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Nevada National Security Site
&
North Las Vegas Facility

National Emission Standards for Hazardous Air Pollutants – Radionuclide Emissions Calendar Year 2010

June 2011

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National Nuclear Security Administration

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National Nuclear Security Administration
Nevada Site Office

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EXECUTIVE SUMMARY

2010 RADIOLOGICAL DOSE TO THE PUBLIC BELOW FEDERAL STANDARD

The U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office operates the Nevada National Security Site (NNSS, formerly the Nevada Test Site) 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 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 those from the damaged Fukushima nuclear power plant in Japan. Because this report is intended to discuss radioactive air emissions during calendar year 2010, data on radionuclides in air from the 2011 Fukushima nuclear power plant releases are not presented but will be included in the report for calendar year 2011.

The NNSS demonstrates compliance with the NESHAP limit by using environmental measurements of radionuclide air concentrations at critical receptor locations (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 2010, the potential dose from radiological emissions to air, resulting from both current and past NNSS activities, at onsite compliance monitoring stations 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 1 percent to a maximum of 17 percent of the allowed NESHAP limit. Because the nearest member of the public resides about 20 kilometers from potential release points on the NNSS, dose to the public would be only a small fraction of that measured on the NNSS. The potential dose to the public from NLVF emissions was also very low at 0.000032 mrem/yr, more than 300,000 times lower than the 10 mrem/yr limit.

NESHAP Compliance for 2010

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**
^{241}Am, ^{238}Pu, $^{239+240}$Pu, ^{3}H	6	Yucca	0.004
	10	Gate 700 S	0.009
	16	Substation 3545	0.004
	20	Schooner	0.169
	23	Mercury	0.004
	25	Gate 510	0.004
NLVF: Compliance Demonstrated by the Highest Potential Offsite Dose Being Less Than 10 mrem/yr			
Estimated offsite dose from NLVF = 0.000032 mrem/yr			

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List of Acronyms and Abbreviations

Am	americium
ARL/SORD	Air Resources Laboratory, Special Operations and Research Division
ASP	Advanced Spectroscopic Portal
BEEF	Big Explosives Experimental Facility
Bldg	building
°C	degrees Celsius
CAP88-PC	Clean Air Package 1988 (EPA software program for estimating doses)
CEDE	collective effective dose equivalent
CEF	Criticality Experiments Facility
CFR	Code of Federal Regulations
Ci	curie(s)
CL	Concentration Level
cm	centimeter(s)
Co	cobalt
Cs	cesium
CTOS	Counter Terrorism Operations Support
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	feet
ft^3/min	cubic feet per minute
g/m^3	grams per cubic meter
^3H	tritium
HEPA	high-efficiency particulate air
HTO	tritiated water
JASPER	Joint Actinide Shock Physics Experimental Research
km	kilometer(s)
km^2	square kilometers
L	liter(s)
LATF	Los Alamos Technical Facility
LLW	low-level waste
m	meter(s)
m^2	square meter(s)
mCi	millicurie(s)
mCi/yr	millicurie(s)/year
MEDA	Meteorological Data Acquisition
MEI	maximally exposed individual
MIDNET	Meteorological Integrated Data Network
MLLW	mixed low-level waste
mrem/yr	milliroentgen equivalent man per year
µrem/yr	microroentgen equivalent man per year

List of Acronyms and Abbreviations (continued)

m/s	meter(s) per second
N	north
NAD	North American Datum
NESHAP	National Emission Standards for Hazardous Air Pollutants
NLVF	North Las Vegas Facility
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NNSS	Nevada National Security Site
NOAA	National Oceanic and Atmospheric Administration
NPTEC	Nonproliferation Test and Evaluation Complex
NTTR	Nevada Test and Training Range
Ops	Operations
pCi	picocurie(s)
pCi/L	picocurie(s) per liter
pCi/m^3	picocurie(s) per cubic meter
Pu	plutonium
RMAD	Reactor Maintenance, Assembly, and Disassembly
RAMATROL	Radioactive Materials Control
rem	roentgen equivalent man
Rm	room
RNCTEC	Radiological/Nuclear Countermeasures Test and Evaluation Complex
RWMC	Radioactive Waste Management Complex
RWMS	Radioactive Waste Management Site
s	second(s)
S	south
Sr	strontium
STAR	Stability Array (grouping of meteorological data)
Th	thorium
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
Nevada Site Office
Air Emissions Annual Report
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Calendar Year (CY) 2010

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SECTION I
FACILITY INFORMATION

SITE DESCRIPTION

The Nevada National Security Site (NNSS, formerly the Nevada Test Site) is operated by the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) as the site for experiments in support of the national Stockpile Stewardship Program. The NNSS also provides support for homeland security activities, national security, and nonproliferation technology development and research and is 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 3,561 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 public exclusion areas (Nevada Test and Training Range [NTTR]) that provide 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 a climate, flora, and fauna typical of the southwest deserts. Based on 2008 (latest available) LandScan population distribution data (UT-Battelle, LLC, 2010), the vast majority of the area within 80 km of the NNSS boundary has no human inhabitants (Figure 1). Higher population densities to the south and southwest drive the overall average population density up to about 1.2 person/km^2. 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 2010 but was still considered a populated location because of the potential for operations to resume. There are two dairies within 80 km of the NNSS, one 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 in Pahrump, 41.8 km south of the NNSS. Agriculture around the NNSS is sparse and consists primarily of alfalfa fields. These are found primarily in Amargosa Center, Pahrump, Penoyer Farm, Reed's Ranch, and ranging from Alamo to Hiko.

The North Las Vegas Facility (NLVF) is a fenced complex composed of 31 buildings that house much of the NNSS project management, diagnostic development and testing, design, engineering, and procurement. The 80-acre facility is located along Losee Road in the city of North Las Vegas. The facility is buffered 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 1958 and 1973 (U.S. Department of Energy [DOE], 1996a). No nuclear tests have been conducted since September 23, 1992 (DOE, 2000). 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) delineated 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.

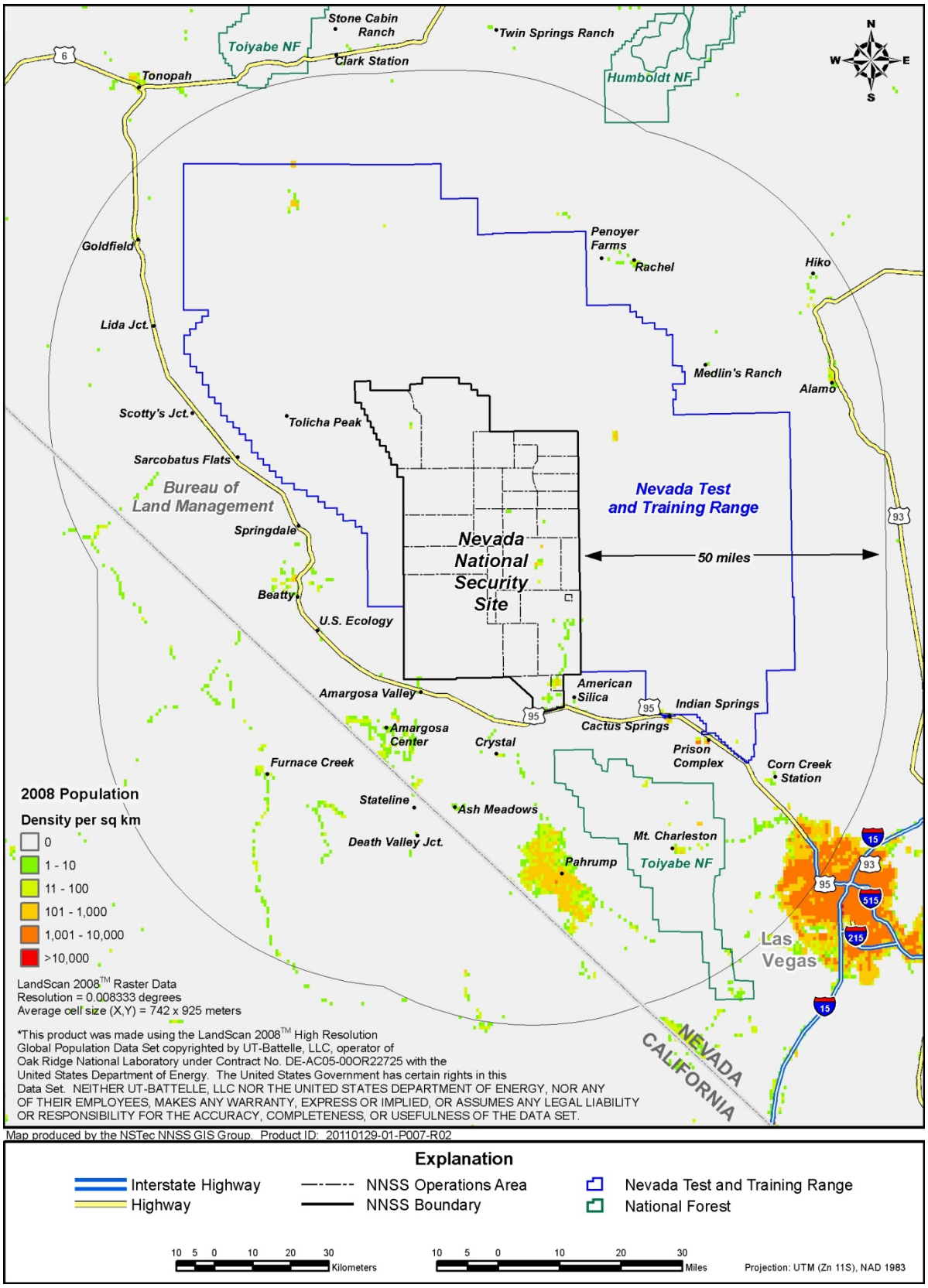

Figure 1. NNSS and Surrounding Populated Area

Surface soils contaminated with plutonium (Pu), americium (Am), tritium (^{3}H), and fission and activation products from past nuclear device safety, atmospheric, or cratering tests that used nuclear explosives could become sources of radionuclide exposure to the public if the soils were to be re-suspended (e.g., during windy conditions, surface cleanup, construction, vehicular travel, or similar activities). In 1981, the 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 an inventory and distribution of radionuclides in the soil in all 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), europium-152 (^{152}Eu), europium-154 (^{154}Eu), and europium-155 (^{155}Eu) are also in soil in various areas on the NNSS; however, their concentrations in air samples are generally below detection levels and collectively contribute less than 10 percent 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.

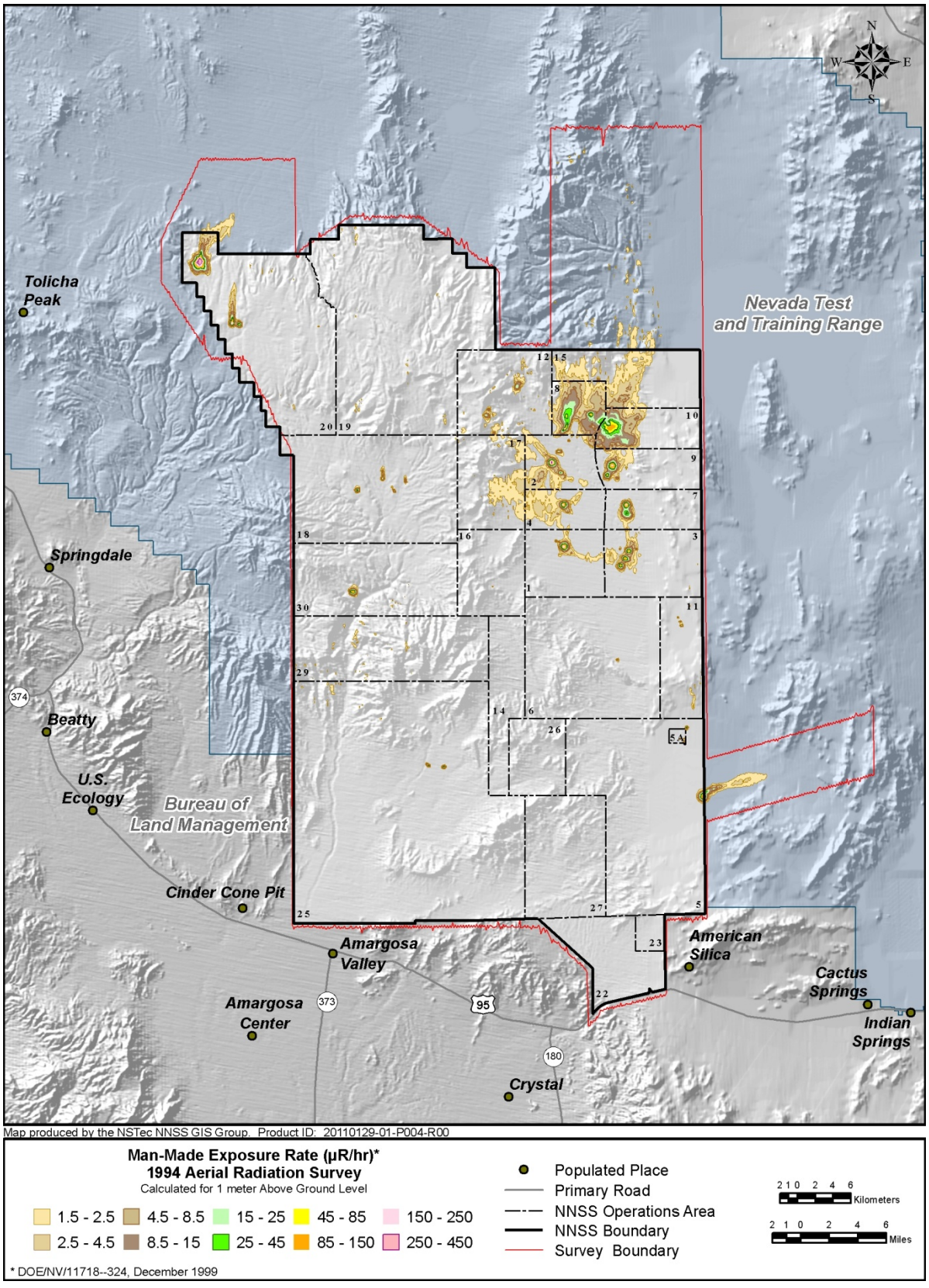

Figure 2. Distribution of Elevated Exposure Rates from Radionuclides in NNSS Soils

Collectively, these diffuse NNSS sources have air emissions with potential to result in an effective dose equivalent (EDE) exceeding 0.1 millirem per year (mrem/yr) which is greater than 1% of the standard (Grossman, 2005). Per requirements set forth in Title 40 Code of Federal Regulations (CFR) Section 61.93(b) (U.S. Environmental Protection Agency [EPA] and DOE, 1995; CFR, 2010a), these are considered a major source requiring continuous monitoring (termed *monitored source* in this report). Sources that result in a potential EDE less than 0.1 mrem/yr are considered minor release points (EPA and DOE, 1995).

