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Nevada Test Site

National Emission Standards for Hazardous Air Pollutants – Radionuclide Emissions Calendar Year 2008

June 2009

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National Emission Standards for Hazardous Air Pollutants –

Radionuclide Emissions Calendar Year 2008

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Nevada Site Office

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EXECUTIVE SUMMARY

2008 RADIOLOGICAL DOSE TO THE PUBLIC BELOW FEDERAL STANDARD

The Nevada Test Site (NTS) is operated by the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. From 1951 through 1992, the NTS was the continental testing location for U.S. nuclear weapons. The release of radionuclides from NTS activities has been monitored since the initiation of atmospheric testing. Limitation to under-ground detonations after 1962 greatly reduced radiation exposure to the public surrounding the NTS. After nuclear testing ended in 1992, NTS radiation monitoring focused on detecting airborne radionuclides from historically contaminated soils. These radionuclides are derived from re-suspension of soil (primarily by winds) and emission of tritium-contaminated soil moisture through evapotranspiration. Low amounts of tritium were also emitted to air at the North Las Vegas Facility (NLVF), an NTS support complex in the city of 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, 2008a) limits the release of radioactivity from a U.S. Department of Energy facility (e.g., the NTS) to 10 millirem per year (mrem/yr) effective dose equivalent to any member of the public. This limit does not include radiation not related to NTS activities. Unrelated doses could come from naturally occurring radioactive elements or from other man-made sources such as medical treatments.

The NTS demonstrates compliance with the NESHAP limit by using environmental measurements of radionuclide air concentrations at critical receptor locations. This method was approved by the U.S. Environmental Protection Agency for use on the NTS in 2001 and has been the sole method used since 2005. Six locations on the NTS 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 of each detected radionuclide at each of these locations is less than the NESHAP Concentration Levels (CLs) for Environmental Compliance listed in 40 CFR 61, Appendix E, Table 2 (CFR, 2008a). At any one location, if multiple radionuclides are detected then 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.

NESHAP Compliance for 2008

NTS: Demonstrated by the Sum of Fractions at Each Critical Receptor Sampler Being Less Than 1.0			
Included Radionuclides	**NTS Area**	**Critical Receptor Location**	**Sum of Fractions of Compliance Levels (CLs)**
^{241}Am, ^{238}Pu, $^{239+240}Pu$, ^{3}H	6	Yucca	0.0164
	10	Gate 700 S	0.0057
	16	Substation 3545	0.0015
	20	Schooner	0.1932
	23	Mercury	0.0026
	25	Gate 510	0.0026
NLVF: Demonstrated by the Highest Potential Offsite Dose Being Less Than 10 mrem/yr			
Estimated offsite dose from NLVF = 0.00006 mrem/yr			

In 2008, the potential dose from radiological emissions to air, from both current and past NTS activities, at onsite compliance monitoring stations was a maximum of 1.9 mrem/yr; well below the 10 mrem/yr dose limit. Air sampling data collected at all six pseudo-critical receptor stations had average concentrations of radioactivity that were a fraction of the CL values listed in Table 2 in Appendix E of 40 CFR 61 (CFR, 2008a). Concentrations ranged from less than 1 percent to a maximum of 19 percent of the allowed NESHAP limit. Because the nearest member of the public resides approximately 20 kilometers (12 miles) from the NTS boundary, concentrations at this location would be only a small fraction of that measured on the NTS. Potential dose to the public from NLVF was also very low at 0.00006 mrem/yr; more than 160,000 times lower than the 10 mrem/yr limit.

