperature and relative humidity measurements are 10 or 15 minute averages and are also transmitted via radio to a computer for processing, checking, displaying, and archiving.

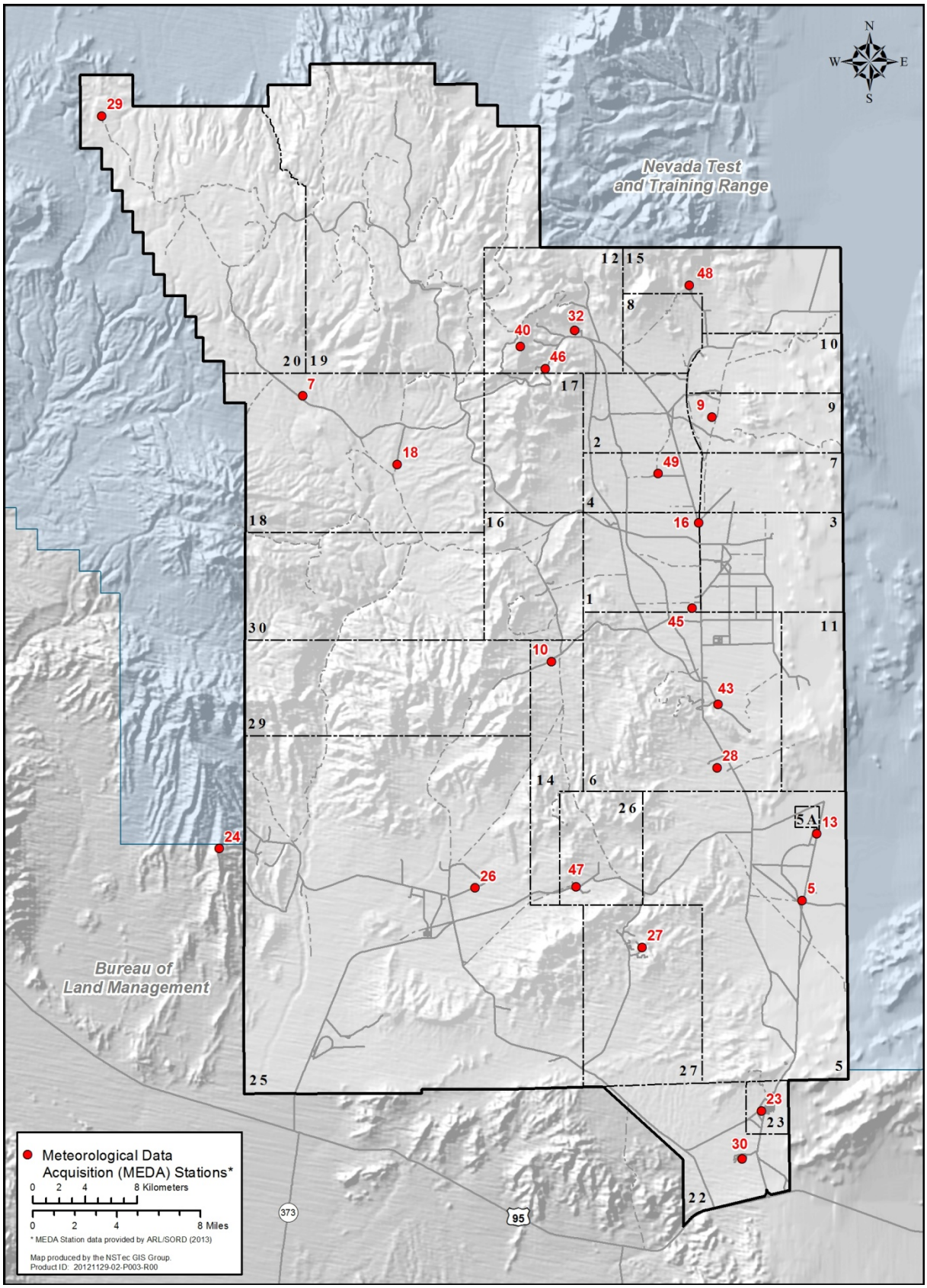

Figure G.1 Locations of MEDA Stations on the NNSS in CY 2012

Cloud cover observations are needed to create the Stability Array (STAR) files with the STAR program. In order to use the most representative meteorological data available for NNSS, cloud observations from DRA are melded with MEDA winds. Cloud data are available for DRA (1978–present) and for UCC (1962–1978). Based on the available data, the cloud cover climatology from DRA and UCC are quite compatible. For example, UCC experienced 192 clear days annually, while DRA has 191 days. In addition, the average annual sky cover from sunrise to sunset for both stations was/is 0.39 daily. The total number of cloudy days for UCC is 81 days and 82 days for DRA, annually. Therefore, the cloud cover observations from DRA and UCC may be considered as representative for most areas of the NNSS.

APPLICATION TO CAP88-PC INPUT

Based on the above considerations and on the limitations of the Clean Air Package 1988 (CAP88-PC) computer program, the cloud cover data from DRA were considered to be representative of the NNSS. Therefore, atmospheric soundings and cloud cover observations from DRA were melded with MEDA surface wind data for input to the STAR program to provide the very best data for calculating transport and dispersion processes. The STAR file is a matrix that includes seven Pasquill stability categories (A through G), six wind speed categories, and 16 wind sectors from wind roses calculated for each specified MEDA station on the NNSS. The STAR files are used by a CAP88-PC utility program to create WIND files that are used by CAP88-PC to model emissions from diffuse tritium sources on the NNSS (Appendix C).