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 10 CFR 835, "Occupational Radiation Protection" (CFR, 2010b). Facilities that have unsealed radioactive material are potential point sources for radiological air emissions. The primary facilities for the key NNSA/NSO missions are shown in Figure 3.

Radioactive emissions are not necessarily produced from these facilities in a given year, but all have the potential for radioactive emissions. During calendar year (CY) 2010, only the Area 3 Radioactive Waste Management Site (RWMS), the Area 5 Radioactive Waste Management Complex (RWMC), and the Dense Plasma Focus (DPF) at the Los Alamos Technical Facility (LAFT) had measurable emissions on the NNSS. Because of the low amounts and low potential for releases from facilities, all are considered a minor release point. Another facility, the Joint Actinide Shock Physics Experimental Research (JASPER) in Area 27, began experimentation using actinide materials as targets in 2003. As required by EPA Region 9, a stack monitoring system was installed downstream of high-efficiency particulate air (HEPA) filters to ensure that the emissions are in conformance with the NESHAP. The JASPER system was disassembled for repairs during CY 2010, so there were no operations or stack monitoring January through December 2010. The facility will resume operations during 2011 and will be monitored upon its resumption. No continuous monitoring is required at other point source facilities on the NNSS.

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 [Area 23]). With environmental samples, the concentrations are generally low, and therefore the potential emissions are negligible. However, there is handling and distillation of radioactive materials in the laboratory in Building 23-652, so it is considered a potential source.

All facilities and activities from which radionuclides were known to be released to air in CY 2010 are listed in Section II, Table 2, and their source information is listed in Appendix A, Table A.1. All facilities with the potential to have unsealed radioactive material but had no known emissions in CY 2010 are listed in Table A.2.

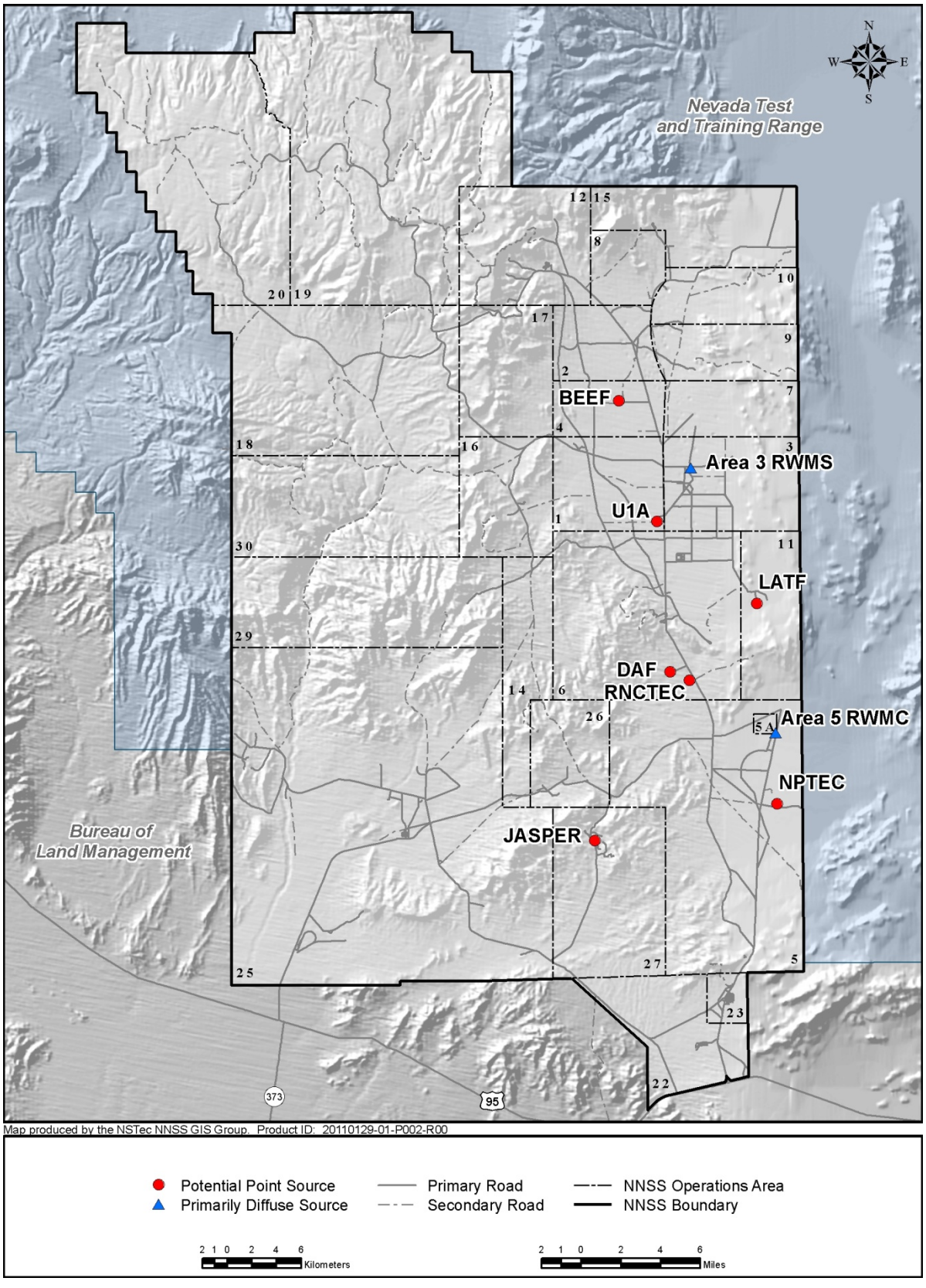

Figure 3. Primary Facilities for Key NNSA/NSO Missions

SECTION II
AIR EMISSIONS DATA

Facilities and operations from which radionuclides were released to the atmosphere during CY 2010 are listed in Table 2. Their locations are displayed in Figure 4. Releases for the year are grouped into six general categories: (1) legacy weapon test and plowshare soil contamination sites; (2) defense, security, and stockpile stewardship; (3) groundwater characterization/control and remediation activities; (4) radioactive waste management; (5) support facility operations; and (6) emanation from contaminated building materials. Descriptions of CY 2010 emission sources by category are described below.

Legacy 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 B. The third general location is a grouping of all nuclear weapon and plowshare test locations from all areas 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 C.

Defense, Security, and Stockpile Stewardship

This category consists of activities making up the bulk of the 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, Big Explosives Experimental Facility (BEEF), JASPER, Device Assembly Facility (DAF), DPF, and tunnel facilities.

The Homeland Security and Defense Applications directorate conducts work to strengthen national security by providing real-world testing, evaluation, and training venues. Certain work conducted under the Test and Evaluation program has potential for radioactive emissions. The primary facilities for this are the T1 Training and Exercise Area, Radiological/Nuclear Countermeasures Test and Evaluation Complex (RNCTEC), and the Nonproliferation Test and Evaluation Complex (NPTEC).

Locations from which radionuclides were known to be released to air in CY 2010 were the DPF and NPTEC. Note that the one monitored point source, the JASPER facility, is not part of the list for emission points during CY 2010. This is because the facility did not operate during CY 2010, so there was no potential for emissions. Radionuclides associated with the T1 Training and Exercise area and BEEF are diffuse soil contamination associated with historical testing and are therefore included with the soil sites in the category mentioned above, Legacy Weapon Test and Plowshare Soil Contamination Sites. Calculations of radionuclide emissions from the DPF and NPTEC are described in Appendix D.

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 collections ponds (E-Tunnel Ponds). The only radiological contaminant that produces a measurable air emission is ^{3}H evaporating as tritiated water (HTO). Calculation of this emission source for CY 2010 is described in Appendix E.

The Underground Test Area (UGTA) Sub-Project has the task of characterizing the aquifers at sites of past underground nuclear tests. To characterize the groundwater regime, suitable wells are being 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 2010, water containing ^{3}H was only pumped from Well ER-20-7 (Figure 4). Calculation of this ^{3}H emission is described in Appendix E.

At the NLVF, parts of the Building A-01 basement were contaminated with ^{3}H in 1995. This affected a vacant 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 the disposal of this water includes using it in evaporative coolers outside the north side of Building A-01 and by disposing of it in the Area 23 Sewage Lagoons at the NNSS when the evaporative coolers were not effective. Calculation of the ^{3}H emission from NLVF water disposed of at the NNSS sewage lagoons during CY 2010 is described in Appendix D, and calculation of the ^{3}H emission from the NLVF evaporative coolers is described in Appendix F.

Environmental Restoration demolition projects conducted during CY 2010 were at the Reactor Maintenance, Assembly, and Disassembly (RMAD) facility, Pluto facility, and Test Cell C. Calculation of potential dose to the public from radioactive emissions to air from these activities is described in Appendix D.

Radioactive Waste Management

The Area 3 RWMS and the Area 5 RWMC are used for the disposal of packaged, dry, low-level waste (LLW) 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 site operations was ^{3}H as HTO in atmospheric moisture. The calculation of the ^{3}H source term for these emissions in CY 2010 is described in Appendix B.

Support Facility Operations

Facilities with laboratories as described at the end of Section I above have the potential to emit low quantities of radionuclides from contaminated environmental samples when they are handled or from the preparation of ^{3}H standards that are used for quality assurance purposes. Also, the Radiological Control Department has responsibilities to conduct 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 (RAMATROL), Building 23-180.

Emanation from Building Materials

The 1995 ^{3}H contamination of the NLVF Building A-01 basement mentioned above also resulted in contamination of the basement building materials. Emanation of 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 EDE for offsite exposure during CY 2010 are presented in Appendix F.

Each potential source of NNSS emissions for CY 2010 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 assuming that 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

In accordance with 40 CFR 61.93(b)(4)(ii) (CFR, 2010a), no credit was taken for pollution control equipment in determining potential air emissions.

Distances and directions from all CY 2010 emission sources to 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 NLVF emission sources. The source type, emission control, and description of the nature of each emission are listed in Table A.1 (Appendix A).

A summary of the CY 2010 emissions for NESHAP reporting by source is shown in Table 3. A summary of the NNSS total CY 2010 emissions for NESHAP reporting by radionuclide is shown in Table 4. A summary of the NLVF total CY 2010 emissions is provided in Table 5. The source type, emission control, and description of the nature of each emission are listed in Table A.1. Appendices B through F describe the methods used to determine the CY 2010 emissions.