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List of Acronyms and Abbreviations

Am	americium
ARL/SORD	Air Resources Laboratory, Special Operations and Research Division
BEEF	Big Explosives Experimental Facility
°C	degrees Celsius
CAP88-PC	Clean Air Package 1988 (EPA software program for estimating doses)
CEDE	collective effective dose equivalent
CFR	Code of Federal Regulations
Ci	curie(s)
Ci/s	curie(s) per second
CL	Concentration Level
cm	centimeter(s)
cm/yr	centimeter(s)/year
Co	Cobalt
Cs	cesium
CY	calendar year
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DPF	Dense Plasma Focus
DRA	Desert Rock Meteorological Observatory
DU	depleted uranium
EDE	effective dose equivalent
EPA	U.S. Environmental Protection Agency
Eu	europium
°F	degrees Fahrenheit
FFACO	*Federal Facility Agreement and Consent Order*
ft	foot or (feet)
ft^3/min	cubic feet per minute
g	gram(s)
GBq	gigabecquerel
^3H	tritium
HEPA	high-efficiency particulate air
HTO	tritiated water
in.	inch(es)
in./yr	inch(es) per year
I	iodine
JASPER	Joint Actinide Shock Physics Experimental Research
km	kilometer(s)
km^2	square kilometers
Kr	krypton
L	liter(s)
LLW	low-level waste
m	meter(s)
m^3	cubic meter(s)
mCi	millicurie(s)
MEDA	Meteorological Data Acquisition
MEI	maximally exposed individual
mi	mile(s)
mi^2	square mile(s)
MIDNET	Meteorological Integrated Data Network

List of Acronyms and Abbreviations (continued)

mph	miles per hour
mrem/yr	millirem per year
m/s	meter(s) per second
NESHAP	National Emission Standards for Hazardous Air Pollutants
NLVF	North Las Vegas Facility
NNSA/NSO	National Nuclear Security Administration Nevada Site Office
NOAA	National Oceanic and Atmospheric Administration
NTS	Nevada Test Site
NTTR	Nevada Test and Training Range
pCi/L	picocurie(s) per liter
$pCi/m^2/s$	picocurie(s) per square meter per second
pCi/m^3	picocurie(s) per cubic meter
Pu	plutonium
rem	roentgen equivalent man
RWMS	Radioactive Waste Management Site
s	second(s)
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
VERB	Visual Examination and Repackaging Building
µrem/yr	microroentgen equivalent man per year
µR/yr	microroentgen per year
Xe	xenon
yr	year(s)

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Report Information

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National Nuclear Security Administration
Nevada Site Office
Air Emissions Annual Report
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SECTION I
FACILITY INFORMATION

SITE DESCRIPTION

The Nevada Test Site (NTS) 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 and the activities listed below. Located in Nye County, Nevada, the site's southeast corner is about 105 kilometers (km) (65 miles [mi]) northwest of the major population center, Las Vegas, Nevada. The NTS covers about 3,561 square kilometers (km^2) (1,375 square miles [mi^2]), an area larger than Rhode Island. Its size is 46 to 56 km (28 to 35 mi) east to west and from 64 to 88 km (40 to 55 mi) north to south. The NTS is surrounded, except on the south side, by public exclusion areas (Nevada Test and Training Range [NTTR]) that provide another 24 to 104 km (15 to 65 mi) between the NTS and public lands (Figure 1.0). The NTS is characterized by desert valley and Great Basin mountain topography, with a climate, flora, and fauna typical of the southwest deserts. Population density within 80 km (50 mi) from the NTS boundary is about 1.2 person/km^2 (3.2 persons/mi^2). Restricted access, low population density in the surrounding area, and extended wind transport times are advantageous factors for the activities conducted at the NTS.

The North Las Vegas Facility (NLVF) is a fenced complex composed of 31 buildings which house much of the NTS 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

The sources of radionuclides include current and previous activities conducted on the NTS (Figure 2.0). The NTS was the primary location for testing of nuclear explosives in the Continental U.S. between 1951 and 1992. Historical testing has 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 (U.S. Department of Energy [DOE], 1996a; 2008). No nuclear tests have been conducted since September 23, 1992 (DOE, 2000). Radionuclides remaining in the soil in some NTS areas have the potential to become suspended into the atmosphere at concentrations that can be detected by onsite air sampling stations. Tritium (^3H) in building materials and shallow groundwater associated with the basement of Building A-1, NLVF, is also emitted at low levels to the atmosphere. This report, and those produced since 1992, have shown that these airborne radionuclides are well within the limit established by the Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAP) of 10 millirem per year (10 mrem/yr) to the public from NTS sources.