Calendar year 2012 data from the MEDA stations for the NNSS areas were used by ARL/SORD personnel to prepare the following STAR files listed in Table G.1.

Table G.1 MEDA System Locations Used to Create STAR Files for Use in Determining Tritium Emissions from the Diffuse Sources on the NNSS

STAR File	MEDA Station	MEDA Location (NNSS Operations Area)	Area of Emission
12Meda09.str	9	9	10
12Meda13.str	13	5	5
12Meda29.str	29	20	20
12Meda45.str	45	1	3

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Appendix H

Supplemental Information

COLLECTIVE EFFECTIVE DOSE EQUIVALENT

The U.S. Environmental Protection Agency has approved the use of critical receptor monitoring locations on the Nevada National Security Site (NNSS) to demonstrate National Emission Standards for Hazardous Air Pollutants (NESHAP) compliance in lieu of using the Clean Air Package 1988 (CAP88-PC) computer software to calculate the radiation doses received by offsite residents within 80 kilometers (km) of NNSS emission sources. The U.S. Department of Energy (DOE) agreed that there is little benefit in doing CAP88-PC calculations just for the collective dose (DOE 2004). The collective dose was calculated for the years 1992–2004, and the results were consistently below 0.6 person-rem [roentgen equivalent man] per year (yr), indicating that it is unlikely that it will exceed 1 person-rem/yr (Figure G.1). However, if operations at the NNSS change whereby radionuclide emissions significantly increase, this change will be reconsidered and calculation of collective dose likely resumed. Since there was not an increase in radionuclide emissions from the NNSS or population surrounding the NNSS during calendar year (CY) 2012 that would result in the collective dose approaching 1 person-rem, this calculation was not performed for CY 2012.