Table 2. CY 2010 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 Weapon Test and Plowshare Crater Locations			
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 Ops Areas	Various locations ranging from 20 to 60 km from offsite locations		
Defense, Security, and Stockpile Stewardship			
DPF	46 km SSE (Cactus Springs)	36 km S (American Silica)	49 km SSE (Indian Springs)
NPTEC	34 km SE (Cactus Springs)	23 km S (American Silica)	38 km SE (Indian Springs)
Groundwater Characterization/Control or Remediation Activities			
Environmental Restoration Projects			
RMAD Demolition	24 km SW (Amargosa Valley)	28 km WSW (Cinder Cone Pit)	37 km SW (Amargosa)
Pluto Demolition	29 km SW (Amargosa Valley)	29 km SE (American Silica)	42 km SW (Amargosa)
Test Cell C Demolition	24 km SSW (Amargosa Valley)	26 km SW (Cinder Cone Pit)	36 km SSW (Amargosa)
E-Tunnel Ponds, Area 12	53 km WSW (Springdale)	55 km WNW (Tolicha Peak)	62 km SW (Beatty)
UGTA Sub-Project			
Well ER-20-7, Area 20	31 km SW (Springdale)	29 km WNW (Tolicha Peak)	46 km SSW (Beatty)
NLVF Groundwater Control			
NLVF, evaporative coolers, north side of A-01	0.6 km W (N Las Vegas)[c]	0.1 km (at north fence of NLVF)	0.85 km W (N Las Vegas)
Area 23 Sewage Lagoons	23 km SW (Crystal)	7 km ESE (American Silica)	32 km ESE (Indian Springs)
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			
Buildings 23-650 and 23-652, Area 23	24 km SW (Crystal)	6 km SE (American Silica)	30 km ESE (Indian Springs)
RAMATROL, Building 23-180, Area 23	25 km SW (Crystal)	7 km SE (American Silica)	31 km ESE (Indian Springs)
Emanation from Building Materials			
Building A-01, basement ventilation, NLVF	0.6 km W (N Las Vegas)	0.1 km (at north fence of NLVF)	0.85 km W (N Las Vegas)

(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

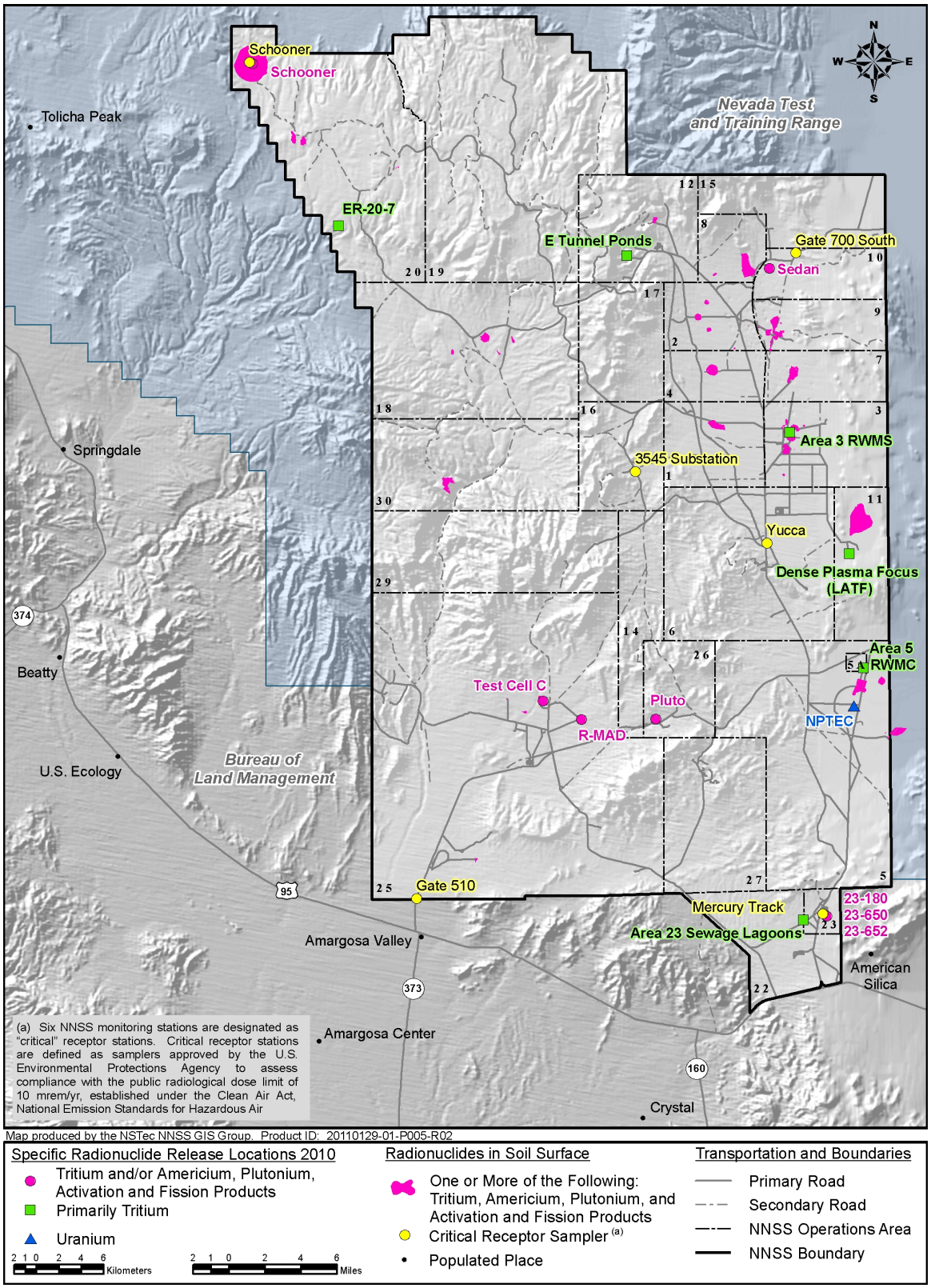

Figure 4. Sources of Radiological Air Emissions on the NNSS in CY 2010

Table 3. Summary of CY 2010 Air Emissions Data by Source

Emission Source[a]	Type of Emissions Control	Nuclide	Annual Quantity (Ci)
Legacy Weapon Test and Plowshare Crater Locations			
Sedan	None	^{3}H[b]	24
Schooner	None	^{3}H[b]	8.3
Grouped Area Sources – All NNSS Ops Areas	None	^{241}Am[c]	0.047
Grouped Area Sources – All NNSS Ops Areas	None	^{238}Pu[c]	0.050
Grouped Area Sources – All NNSS Ops Areas	None	$^{239+240}Pu$[c]	0.29
Defense, Security, and Stockpile Stewardship			
DPF	None	^{3}H[d]	400
NPTEC	None	depleted Uranium[d]	0.00015
Groundwater Characterization/Control or Remediation Activities			
Environmental Restoration Projects			
RMAD Demolition	dust suppression	mixed fission and activation products, actinides[d]	negligible
Pluto Demolition	dust suppression	mixed fission and activation products, actinides[d]	negligible
Test Cell C Demolition	dust suppression	mixed fission and activation products, actinides[d]	negligible
E-Tunnel Ponds	None	^{3}H[e]	8.1
UGTA Sub-Project			
Well ER-20-7	None	^{3}H[e]	153
NLVF Groundwater Control			
NLVF, evaporative coolers, north side of A-01	None	^{3}H[e]	0.00028
NNSS Area 23 Sewage Lagoons	None	^{3}H[e]	0.00056
Radioactive Waste Management			
Area 3 RWMS	Soil cover over waste	^{3}H[b]	29
Area 5 RWMC	Soil cover over waste	^{3}H[b]	3.0
Support Facility Operations			
Buildings 23-650 and 23-652	None	^{3}H	negligible
RAMATROL, Building 23-180	None	various	negligible
Emanation from Building Materials			
Building A-01, basement ventilation, NLVF	None	^{3}H[f]	0.0062

(a) All locations are on the NNSS except for Building A-01.
(b) Emission based on environmental surveillance results and CAP88-PC software.
(c) Sum of emissions estimated from re-suspension model; see Table C.1 for individual area estimates.
(d) See Appendix D.
(e) Emission based on HTO discharged into containment pond(s), onto the ground, or through evaporators.
(f) Based on air concentrations and ventilation system flow rate.

Table 4. Total Estimated NNSS Emissions for CY 2010

Radionuclides[(a)]	Total Quantity (Ci)
^{3}H	625
^{241}Am	0.047
^{238}Pu	0.050
$^{239+240}Pu$	0.29

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

(a) Radionuclides contributing ≥ 10 percent of the potential EDE.

Table 5. Total Estimated NLVF Emissions for CY 2010

Radionuclide	Total Quantity (Ci)
^{3}H	0.0065

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 was approved by EPA Region 9 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 pseudo-critical receptor locations because no person actually resides at these onsite locations. They are used as such to conservatively represent hypothetical offsite critical receptors. Table 6 displays the distances between the critical receptor monitoring stations and points of interest offsite as well as their distance from the closest onsite emission location.

Compliance with the NESHAP inhalation dose limit to the public of 10 mrem/yr is demonstrated if the measured annual average concentration of each detected radionuclide at each of these six locations is less than the NESHAP Concentration Levels (CLs) for Environmental Compliance. 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 2010 air sampling results from the six compliance stations are presented in Table 7.

COMPLIANCE ASSESSMENT

Table 7 lists the 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 1 percent of the CLs except for the ^{3}H average at the Schooner sampler station, which was about 17 percent of the CL. The average concentration of ^{3}H is high at Schooner because the air sampler is only 269 meters (m) from the center of the crater and located within the area that received ejecta from the cratering experiment (Figure 6). At the Schooner station, the highest sum of the fractions of measured annual concentrations divided by the NESHAP CL for each radionuclide was 0.169, well below 1.0 and therefore in compliance. Figure 7 displays the sum of fraction results for the Schooner station from 2001 to 2010. Scaling this 0.169 sum of fractions for the Schooner station to the 10 mrem/yr limit gives an estimated EDE of 1.7 mrem/yr from air emissions for a hypothetical individual living year-round at this station. A more realistic estimate of a measure of the maximally exposed individual (MEI) dose would be from the Gate 510 sampler, which is the closest to a public receptor (about 3.5 km). Scaling the 0.004 sum of fractions for the Gate 510 station to the 10 mrem/yr limit gives an estimated EDE of 0.04 mrem/yr from air emissions for a hypothetical individual living year-round at this station. For comparison, MEI dose estimates made using CAP88-PC software from 1992 through 2004 are displayed in Figure 8.

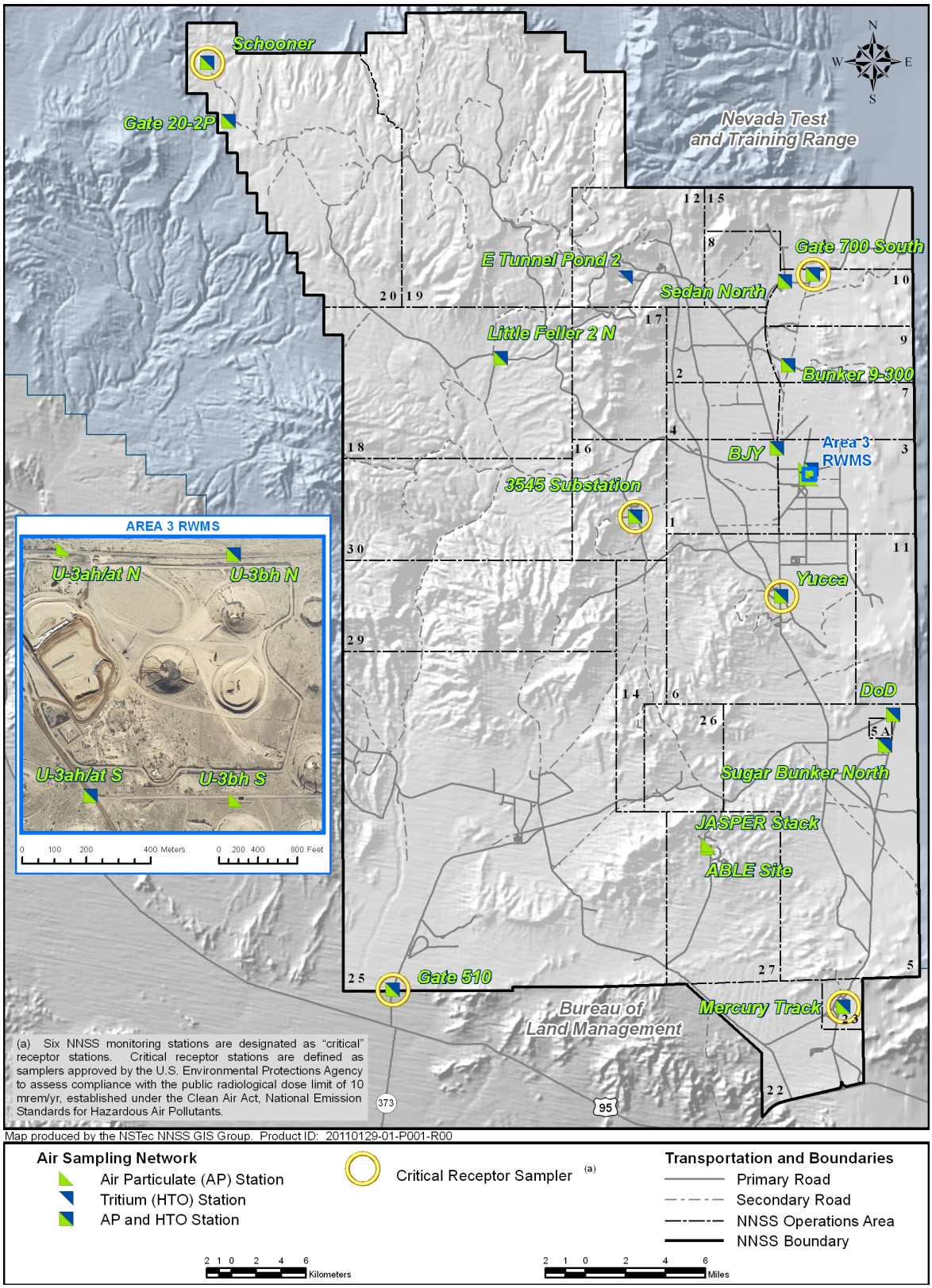

Figure 5. Air Sampling Network on the NNSS

Table 6. Distance of Critical Receptor Air Monitoring Stations to 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
Area 6, Yucca	47 km SW (Amargosa Valley)	38 km SSE (American Silica)	54 km SE (Indian Springs)	10 km N (Area 3 Radioactive Management Site)
Area 10, Gate 700	49 km ENE (Medlin's Ranch)	56 km NNE (Rachel)	77 km ENE (Alamo)	2.4 km WSW (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 Management Site)
Area 20, Schooner	36 km WSW (Sarcobatus Flat)	20 km WSW (Tolicha Peak)	56 km SSW (Beatty)	0.2 km SE (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)	17 km NNE (Engine Maintenance, Assembly, and Disassembly)