Programs and activities involving radioactive materials include:

- disposal of water removed from the sump well below Building A-1, NLVF
- Underground Test Area (UGTA) Sub-Project pumping contaminated water to the surface from wells used to characterize the aquifers at the sites of past underground nuclear tests
- pulsed neutron generator activities at the Dense Plasma Focus (DPF) Facility
- operation of radioactive waste management sites (RWMSs) for low-level radioactive and mixed waste
- dynamic experiments and hydrodynamic tests at the Big Explosives Experimental Facility (BEEF)
- subcritical experiments at U1a

- Environmental Restoration projects
- analytical laboratory operations
- handling, transport, storage, and assembly of radioactive targets for the Joint Actinide Shock Physics Experimental Research (JASPER) gas gun
- Borehole Management projects
- special research projects

Monitoring and evaluation of these possible radionuclide air emissions indicate that the potential sources of offsite radiation exposure in calendar year (CY) 2008 were releases from those further described in the following six subsections.

North Las Vegas Facility

At the NLVF, parts of the Building A-1 basement were contaminated with ^{3}H in 1995. The incident involved the release of ^{3}H as HTO and led to a very small potential exposure (<0.001 mrem/yr) to an offsite person. The HTO emission has continued at lower levels through emanation from building materials into air that is exhausted from the building through the ventilation system. A description of the incident and the potential effective dose equivalent (EDE) for offsite exposure during CY 2008 are presented in Appendix A.

Evaporation of Contaminated Groundwater

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.

Historically, radionuclide contaminated water seeped from multiple open tunnels in Area 12. In recent years these tunnels have been successfully sealed except E Tunnel. Water continuing to flow from the E Tunnel is collected in ponds resulting in water evaporation and seepage into the soil. The only radiological contaminant that produces a measurable air emission from this evaporating water is ^{3}H as HTO. Calculation of this emission source for CY 2008 is described in Appendix B.

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 measureable air emission from this evaporating water is ^{3}H as HTO. During CY 2008, water containing tritium was pumped from Wells UE-2ce, U-4u PS #2A, and U-19ad PS #1A (Figure 2.0). Calculations of the tritium emissions from these sources are described in Appendix B.

Tritium attributed to the same 1995 NLVF incident described above also affected a vacant radiation source well that had been filling with water due to the soil bottom in the well and a rise in groundwater. This source well was removed in 2001 and a pump installed to remove the residual tritium contaminated water. The State of Nevada has approved the disposal of the water using evaporative coolers outside the north side of Building A-1 and by disposal in the Area 5 Sewage Lagoon at the NTS when the evaporative coolers are not effective. Calculation of tritium emissions from the evaporative coolers and the Area 5 Sewage Lagoon during CY 2008 are described in Appendices A and B, respectively.