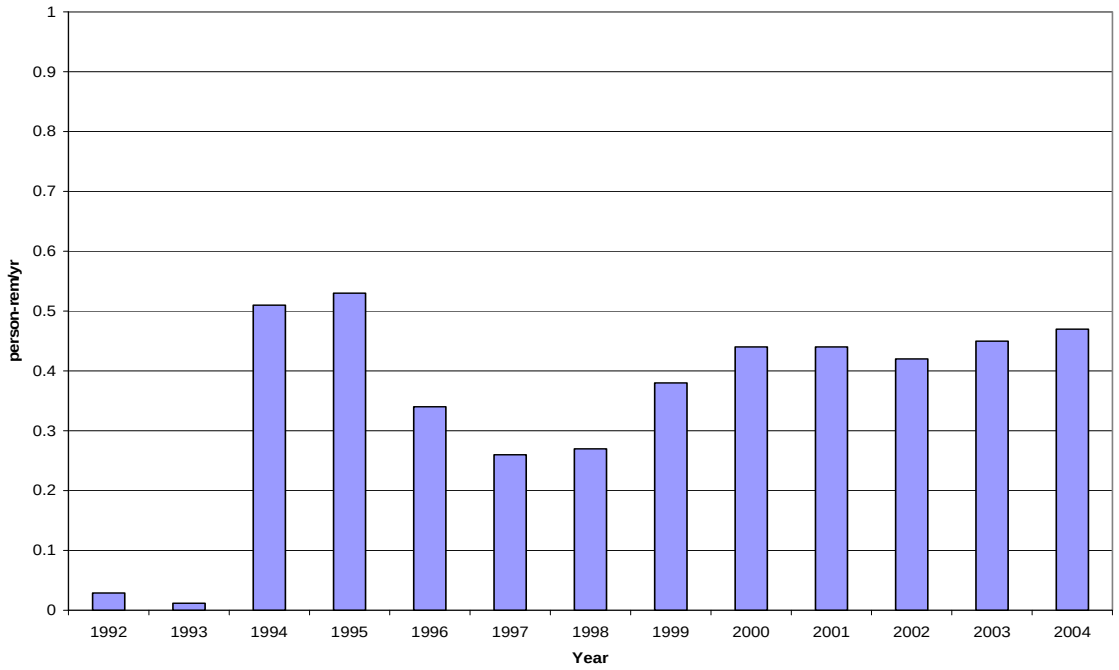

Figure H.1 Collective Dose to Populations within 80 km (50 miles) of Emission Sources

COMPLIANCE WITH 40 CFR 61, SUBPARTS Q AND T

The NNSS is regulated by Title 40 Code of Federal Regulations (CFR) Part 61, Subpart H (National Emission Standards for Emissions of Radionuclides Other Than Radon from DOE Facilities) but not Q (National Emission Standards for Radon Emissions from DOE Facilities) or T (National Emission Standards for Radon Emissions from the Disposal of Uranium Mill Tailings). However, U. S. Department

of Energy Order DOE O 435.1, "Radioactive Waste Management" (DOE 1999a) does include limits on radon flux from waste disposal facilities. Therefore, radon flux measurements are routinely made at the Area 3 Radioactive Waste Management Site and at the Area 5 Radioactive Waste Management Complex. This is done to confirm that radon fluxes are well below the standard of 20 picocuries per square meter per second required by U.S. Department of Energy Manual DOE M 435.1-1, "Radioactive Waste Management Manual" (DOE 1999b). The results of the most recent study (National Security Technologies, LLC 2012) showed that the radon flux was not significantly different from background levels. An assessment of the potential risks posed by the Area 5 Radioactive Waste Management Complex to the public projected that the in-growth of radon-222 from the decay of thorium-230 in thorium wastes would not exceed the standard for approximately 30,000 years (Shott et al. 1998).

NON-DISPOSAL/NON-STORAGE SOURCES OF RADON EMISSIONS

None of these sources exist on the NNSS.

QUALITY ASSURANCE PROGRAM FOR NESHAP COMPLIANCE

The quality assurance program for samples collected and analyzed for NESHAP compliance is documented in an environmental monitoring plan (DOE 2003). The applicable requirements of 40 CFR 61, Appendix B, Method 114, "Test Methods for Measuring Radionuclide Emissions from Stationary Sources" (U.S. Environmental Protection Agency 2001b), and of DOE O 414.1D, "Quality Assurance" (DOE 2011), have been implemented in this plan.