(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), CY 2010

Location	Radionuclide	Average Concentration in Air (pCi/m^3)[a]	CL[b] (pCi/m^3)	Average Concentration as Fraction of CL
Yucca	^{3}H	0.27×10^{0}	1500	0.0002
Gate 700		0.29×10^{0}		0.0002
Substation 3545		0.12×10^{0}		0.0001
Schooner		241.78×10^{0}		0.1612
Mercury		0.22×10^{0}		0.0001
Gate 510		-0.04×10^{0}		0.00000 (rounded negative average up to zero)
Yucca	^{241}Am	3.48×10^{-6}	0.0019	0.0018
Gate 700		4.09×10^{-6}		0.0022
Substation 3545		1.46×10^{-6}		0.0008
Schooner		4.75×10^{-6}		0.0025
Mercury		3.66×10^{-6}		0.0019
Gate 510		2.95×10^{-6}		0.0016
Yucca	^{238}Pu	0.73×10^{-6}	0.0021	0.0003
Gate 700		2.21×10^{-6}		0.0011
Substation 3545		1.00×10^{-6}		0.0005
Schooner		4.10×10^{-6}		0.0020
Mercury		1.90×10^{-6}		0.0009
Gate 510		2.19×10^{-6}		0.0010
Yucca	$^{239+240}Pu$	4.29×10^{-6}	0.0020	0.0021
Gate 700		11.72×10^{-6}		0.0059
Substation 3545		4.42×10^{-6}		0.0022
Schooner		6.69×10^{-6}		0.0033
Mercury		1.74×10^{-6}		0.0009
Gate 510		3.71×10^{-6}		0.0019
Yucca	Sum of Fractions by Location			0.004
Gate 700				0.009
Substation 3545				0.004
Schooner				0.169
Mercury				0.004
Gate 510				0.004

(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)

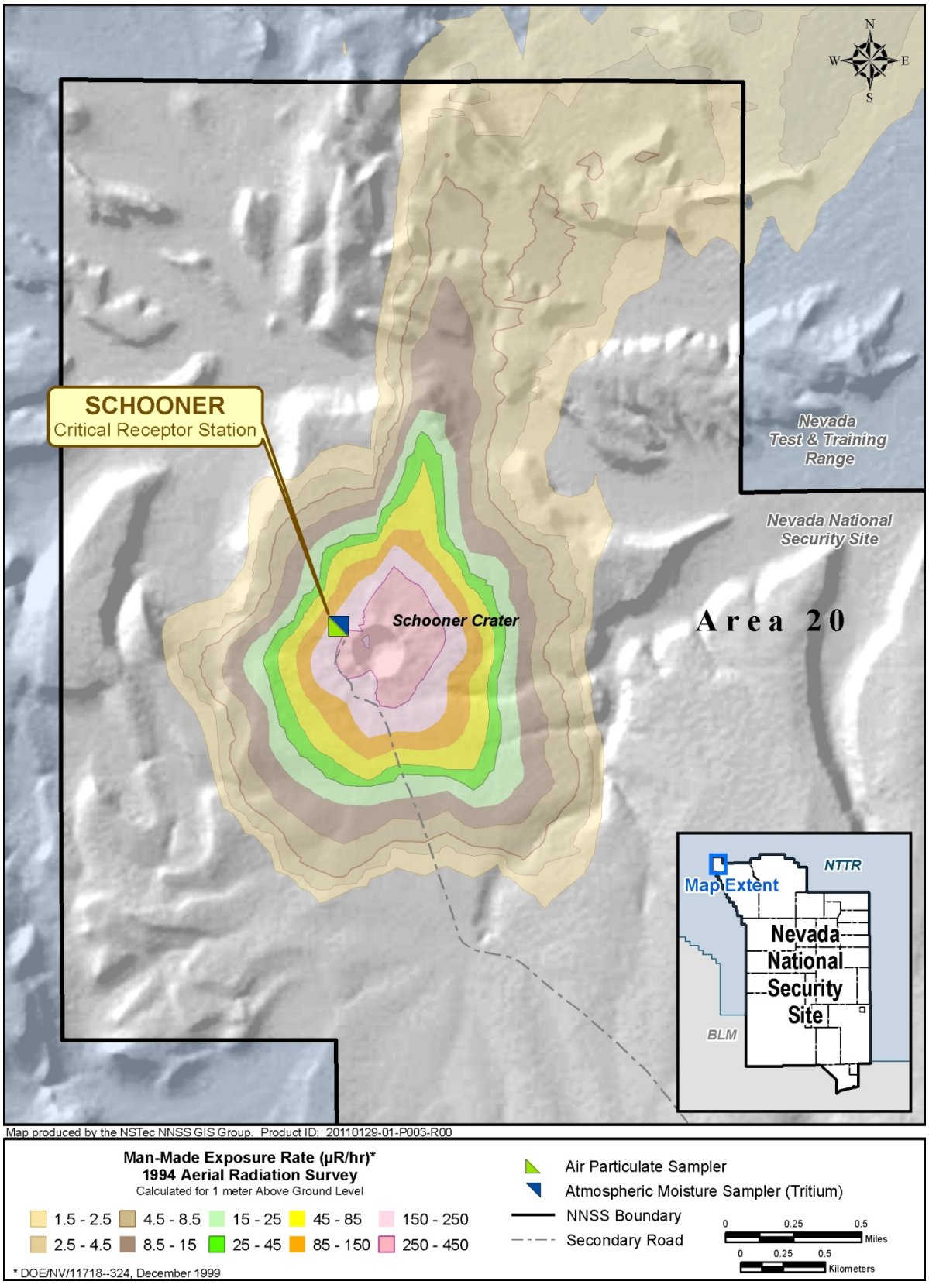

Figure 6. Schooner Critical Receptor Air Sampling Station

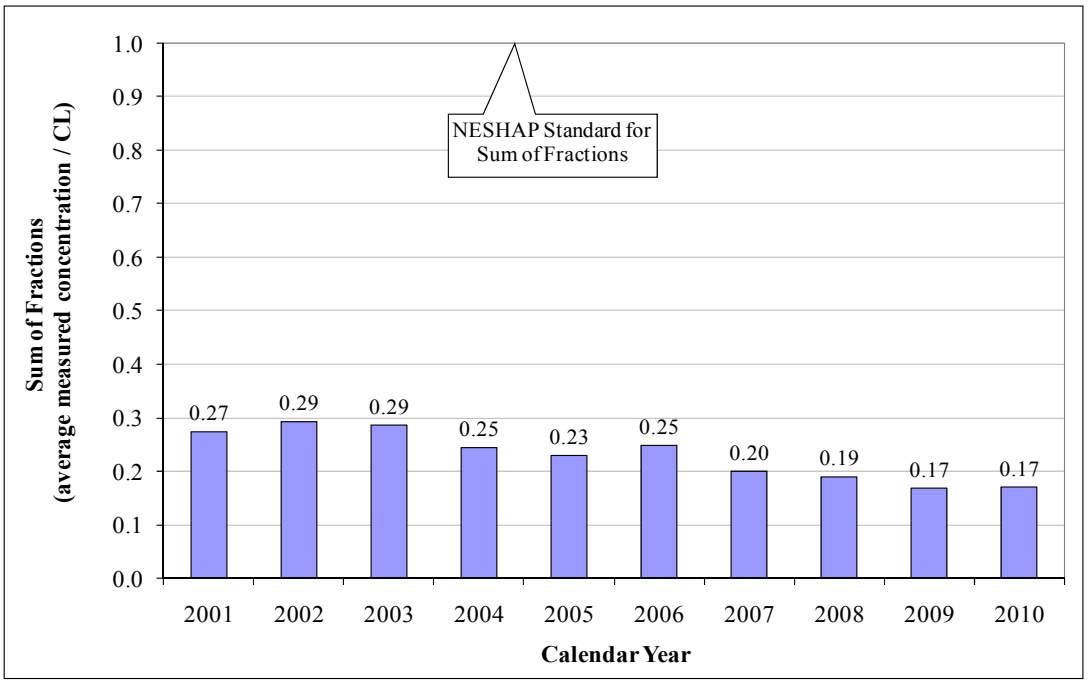

Figure 7. Sum of Fractions (Annual Average Radionuclide Concentrations Divided by CLs) for the Schooner Critical Receptor Location, CY 2001 to CY 2010

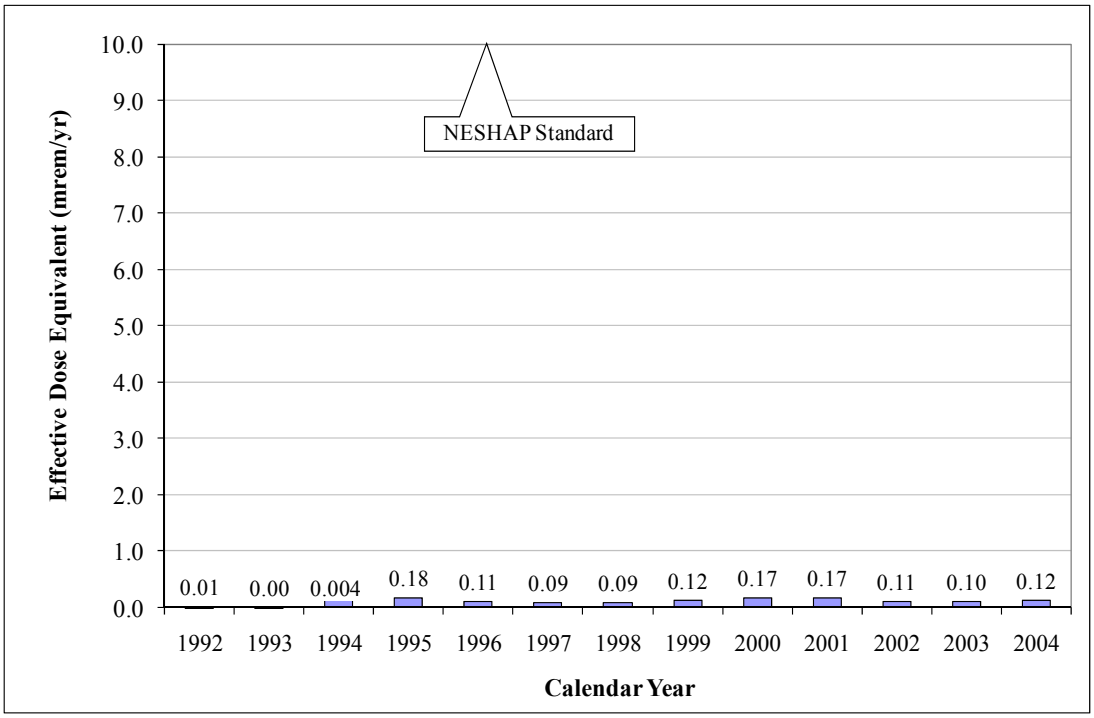

Figure 8. Effective Dose Equivalent to Offsite MEI prior to use of Onsite Critical Receptor Stations

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SECTION IV
ADDITIONAL INFORMATION

NEW CONSTRUCTION/MODIFICATION OR PERIODIC CONFIRMATORY MEASUREMENT ACTIVITIES AT THE NNSS

During CY 2010, NESHAP evaluations were completed for suspension of radionuclides in soil due to use of explosives at the Baker Blast Pad (Area 27); suspension of radionuclides from the demolition of Test Cell C, Building 3210 (Area 25); and for the emission of radionuclides from the handling of radioactive materials at the NPTEC in Area 5 and at the DAF in Area 6. These evaluations were completed in order to determine if these projects have the potential to release airborne radionuclides that would expose the public to a dose equal to or greater than 0.1 mrem/yr. For any project or facility with this potential, the EPA requires approval prior to operation and point-source operational monitoring. Summaries of these assessments are provided in Table 8 below. See Appendix D for a more detailed description of the dose evaluations.

Table 8. Summary of CAP88-PC Dose Evaluations

Location	Distance to Nearest NNSS Boundary (km)	CAP88-PC Predicted Dose (mrem/yr)
Baker Blast Pad	11	< 0.1
Test Cell C	15	0.000000036
NPTEC	3	0.008
DAF	11	0.024

As shown in Table 8, the predicted radiation dose at the nearest NNSS boundary for each location was less than the 0.1 mrem/yr level specified in 40 CFR 61.96. It was therefore concluded that these activities constituted minor sources and did not require regulatory approval or specific monitoring.

Periodic confirmatory measurements are required by 40 CFR Section 61.93(b)(4)(i) (CFR, 2010a) to ensure an emission source is still a minor source. The only periodic confirmatory measurement made during CY 2010 was for potential emissions from the DAF listed above. This is summarized in Appendix D.

UNPLANNED RELEASES DURING CY 2010

No unplanned releases occurred during CY 2010.

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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: Stephen A. Mellington, Manager, NNSA/NSO

Signature: Stephen A Mellington Date: 6/20/11

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APPENDICES

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Appendix A

Potential National Emission Standards for Hazardous Air Pollutants (NESHAP) Sources

Table A.1 Facilities or Areas from which Radionuclides were Released to Air in Calendar Year (CY) 2010

Facility or Area	Type	Potential Air Source Term	Handling/ Processing	Nature of Emissions	Source	Effluent Controls	Release Amount/NESHAP Evaluation
Legacy Weapon Test and Plowshare Soil Contamination Sites							
Sedan Crater (Plowshare)	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	Minor[a]	None	• 24 curies (Ci) ^{3}H, 2010 (Appendix B) • Nearest critical receptor location is the Gate 700 S sampler at 2.4 km to the ENE[b] but the Gate 700 S sampler is closest overall at 0.8 km to the N
Schooner Crater (Plowshare)	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	Minor[a]	None	• 8.3 Ci ^{3}H, 2010 (Appendix B) • Nearest critical receptor location is the Schooner sampler at 0.2 km to the 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 emitted from Sedan and Schooner—see above)	None	Wind causing suspension of soil containing small amounts of historical fallout/legacy radioactive materials	Monitored[c,d]	None	• Majority of ^{3}H emitted from Sedan and Schooner Craters (listed above) • 0.047 Ci ^{241}Am • 0.05 Ci ^{238}Pu • 0.29 Ci $^{239+240}$Pu (Table 4) (Appendix C)

Table A.1 Facilities or Areas from which Radionuclides were Released to Air in Calendar Year (CY) 2010 (continued)

Facility or Area	Type	Potential Air Source Term	Handling/ Processing	Nature of Emissions	Source	Effluent Controls	Release Amount/NESHAP Evaluation
Defense, Security, and Stockpile Stewardship							
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	Minor [a]	None	• 400 Ci, 2010 (Appendix D) • 3.2×10^{-3} mrem/yr to the maximally exposed individual (MEI) from DPF operations estimated in 2006 • Nearest critical receptor location is the Yucca sampler at 7.4 km to the WNW
Nonproliferation Test and Evaluation Complex (NPTEC), Area 5	Diffuse	Depleted uranium	Handling of powder compounds	Suspension of particulates	Minor [a]	None	• 1.54×10^{-4} Ci, 2010 (Appendix D) • The Yucca sampler is the closest critical receptor station at 16.4 km to the NNW but the Sugar Bunker air sampling station is closest overall at 2.5 km NNE

Table A.1 Facilities or Areas from which Radionuclides were Released to Air in Calendar Year (CY) 2010 (continued)

Facility or Area	Type	Potential Air Source Term	Handling/ Processing	Nature of Emissions	Source	Effluent Controls	Release Amount/NESHAP Evaluation
Groundwater Characterization/Control and Remediation Activities							
Environmental Restoration Projects							
Reactor Maintenance, Assembly, and Disassembly facility (RMAD), Area 25	Diffuse	Mixed fission and activation products, actinides	Demolition of the RMAD facility by mechanical and explosive means	Suspension of contaminated particulates during demolition	Minor[a]	Wetting of material for dust control	• 6.3×10^{-10} mrem/yr from estimated releases (see Appendix D) • Nearest critical receptor location is the Gate 510 sampler at 22 km to the SW
Test Cell C, Area 25	Diffuse	Mixed fission and activation products, actinides	Demolition of the Test Cell C, Building 3210 by mechanical means	Suspension of contaminated particulates during demolition	Minor[a]	Wetting of material for dust control	• 3.6×10^{-8} mrem/yr from estimated releases (see Appendix D) • Nearest critical receptor location is the Gate 510 sampler at 21 km to the SSW

Table A.1 Facilities or Areas from which Radionuclides were Released to Air in Calendar Year (CY) 2010 (continued)

Facility or Area	Type	Potential Air Source Term	Handling/ Processing	Nature of Emissions	Source	Effluent Controls	Release Amount/NESHAP Evaluation
Groundwater Characterization/Control							
Environmental Restoration, E-Tunnels, 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	Minor[a]	None	• 8.1 Ci, 2010 (Appendix E) • Nearest critical receptor location is the Gate 700 S station at 15 km to the E but the E-Tunnel Pond #2 sampler is closest overall at 0.4 km to the SE
Underground Test Area, Sub-project, Well ER-20-7, Area 20	Diffuse	^{3}H as HTO	Groundwater from wells at sites of past underground nuclear tests is pumped to the surface	Evaporation of ^{3}H as HTO	Minor[a]	None	• 153 Ci, 2010 (Appendix E) • Nearest critical receptor location is the Schooner sampler at 17 km to the NNW but the Gate 20-2P sampler is closest overall at 11.3 km to the NNW
NLVF Groundwater Control							
NLVF, evaporative coolers, north side of A-01	Point	^{3}H in groundwater pumped from NLVF Building A-01 source well	Water removed from source well and disposed by putting it through evaporative coolers (State-approved method)	^{3}H as HTO through evaporation	Minor[a]	None	• 0.00028 Ci, 2010 • 3.2 x 10^{-5} mrem/yr to MEI, 2010 (Appendix F)
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, when the evaporative coolers are not effective or are not used	^{3}H as HTO through evaporation	Minor[a]	None	• 0.00056 Ci, 2010 (Appendix E) • Nearest critical receptor location is the Mercury Track sampler at 1.0 km to the ENE

Table A.1 Facilities or Areas from which Radionuclides were Released to Air in Calendar Year (CY) 2010 (continued)

Facility or Area	Type	Potential Air Source Term	Handling/ Processing	Nature of Emissions	Source	Effluent Controls	Release Amount/NESHAP Evaluation
Radioactive Waste Management							
Area 3 Radioactive Waste Management Site (RWMS) and surrounding area							
Cells U3ah/at and U3bh	Diffuse	Bulk low-level waste (LLW)	Subsurface burial of waste (no active burial during CY 2010)	^{3}H as HTO through evaporation from soil or transpiration from plants	Minor[a]	Soil cover	• 29 Ci, 2010 (Appendix B) • Nearest critical receptor location is the Yucca sampler at 10 km SSW, but the U-3bh N, U-3bh S, U-ah/at N, and U-3ah/at S samplers are closest. These samplers surround the Area 3 RWMS adjacent to its boundary.
Closed cells U3ax/bl	Diffuse	Bulk LLW	Closed subsurface burial site	^{3}H as HTO through evaporation from soil or transpiration from plants	Minor[a]	Soil cover	
Area 5 Radioactive Waste Management Complex (RWMC)							
Area 5 RWMS active cells	Diffuse	LLW and Mixed LLW (MLLW)	Subsurface burial of waste	Evaporation from soil or transpiration from plants of ^{3}H as HTO	Minor[a]	Soil cover	• 3.0 Ci ^{3}H from entire Area 5 RWMC (Appendix B) • Nearest critical receptor location is the Yucca sampler at 14 km NNW, but the Sugar Bunker North and DoD air sampling stations are closest overall at 1.0 km SSW and 1.5 km NNE, respectively
Area 5 Waste Management Site - 28 closed disposal cells, 13 inactive or closed Greater Confinement Disposal boreholes	Diffuse	LLW, MLLW, and Transuranic (TRU) waste	Maintenance of closed cells and boreholes where wastes have been buried	Evaporation from soil or transpiration from plants of ^{3}H as HTO	Minor[a]	Soil cover	

Table A.1 Facilities or Areas from which Radionuclides were Released to Air in Calendar Year (CY) 2010 (continued)

Facility or Area	Type	Potential Air Source Term	Handling/ Processing	Nature of Emissions	Source	Effluent Controls	Release Amount/NESHAP Evaluation
Support Facility Operations							
Occupational Medicine and Radiological Control Building 23-650; 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	Minor[a]	None	• 1.8 x 10^{-9} mrem/yr from estimated releases, 2004[e] • Nearest critical receptor location is the Mercury Track sampler at 0.2 km to the ESE
RAMATROL, Building 23-180, Source Storage and Counting Equipment	Point	Radioactive sources and materials received and those waiting disposal	Storage, shipment, receipt, opening, and surveying of packages containing radioactive materials	Aerosolized radioactive material	Minor[a]	None	• Negligible release • Nearest critical receptor location is the Mercury Track sampler at 0.2 km to the ESE
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	Minor[a]	None	• 0.0062 Ci, 2010 • 3.2 x 10^{-5} mrem/yr to MEI, 2010 (Appendix F)

[a] Minor source has a potential release resulting in a dose of <0.1 mrem/yr to the MEI.
[b] N=north, S=south, E=east, W=west in all direction combinations shown. Multiply km distance by 0.62 to get miles.
[c] Monitored source has a potential to release resulting in a dose of ≥0.1 mrem/yr to the MEI.
[d] The NNSS Air Sampling Network, including the critical receptor sampling stations, monitors radionuclides in air from wide-area diffuse emissions on the NNSS.
[e] NESHAP dose evaluation for potential release from 23-652 as reported in Grossman (2005).

Table A.2 Locations with Potential to have Unsealed Radioactive Material But Had No Known Emissions in CY 2010

NNSS Operations Area	Building Name/Area Description	Radioactive Material	Handling/Processing
1	01/Condition Release Storage Yard East	Mixed fission and activation products, actinides	Storage of legacy post-shot, slant hole drill rig and associated equipment, with possible internal contamination
1	01/Condition Release Storage Yard West	Mixed fission and activation products, actinides	Storage of legacy drilling pipe equipment with possible internal contamination
1	01/Post Shot Drill Rig (Readiness)	Mixed fission and activation products, actinides	Storage of legacy post-shot drill rig and components with possible internal contamination
1	01/Railcar #8 (202044)	Mixed fission and activation products, actinides	Storage of legacy materials with possible internal contamination
1	Special Projects Office 01-121/Conex # 295145	Actinides	Stored awaiting disposition
1	U1a Complex 01/U1a Complex Barolo Experiment Area	Actinides, fission products, depleted uranium (DU)	Sources used to calibrate/performance test radiological instruments
5	05/Visual Examination and Repackaging Building (Bldg)	LLW, MLLW, and TRU waste	05-32 is in cold standby (placed in cold standby mid-2009) but has contamination in the vent system
5	Real Time Radiography	LLW, MLLW, and TRU waste	X-ray unit used to characterize waste in sealed containers
5	Thermal Conditioning Unit	LLW, MLLW, and TRU waste	Holding of sealed waste containers in a thermo stabilizer
5	Sprung Instant Structure	LLW, MLLW, and TRU waste	Waste characterization
5	Waste Management Compound	LLW	Subsurface burial of LLW
5	Drum Holding Pad	LLW, MLLW, and TRU waste	Temporary storage of waste containers during processing
6	Tower Yard - Crane Test Weights	DU	Storage of legacy radioactive crane test weights with possible internal contamination awaiting disposition
6	06/6-911 Yard North Transportainer	Uranium (U) and DU	Storage of U contaminated equipment and DU metal in approved shipping packages
6	06/6-911 Yard South Transportainer	U and DU	Storage of U contaminated equipment and DU metal in approved shipping packages

Table A.2 Locations with Potential to have Unsealed Radioactive Material But Had No Known Emissions in CY 2010 (continued)

NNSS Operations Area	Building Name/Area Description	Radioactive Material	Handling/Processing
6	06/Construction Yard East	Mixed fission and activation products, actinides	Storage of legacy mud pump with possible internal contamination
6	06/Construction Yard West	Mixed fission and activation products, actinides	Storage of legacy post-shot drill rigs, structures, and other equipment with possible internal contamination
6	Manitowoc Crane Area - NE Corner - Crane Test Weights	DU	Storage of crane test weights with possible internal legacy contamination
6	Manitowoc Crane Area - SE Corner - Crane Test Weights	DU	Storage of crane test weights with possible internal legacy contamination
6	06/6-623 Yard	Mixed fission and activation products, actinides	Storage of legacy-contaminated steel targets
6	Active Interrogation Bldg	Various radionuclides for sensor testing/ development	Storage and use for evaluating arrays of monitors, portals, and other sensor arrangements
6	Bunker 06/ Bunker Class 1	Mixed fission and activation products, actinides	Contaminated soil samples from legacy atmospheric test areas
6	Criticality Experiments Facility (CEF)	U and thorium (Th) nuclides	Solid materials to support the CEF Th metal in unopened, approved shipping packages
6	06/Outside Device Assembly Facility (DAF) - Conex #s 043509, 043510, & 043511	Medical isotopes and U	Stored awaiting disposition
6	06/Outside DAF - Conex #s 043509 & 043510	U	Stored awaiting disposition
6	06/CP-50 Yard Advanced Spectroscopic Portal (ASP) Container # 056824	U	Stored awaiting disposition
6	06/CP-50 Yard ASP Container # 056824	Actinides	Stored awaiting disposition
6	Bunker 06/CP-111 A and/or B	DU	Stored awaiting disposition
6	DAF 06/SeaLand outside Bldg.500	Actinides	Waste awaiting disposition
6	DAF 06	Mixed fission and activation products, actinides	Machines have fixed contamination and internal contamination
12	Core Library 12/Lawrence Livermore National Laboratory Core Library	Mixed fission and activation products, actinides	Storage of samples

Table A.2 Locations with Potential to have Unsealed Radioactive Material But Had No Known Emissions in CY 2010 (continued)

NNSS Operations Area	Building Name/Area Description	Radioactive Material	Handling/Processing
12	G-Tunnel 12/U12g Tunnel	Equipment containing various radioactive material	In operational ready mode to support research and testing
12	G-Tunnel 12/Conex #9127908	Potentially contaminated	Piece of equipment, stored awaiting disposition
19	19/U19ad Temporary Area for Waste Storage	Tritium (^{3}H), fission and activation products, or actinides in waste	Stored awaiting disposition
23	Core Storage 23/Bldg 116, Room (Rm) 104 (Counter Terrorism Operations Support [CTOS])	Mixed fission and activation products, actinides	Storage of samples
23	Core Storage 23/Bldg 116, Rm 105 (CTOS)	Various	Storage awaiting disposition
23	Nuclear Operations Directorate Container Package Center 23/Bldg 128, northeast Corner of Warehouse	LLW	Disassembly and assembly of Department of Transportation Type A and B shipping containers
23	Physical Standards Lab 23/Bldg 153 Rad Services Instrument Cage	Mixed fission and activation products, actinides, DU, ^{3}H	Radioactive check sources and waste storage containers
23	Physical Standards Lab 23/Bldg 153 Sealand #PNWU 2993719	Mixed fission and activation products, actinides, DU, ^{3}H	Storage of waste, soil samples, and potentially internally contaminated equipment
23	Radioactive Materials Control 23/Bldg 180 Source Storage & Counting Equipment	Mixed fission and activation products, actinides	Storage and potential repackaging
23	Joint Testing Office 23/Bldg 600 Rm 304 D&F Source Storage	^{3}H, actinides, DU	Lab is used to prepare and count ^{3}H samples in water; actinides and DU used for equipment testing
23	Occupational Medicine and Radiation Control 23/Bldg 650 Basement	Mixed fission products, actinides, ^{3}H	Radioactive standards left over from the historical Analytical Services Laboratory
23	Occupational Medicine and Radiological Control 23/Bldg 650 Rm 29	Actinides, mixed fission products, mixed gamma performance standards	All samples held in their sealed containers and are counted using a gamma ray spectrometer and then returned for disposal
23	Occupational Medicine and Radiation Control 23/Bldg 650 Rm 36	Sealed sources and historical radioactive sources and samples Volatile radioactive sources: ^{3}H, Krypton-85, Iodine-129	Temporary storage of low-level radiological waste products, storage of sealed radioactive sources for instrument calibrations and measurement, and tools necessary to perform contamination measurement of material and components entering and departing the NNSS

Table A.2 Locations with Potential to have Unsealed Radioactive Material but had no Known Emissions in CY 2010 (continued)

NNSS Operations Area	Building Name/Area Description	Radioactive Material	Handling/Processing
23	Environmental Monitoring 23/Bldg 652 Rm 10	Mixed fission products, actinides, ^{3}H	Radioactive standards used to make spiked samples and counting standards for analysis of radionuclides in environmental samples
23	Environmental Monitoring 23/Bldg 652 Rm 7	Mixed fission products, actinides, ^{3}H	Samples and standards are placed in 652 Rm 7 when being screened with radiation detection equipment
23	Equipment Trailer 23/722003	Mixed fission products, actinides, ^{3}H	Storage of field samples awaiting disposition
23	Warehouse 23/Warehouse 9	^{3}H, Carbon-14	Storage of exit signs that contain ^{3}H and calibration standards
27	Able Site Assembly Joint Actinide Shock Physics Experimental Research (JASPER)[a]	TRU	Material located in primary and secondary containment chambers; due to reconfigurations no material was used during CY 2010; storage of primary and secondary containment chambers awaiting disposition
27	Transport Vehicle Garage 27/Bldg 5110	TRU	Stored until waste box is filled, then will be transported to Area 5 RWMS for management
27	5320 27/Bldg 5320	Cobalt-60 and LLW	Stored awaiting characterization, excess, and/or disposal

[a] EPA-required stack monitoring at JASPER but because the system did not operate during 2010, there were no emissions.

Appendix B

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. 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 E. For the remaining sites listed, emissions were estimated by scaling concentrations of ^{3}H in air predicted by a modeled unit release to those measured at nearby sampling stations.

There are 19 sampling stations referred to as environmental samplers on the NNSS. They include 3 stations that have exclusively low-volume air particulate samplers, 1 that has exclusively a HTO sampler, and 15 that have both air particulate and HTO samplers, 6 of which are designated as critical receptor locations. They are located throughout the NNSS in or near the highest diffuse radiation sources. Figure 5 of this report shows the current NNSS air sampling station locations and Table B.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 curie (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 B.1 lists the estimated emissions for each source location.

Table B.1 Tritium Emissions from Airborne Tritium Sampling Results during CY 2010

Emission Source	Air Sampler	Tritium Concentration (pCi/m^3)[(a)]	CAP88-PC Concentration for 1 Ci Emission (pCi/m^3)	Tritium Emission (Ci)
Area 3 RWMS	BJY	0.80	0.0276	29[(b)]
	U-3bh N	0.40	0.715	0.56
	U-3ah/at S	0.83	0.385	2.2
Area 5 RWMC	DoD	0.27	0.0903	3.0[(c)]
	Sugar Bunker North	0.82	0.489	1.7[(c)]
Area 10 Sedan	Sedan North	5.07	0.214	24[(c)]
	Gate 700[(d)]	0.29	0.0128	23[(c)]
Area 20 Schooner	Schooner[(d)]	242	1.17	210[(e)]
	Gate 20-2P	0.24	0.0288	8.3

(a) pCi/m^3 = picocuries per cubic meter
(b) Diffuse emissions of ^3H from nearby atmospheric nuclear weapons test locations likely elevated the annual average concentrations of ^3H measured at the BJY sampler. It is probable that this resulted in the emission estimate for the Area 3 RWMS to be high. Estimate still used for conservatism.
(c) The higher of the two emission estimates for each location was used for that location.
(d) Critical Receptor Station
(e) Emission estimate likely biased high due to sampler being close to the diffuse emission source (see Appendix H, Estimating Tritium Emissions from Schooner and Sedan). The alternative emission estimate, based on the Gate 20-2P sampling location, is considered more defensible and was therefore used.

Appendix C

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 1.0 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) is given as follows:

$$S = K \times V_g$$

where: S = fractional re-suspension rate (per second), or the fraction of the inventory re-suspended per second
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). On page 75 of DOE (1992), values of K are given for the NNSS. 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 put into the above equation, S is between 2×10^{-12} and 1×10^{-11} per second (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 1.0) and S as follows:

$$(37 \text{ Ci}) \times (1 \times 10^{-11}/\text{s}) \times (10^{12} \text{ pCi/Ci}) = 370 \text{ pCi/s}$$

Since 1 year (yr) = 3,600 s/hour x 24 hours/day x 365 days/yr = 3.15×10^7 s/yr, the annual emission rate becomes:

$$370 \text{ pCi/s} \times 3.15 \times 10^7 \text{ s/yr} = 1.17 \times 10^{10} \text{ pCi/yr or } 11.7 \text{ millicuries (mCi)/yr}$$

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

Table C.1 Calculated Emissions from Inventories[(a)] of ^{238}Pu, $^{239+240}$Pu, and ^{241}Am in NNSS Ops Areas

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	1.32	2.05	7.57
2	2.9	8.6	22	2×10^{-10}	0.05	0.91	2.71	6.94
3	4.6	3.1	37	2×10^{-10}	0.05	1.45	0.98	11.67
4	6.6	13	40	2×10^{-10}	0.05	2.08	4.10	12.61
5	0.6	0.1	4.8	2×10^{-10}	0.05	0.19	0.03	1.51
6	1.7	3.3	8.4	2×10^{-10}	0.05	0.54	1.04	2.65
7	2.2	0.6	16	2×10^{-10}	0.05	0.69	0.19	5.05
8	17	8	110	2×10^{-10}	0.05	5.36	2.52	34.69
9	4.2	2.2	89	2×10^{-10}	0.05	1.32	0.69	28.07
10	19	19	110	2×10^{-10}	0.05	5.99	5.99	34.69
11	3.3	0.5	29	2×10^{-10}	0.05	1.04	0.16	9.15
12	5.7	8.5	39	2×10^{-10}	0.05	1.80	2.68	12.30
15	8	7.8	63	2×10^{-10}	0.05	2.52	2.46	19.87
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	0.88	1.42	5.68
18	19	5.6	100	2×10^{-10}	0.05	5.99	1.77	31.54
19	21	32	140	2×10^{-10}	0.05	6.62	10.09	44.15
20	23	30	41	2×10^{-10}	0.05	7.25	9.46	12.93
30	3.2	4.5	14	2×10^{-10}	0.05	1.01	1.42	4.42
TOTAL	150	160	910			47	50	290

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

As shown in Table C.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 2010. 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 percent to the total dose from all radionuclide emissions calculated from re-suspension calculations, and therefore they have not been included in evaluations for National Emission Standards for Hazardous Air Pollutants compliance.

Appendix D

Radionuclide Emissions from Environmental Restoration, Waste Management, Construction, and Research Projects and Periodic Confirmatory Measurements

This appendix contains summaries of radionuclide emission and resultant dose to the public estimates for cleanup or characterization efforts, research, and construction projects, as well as for periodic confirmatory measurements made for existing projects.

ENVIRONMENTAL RESTORATION PROJECTS

Reactor Maintenance, Assembly, and Disassembly (RMAD) and Pluto Demolition

Environmental Restoration program projects on the Nevada National Security Site (NNSS) included demolition projects that were begun in calendar year (CY) 2009 for the Reactor Maintenance, Assembly, and Disassembly (RMAD) facility in Area 25 and the Pluto facility in Area 26. These were completed in CY 2010. As reported in the 2009 NESHAP report, the potential radiation dose at the nearest offsite populated location from either of the demolitions was several orders of magnitude less than 0.1 millirem per year (mrem/yr). An additional demolition project for Test Cell C, Building 3210, in Area 25, began in CY 2010. The National Emission Standards for Hazardous Air Pollutants (NESHAP) evaluation for this project is summarized below.

Test Cell C Demolition

The Environmental Restoration program completed a closure in place of the Test Cell C, Building 3210, in Area 25 of the NNSS during CY 2010. The site contained radiologically impacted and hazardous material. The structure was demolished using traditional mechanical methods (non-explosive). As much demolition debris as space allowed was placed into the structure's basement. Material not fitting into the basement was packaged for onsite disposal as low-level radioactive waste. During demolition activities, radionuclides associated with particulates were suspended into the air and potentially available for transport off the NNSS by wind. Prior to the commencement of the work, the potential radiation dose to the nearest member of the offsite public from radionuclides released to air during this demolition was assessed to ensure it was in compliance with NESHAP, Title 40 Code of Federal Regulations (CFR) Section 61. The Clean Air Package 1988 (CAP88) computer model, specifically CAP88 – PC version 3.0, was used for this assessment in accordance with 40 CFR 61.93.

Model Inputs

Distances to Potential Receptors

Release point (Test Cell C): Latitude 36.831233, Longitude 116.277965 (decimal degrees, North American Datum (NAD) 83). The distance to the nearest NNSS boundary (15.1 kilometers [km]) was determined using ArcMap version 9.3 (ESR) software. Nobody resides, or was stationed full-time, at the nearest NNSS boundary. It was only used as a reference. Since personnel residing full-time on the NNSS are not considered members of the public, the nearest offsite member of the public was located in Amargosa Valley, 23.8 km southwest of Test Cell C.

Meteorological Data

National Oceanic Atmospheric Administration, Air Resources Laboratory, Special Operations and Research Division (ARL/SORD) Meteorological Data Acquisition (MEDA) station number 26, located in the eastern portion of Area 25 about 3.4 km southeast of Test Cell C, was used to obtain representative meteorological data for Test Cell C. The wind speed range of 4–6 knots was used, and it was conservatively assumed that the wind was blowing 100 percent of the time directly towards populated locations. Average values were used for precipitation (14.5 centimeters per year [cm/yr]) and temperature (16.8 degrees Celsius [°C]) for Area 25 as reported by ARL/SORD. Absolute humidity was assumed to be 5 grams per cubic meter (g/m^3)

Source Data

The area of the release was estimated to be the entire demolition site (950 square meters [m^2]) and a release height of 0 feet (ft).

The plume rise was assumed to be zero, and the Height of Lid parameter was limited to 1,000 meters (m) for the CAP88-PC run.

The total amount of radioactivity released to air is listed in Table D.1 and was based on the estimated radionuclide inventory in Test Cell C materials and the use of an emission factor listed in the *Preferred Method to Estimate Radionuclide Emissions from Demolition*, listed in *Methods for Estimating Fugitive Air Emissions of Radionuclides from Diffuse Sources at DOE Facilities* (U.S. Environmental Protection Agency [EPA], 2004). No emission control factor was applied for conservatism even though water misting was used to control dust.

Table D.1 Potential Amount of Radioactive Air Emissions from the Demolition of the Test Cell C Facility

Total Inventory		Emission[(a)]
Isotope	**Curies (Ci)**	**Ci**
Eu-152	9.88E-02	2.87E-06
Eu-154	3.37E-03	9.77E-08
Sr-90	2.10E-03	6.09E-08
U-235	9.68E-04	2.81E-08
Co-60	7.63E-03	2.21E-07
Cs-137	8.55E-03	2.48E-07

[(a)] Emission factor of 2.9E-05 applied (Section 7.4.1.6 of EPA, 2004)

Food Source Scenario

It was assumed that intake would be based on a rural food source scenario. This is conservative as it assumes all food is derived regionally (none imported).

Results and Conclusion

The CAP88 predicted dose at the nearest boundary (3.6×10^{-8} millirem per year [mrem/yr]) was significantly lower than the 0.1 mrem/yr level specified in 40 CFR 61.96 and the 10 mrem/yr limit specified in 40 CFR 61.92. It was therefore concluded that the potential offsite dose from radionuclides suspended during demolition of Test Cell C was minor and did not require specific monitoring or application for approval to the regulator. The nearest critical receptor station for demonstrating compliance with 40 CFR 61.92 is Gate 510 located about 2.8 km closer to Test Cell C than the nearest offsite resident in Amargosa Valley and is in the same general direction from Test Cell C as Amargosa Valley.

WASTE MANAGEMENT PROJECTS

No construction/modification activities took place at waste management facilities during CY 2010.

CONSTRUCTION PROJECTS

No construction projects with potential for radionuclide emissions were initiated during CY 2010.

RESEARCH PROJECTS

During CY 2010 research activities from two projects conducted under the general category of Defense, Security, and Stockpile Stewardship had radioactive emissions to air. These projects were the ongoing Dense Plasma Focus (DPF) conducted in Area 11 and research activities initiated during 2010 at the Nonproliferation Test and Evaluation Complex (NPTEC) in Area 5. Activities at another location, the Baker Blast Pad, were also evaluated to estimate offsite dose from radionuclides potentially suspended in air during operations. Summaries of the radionuclide emission and potential offsite dose from these projects are summarized below.

Dense Plasma Focus

Operations at the DPF, in Building 11-102 on the NNSS, use a deuterium-tritium reaction to create a neutron flux for research purposes. During CY 2010 these operations resulted in a release of tritium (^{3}H) to the atmosphere. The amount of ^{3}H released was calculated based upon the change in pressure in a tank of tritium gas used in the experiments:

Total emission = (0.017 mol) x (24300 Ci/mol) ≈ 400 Ci released

A 2006 NESHAP evaluation using CAP88-PC used 2,000 Ci of tritium released. The resultant dose to the maximally exposed individual (MEI) was 0.00086 mrem/yr at Cactus Springs, 46 km south of Building 11-102. The amount of tritium released during CY 2010 is about five times less than the amount producing this small dose. Long distances, low energy beta particles, and dispersal of tritium result in low offsite doses from even relatively large (many thousand Ci) releases.

Handling and Use of Radioactive Material at NPTEC

NPTEC, in support of several government agencies, conducted experiments that involved the handling of radioactive material in a particulate and liquid form. Storage and handling of material was performed in an area located in Area 5 south of the 5-07 Road. This "Solids Project," conducted in April 2010, consisted of putting depleted uranium (DU) compounds in configurations for sensor development and testing. All radioactive materials were first in particulate form, and most were placed on adhesive tape which was displayed for periods lasting approximately 1 to 3 hours each. Some of the radioactive material was put in solution and placed on concrete/cement pads, allowed to dry, and left exposed for remote sensing tests. These pads are referred to as the spill pads.

Because the radioactive materials in particulate form were handled and exposed to the environment for limited amounts of time and the liquid material was allowed to dry and left exposed, there was opportunity for radionuclides to become suspended into the air and potentially transported off of the NNSS by the wind. Nominal size for particulates used were quite large (45 to 600 micrometers) and not

likely to become airborne for long distances or to be respirable. Nevertheless, a dose assessment for this project was conducted with the CAP88-PC dose model to determine if the radiation dose to a member of the offsite public from radionuclides potentially released to air during these experiments would exceed the dose level of 0.1 mrem/yr (at which monitoring and an application for approval to the State of Nevada is required), or the dose standard of 10 mrem/yr (specified in 40 CFR 61, Subpart H).

CAP88 Model Inputs

Distances to Potential Receptors

Release point: Latitude 36.824651, Longitude 115.964313 (decimal degrees, NAD 83). The distance to the nearest NNSS boundary (3.2 km) was determined using ArcMap version 9.2 (ESR). Nobody resides, or is stationed full-time, at the nearest NNS boundary. It was only used as a reference. Since personnel residing full-time on the NNSS are not considered members of the public, the nearest offsite MEI resided in Cactus Springs, 34.2 km southeast of the Solids Project location.

Meteorological Data

The wind speed range of 4–6 knots and the calm stability class G was assumed in the modeling, which would maximize the calculated dose. It was also conservatively assumed that the wind was blowing 100 percent of the time directly towards a populated location. Other parameters used were as follows:

Average precipitation during the month of April for Area 5 Well 5B (1963–2009) = 0.86 cm
The temperature was predicted to be 23.9°C
The mixing height (Height of Lid parameter in the CAP88 model) was predicted to be 1,000 m.
Absolute humidity was assumed to be 5 g/m^3.

Source Data

The amounts of radioactive material were provided by project personnel. The emission factor (1.00E-03) from Appendix D of 40 CFR 61 for handling solid particulates or liquids was applied to the amount of activity handled to obtain an estimate of the air emission (Table D.2). The number of times materials were predicted to be handled, per year, was four for the solid particulates and twice for the material placed on the spill pads. The area of the possible release was 17.75 m^2 and at a height of about 0.15 m.

Table D.2 Emission Estimate for the NPTEC Solids Project

	Emission (Ci) of each isotope				
	Compound 1	Compound 2	Compound 3	Compound 4	**Total Emission (Ci)**
U-233	1.15E-05	2.14E-07	1.36E-05	3.24E-07	2.57E-05
U-234	1.49E-05	2.77E-07	1.76E-05	4.18E-07	3.32E-05
U-235	7.19E-07	1.34E-08	8.49E-07	2.02E-08	1.60E-06
U-236	1.32E-06	2.44E-08	1.55E-06	3.69E-08	2.93E-06
U-238	4.01E-05	7.45E-07	4.73E-05	1.13E-06	8.93E-05

Food Source Scenario

It was assumed that intake would be based on a rural food source scenario. This is conservative as it assumes all food is derived regionally (none imported).

Results and Conclusion

The predicted dose at the nearest boundary (8.0 x 10-3 mrem/yr) was 12.5 times lower than the 0.1 mrem/yr level specified in 40 CFR 61.96 for requiring application for approval or notification, and 1,250 times lower than the 10 mrem/yr limit specified in 40 CFR 61.92. The predicted dose at the nearest offsite residence (Cactus Springs) was over 44 times lower than at the nearest boundary. It was therefore concluded that the potential offsite doses from radioactive materials potentially suspended during the Solids Project at NPTEC in Area 5 were minor and did not require specific monitoring from a NESHAP perspective or application for approval to the regulator.

Use of Explosives at the Baker Site

Defense Facilities and Nuclear Operations, in support of several government agencies, plans to conduct tests with explosives at the Baker Site in Area 27 of the NNSS. It is predicted that up to 20,000 pounds of explosives could be used annually at this location. Because the detonations will be conducted over bare soil, any soil-associated radionuclides have potential to be suspended into the air and available for transport off the NNSS by wind.

Distances to Potential Offsite Receptors
The proposed blast pad is at the Baker Site in Area 27: Latitude 36.7703857, Longitude 116.1079951 (decimal degrees, NAD 83). The distance to the nearest NNSS boundary (11.0 km) was determined using ArcMap version 9.3 (ESR) software. Nobody resides, or was stationed full-time, at the nearest NNSS boundary. It was only used as a reference. The nearest offsite resident member of the public was determined to be in Amargosa Valley, 29.7 km west-southwest of the Baker Site.

Source Data
Explosive operations at this blast pad will be virtually the same as those in previous assessments (National Security Technologies, LLC, 2010a); however, concentrations of radionuclides in surface soil in Area 27 are lower than the other areas previously assessed for potential radiological emissions during explosive detonations. It was therefore concluded that the potential offsite dose from soil suspended during explosive detonations near the Baker Site would be minor and does not require specific monitoring from a NESHAP perspective.

PERIODIC CONFIRMATORY MEASUREMENTS

North Las Vegas Facility, Building A-01

See Appendix E

Handling of Unclad Radioactive Material at the Device Assembly Facility (DAF)

To ensure that the handling of unclad radioactive material in the DAF remains in conformance with NESHAP, 40 CFR 61, Subpart H, the airborne radioactive emissions resulting from the handling of this material was evaluated in accordance with NESHAP criteria. The estimated emissions, without pollution controls, were used as input to CAP88-PC software, as recommended by NESHAP, to calculate the effective dose equivalent (EDE) to the MEI offsite. If the result of this calculation is less than 0.1 mrem/yr, no stack monitoring or regulatory approval is required.

Method for Estimating Emissions

Unclad radioactive material handled at the DAF consists predominately of uranium (U). From the amount of U allowed in each building, the radioactive emissions to the air exhausted from the buildings with no pollution controls was estimated by multiplying the total amount of U by an emission factor allowed by 40 CFR 61 Appendix D.

The values used in estimating the emission of each uranium isotope are summarized in Table D.3.

Table D.3 Potential Radioactive Emissions from the Handling of U at the DAF

Radionuclide	Estimated Emission (Ci)
^{234}U	1.00E-01
^{235}U	1.36E-03
^{238}U	4.81E-05

CAP88-PC Input Parameters

The estimated emissions were used as the source term for a CAP88-PC calculation to determine the EDE to the MEI located offsite.

- Emission estimate from Table 1.
- Annual precipitation average for years 1958–April 2010 at Yucca Dry Lake (ARL/SORD) = 17 cm.
- Average temperature for 1983–2001 (ARL/SORD), 13°C.
- Stack height = 7.31 m.
- Stack diameter = 0.254 m.
- Stack exhaust velocity used = 4.85 m/s.
- Absolute humidity = 6 g/m^3.
- EPA food source scenario = rural.
- Average wind speed, direction, and stability class from the MEDA13 station for CY 2009.

Results and Conclusion

The EDE at the nearest NNSS boundary was 0.024 mrem/yr, and the EDE at the nearest populated location, Amargosa Valley, was 0.0027 mrem/yr. Since the potential EDE at the populated location was a factor of 37 times lower than the 0.1 mrem/yr level, it was concluded that potential releases from handling unclad radioactive material at the DAF constitutes a minor source, which does not require specific monitoring or application for approval to the regulator.

Appendix E

Calculation of Tritium Emissions from Contaminated Groundwater Discharges

The calendar year (CY) 2010 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 2010 to determine the tritium concentration.

Water from the well listed in Table E.1 is purge water from Underground Test Area Sub-Project sampling activities. The volume of water purged from the well 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 E.1 lists the values used to make emission estimates.

Table E.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	4.91×10^{5}	1.66×10^{7}	8.1
Area 23 Sewage Lagoons	6.38×10^{2}	8.75×10^{5}	0.00056
Building A-01, evaporative coolers, NLVF	6.38×10^{2}	4.30×10^{5}	0.00028
Well ER-20-7	1.72×10^{7}	2.35×10^{6}	153

(a) All water was assumed to evaporate during CY 2010.

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Appendix F

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, 1996b), 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 2010, air sampling for HTO in the basement was conducted intermittently. For CY 2010, the results of two atmospheric moisture samples were 466 picocuries per cubic meter (pCi/m^3) for the sample collected April 5 to April 12, 2010, and 766 pCi/m^3 for the sample collected September 1 to September 8, 2010. The average of these sample results (616 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).

$$\frac{616\,pCi}{m^3}\times\frac{673\,ft^3}{\min}\times\frac{0.02832\,m^3}{ft^3}\times\frac{525{,}600\min}{yr}\times\frac{1\times10^{-9}\,mCi}{pCi}=\frac{6.17\,mCi}{yr}$$

An additional 0.28 mCi/yr of tritium was released from Building A-01 by evaporating water from the radiation source well, resulting in a total emission of 6.45 mCi/yr.

Clean Air Package 1988 modeled dose to the MEI from NLVF tritium releases from 1995 to 2001 gave a dose coefficient of 5.0 x 10^{-6} millirem per year per millicurie released ([mrem/yr]/mCi). This coefficient multiplied by the tritium emission for CY 2010 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).

$$\frac{6.45\,mCi}{yr}\times\frac{5.0\times10^{-6}\,mrem}{mCi}=\frac{0.000032\,mrem}{yr}\,or\,\frac{0.032\,\mu rem}{yr}$$

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

Table F.1. Comparison of Tritium Emission Rates from Building A-01, NLVF from 1995 to 2010

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

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 Site Office (NNSA/NSO) 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/NSO programs under the authority of an Interagency Agreement between NOAA and NNSA/NSO.

METEOROLOGICAL OBSERVATIONS

The ARL/SORD manages, operates, and maintains a meteorological monitoring program that is designed and used to support the NNSA/NSO-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 approximately 30 mobile meteorological towers located primarily on the NNSS (Figure G.1). The MIDNET consists of communications systems, local area networks, upper-air sounding stations, and surface-based instrumentation used to measure wind direction and speed, temperature, relative humidity, pressure, and precipitation. 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.

Routine and special surface observations are collected by trained ARL/SORD personnel 16 hours per day, Monday through Friday at the Desert Rock Meteorological Observatory (DRA; elevation 1,007 meters [m]) located 4.8 kilometers (km) southwest of Mercury, Nevada (Station Number 23) (Figure G.1). Upper-air observations (radiosondes) are taken twice daily from DRA. DRA has been in operation since May 1978. DRA was built to replace a similar observatory that was located at the Yucca Flat Meteorological Observatory (UCC; elevation 1,196 m, Station Number 6) 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 an enclosed trailer, a portable 10 m tower, a microprocessor, and a radio transmitter. Wind speed and direction sensors are located on tower tops or booms oriented into the prevailing wind direction and at a minimum distance of two tower widths from the tower. Wind sensors are located 10 m above the ground.

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. MEDA station distribution and density (Figure G.1) are sufficient to document individual basin flow regimes and potential inter-basin air exchanges.

Ambient temperature and relative humidity sensors are located at 3 m above ground level. A total of 30 primary MEDA stations are located on or around the NNSS (Figure G.1) to ensure that meteorological conditions are thoroughly documented for the complex terrain environment found on the NNSS.

Wind direction is measured to 2 degrees of azimuth, and wind speed is accurate to 0.3 miles per hour. Wind data are collected as 5 minute averages and are transmitted via radio and sent over the NNSS intranet to a central processor every 15 minutes. These data are checked operationally by the duty forecaster, and quality control is overseen by ARL/SORD Meteorologists. Plotted wind products are generated every 15 minutes for operational use. These data are stored and archived for climatological purposes.

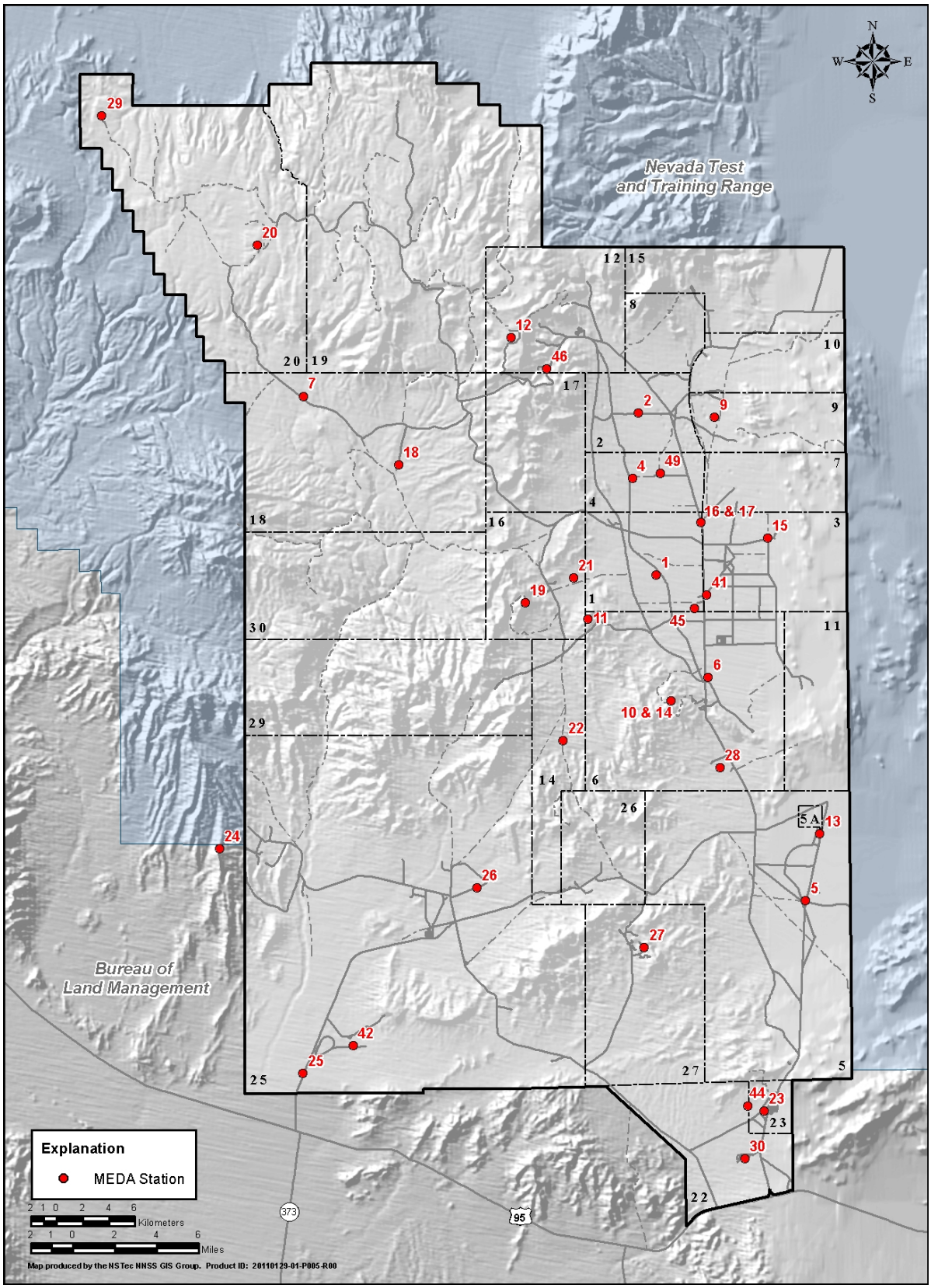

Figure G.1 Locations of MEDA Stations on the NNSS in CY 2010

MEDA temperature is accurate to 0.2 degrees Celsius (°C) between −39°C and 60°C (absolute range for the NNSS is −29°C to 46°C). Temperature measurements are instantaneous and are taken every 15 minutes at all MEDA stations. These data are also transmitted via radio to a computer for processing, displaying, and archiving.

To use the most representative meteorological data available for NNSS sources, cloud observations from DRA are melded with MEDA winds. Cloud cover observations needed as input to the Stability Array (STAR) program are available from DRA (1978–present) and from UCC (1962–1978). Based on the available data, the cloud cover climatology from DRA and UCC are quite compatible. For example, UCC experiences 192 clear days annually, while DRA has 191 days. In addition, the average annual sky cover from sunrise to sunset for both stations 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 can be considered as representative for most 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 in calculating diffusion calculations. Beginning in 2002, only weather data for the current year were used in creating the STAR files for the CAP88-PC calculations.

Calendar year 2010 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 Meteorological Data Acquisition System Locations Used to Create STAR Files for Use in Determining Radiological Emissions from the NNSS (Appendix B).

STAR File	MEDA Station	MEDA Location (NNSS Operations Area)	Area of Emission
10meda02.str	MEDA02	2	10
meda13.str	MEDA13	5	5
10meda29.str	MEDA29	20	20
meda41.str	MEDA41	3	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. Since the U.S. Department of Energy (DOE) agreed that there is little benefit in doing CAP88-PC calculations just for the collective effective dose equivalent (CEDE) (DOE, 2004), this calculation was not performed for calendar year 2010. As shown in Figure H.1, the CEDE has been consistently below 0.6 person-rem [roentgen equivalent man] per year (yr) for the years 1992 to 2004, indicating that it is unlikely that the CEDE will exceed 1 person-rem/yr. However, if operations at the NNSS change whereby radionuclide emissions significantly increase, this change will be reconsidered and calculation of CEDE likely resumed.

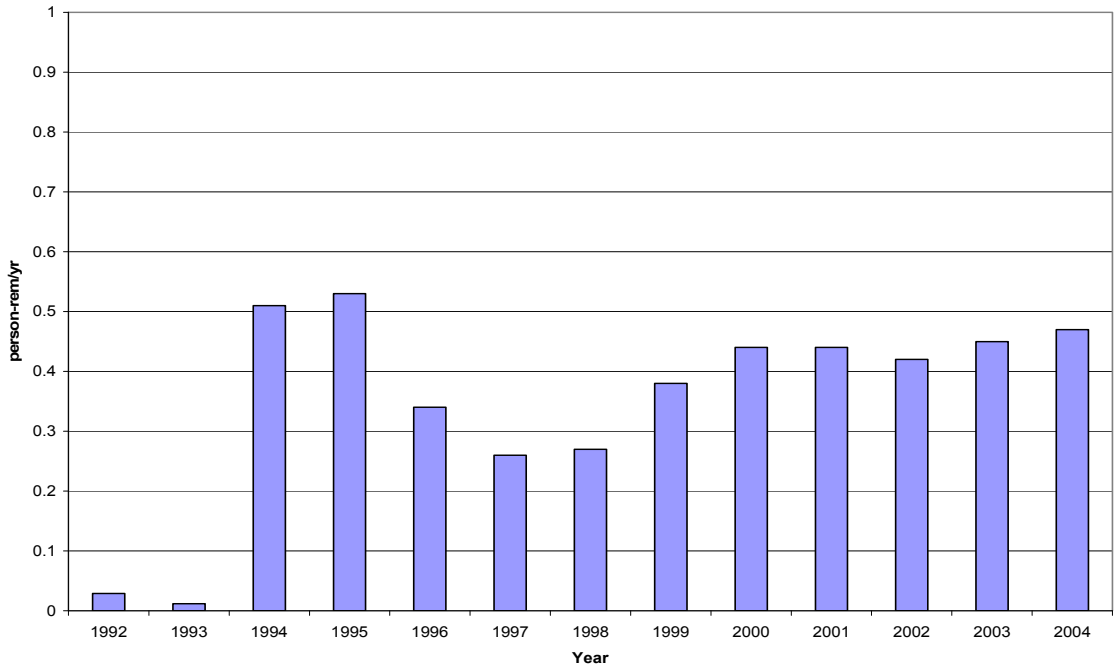

Figure H.1 CEDE to Populations within 80 km (50 miles) of Emission Sources

ESTIMATING TRITIUM EMISSIONS FROM SCHOONER

Prior to 2002, the area of diffuse tritium emissions from the Schooner site was assumed to be the size of its crater. From the measurement of tritium in vegetation samples collected in 2002 and 2004 the area of emissions appeared to be much larger. The current estimate for this area is 3.6×10^6 square meters. As this places the Schooner air sampling location within the source term area, the CAP88-PC concentration estimates at these sampler locations for a 1 curie per year release have high uncertainty (Figure H.2).

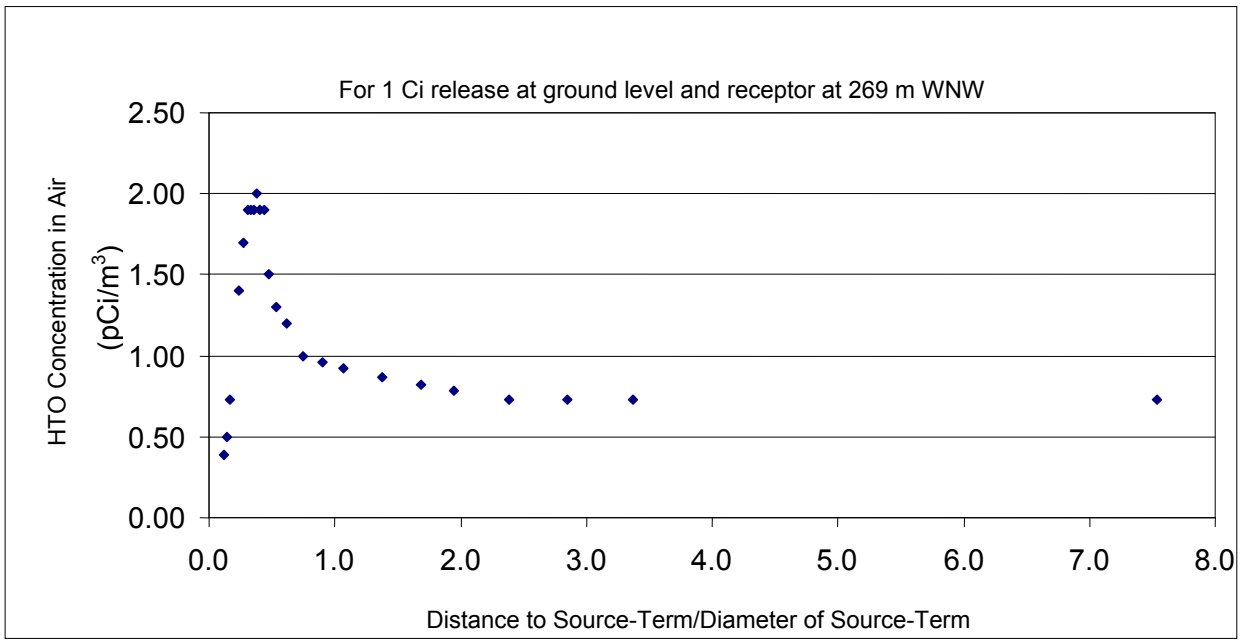

Figure H.2 CAP88-PC Predicted Air Concentration versus Ratio of Distance-to-Source/Diameter of Source

According to CAP88-PC documentation, the software estimates for area sources is reliable only for locations where the ratio (distance between the sampling location and source)/(source diameter) is greater than about 1.3. At a ratio greater than 2.5, the source is assumed to be a point source instead of an area source. To increase the reliability of tritium emission estimates, air samplers at further distances from the center of the source terms are included in making the release estimates, such as the air sampler positioned at Gate 20-2P, which is 4,790 meters south-southeast of the Schooner crater. At this distance, area source is treated by CAP88-PC nearly as a point source (ratio of 2.2). See Appendix B for a description of the method and results.

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 the Area 5 Radioactive Waste Management Complex to confirm inventory records that only small amounts of radium were disposed of in these areas and to make sure that the 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, 2010b) 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 414.1C, "Quality Assurance" (DOE, 2005) have been implemented in this plan.

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