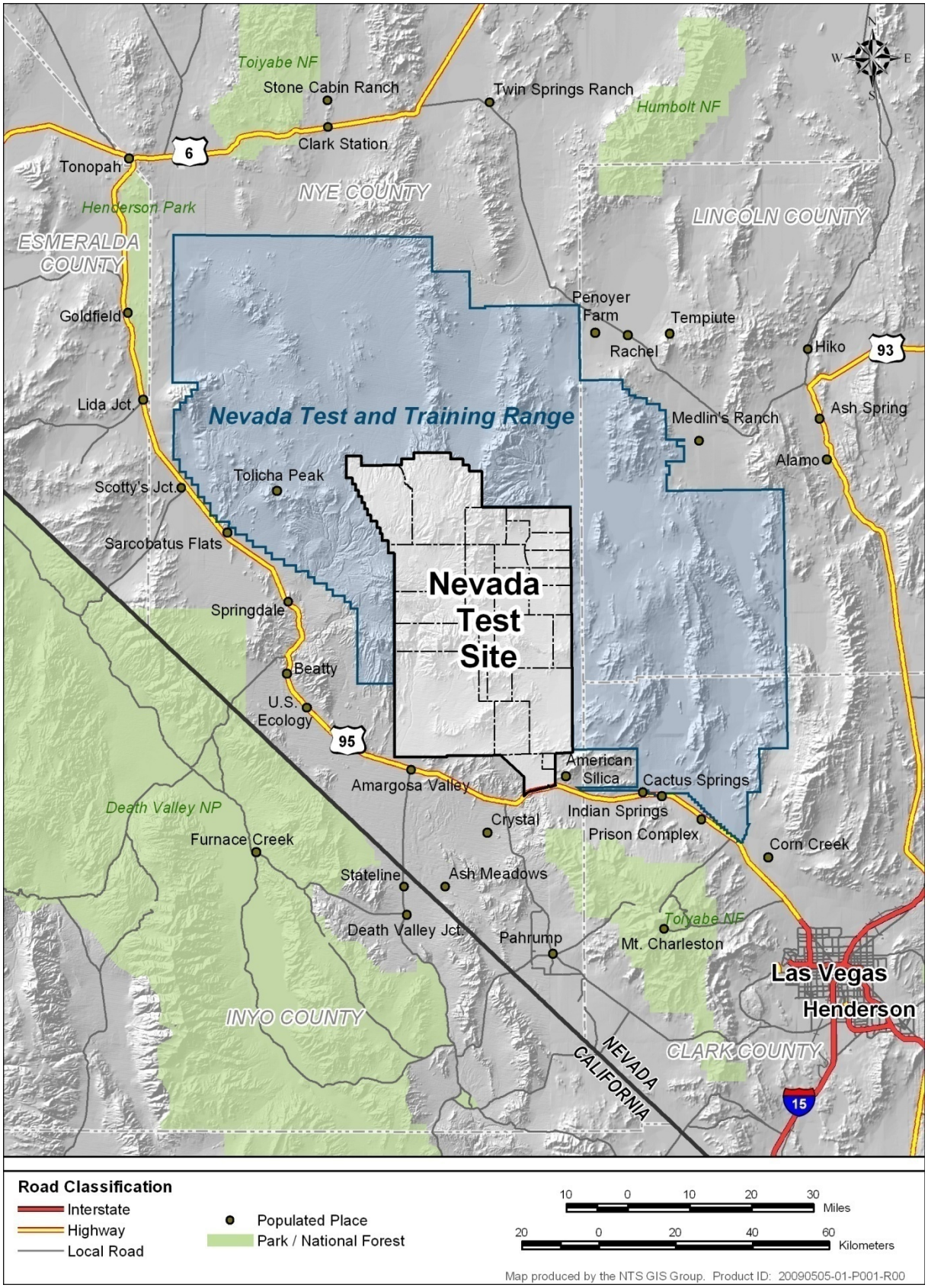

Figure 1.0 NTS and Surrounding Populated Area

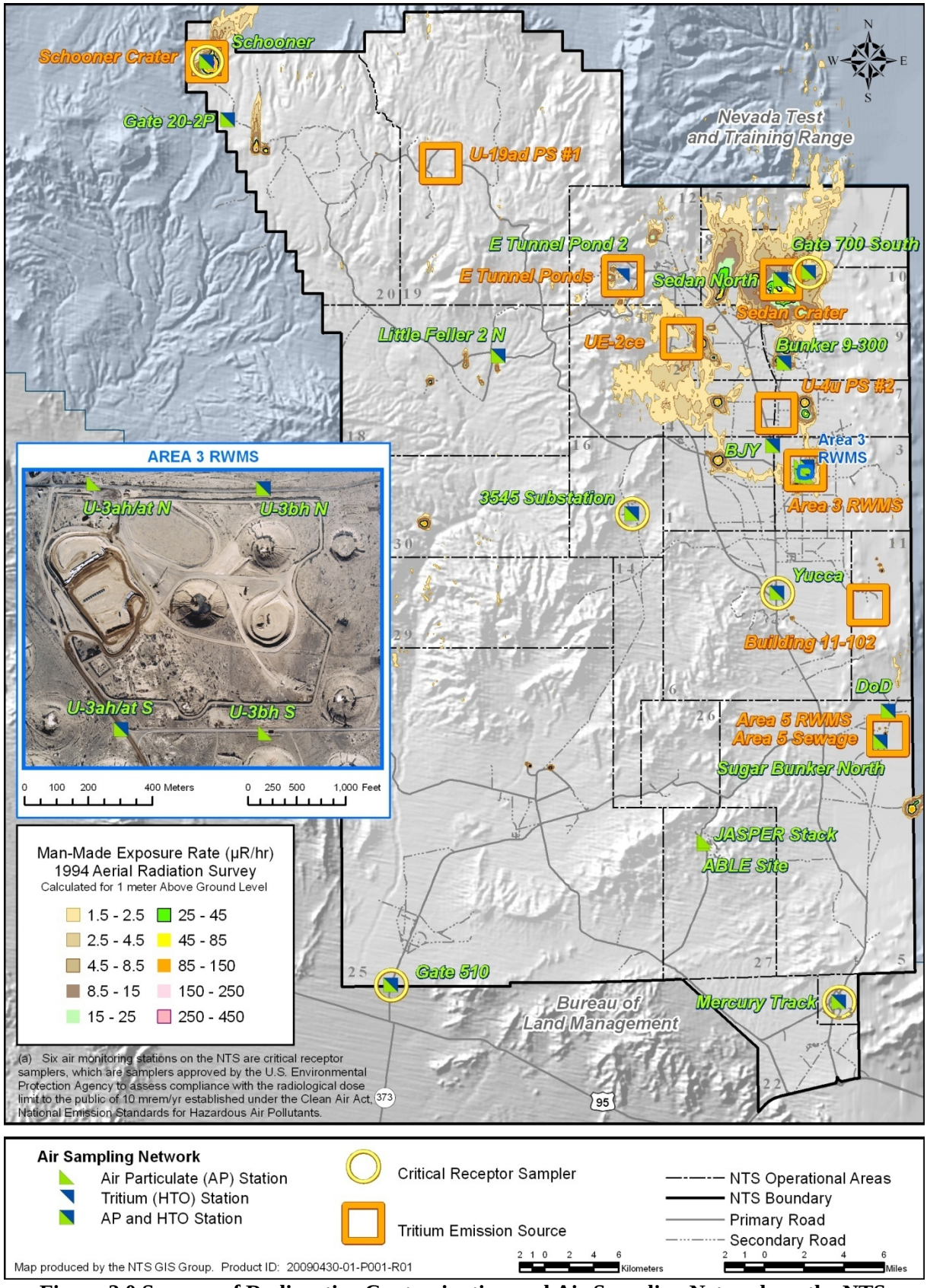

Figure 2.0 Sources of Radioactive Contamination and Air Sampling Network on the NTS

DPF Facility

NTS operations began at the DPF Facility, Building 11-102, in 2007. This operation produces a neutron flux using a deuterium-tritium reaction, which has the potential for small tritium emissions to air. A 2006 NESHAP evaluation of a maximum release of 2 kilocuries of tritium gas from this facility predicted an EDE of 0.86 microrem per year (µrem/yr) to a maximally exposed individual (MEI) offsite. Operations during CY 2008 released a fraction of the potential maximum to air. The tritium emission from this source is described in Appendix C.

Radioactive Waste Management Sites

The Area 3 RWMS and the Area 5 RWMS are used for the disposal of packaged, dry low-level waste (LLW) in pits and trenches. The Area 5 RWMS is also used for 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 Visual Examination and Repackaging Building (VERB) is also located at the Area 5 RWMS. Results of a NESHAP evaluation conducted for activities performed at the VERB (0.00077 µrem/yr to the MEI) were reported in the NESHAP report for CY 2007 (NSTEC, 2008). Both Area 3 and Area 5 facilities are considered a diffuse source of radiological effluents. The only radioactive emission detected by the various types of samplers located downwind of these sites and attributed to site operations was tritium as HTO in atmospheric moisture. The calculation of the tritium source term for these emissions in CY 2008 is described in Appendix D.

Surface Areas Contaminated with Tritium, Plutonium, or Americium

Tritium released from the Sedan and Schooner craters dominates diffuse tritium sources on the NTS. Tritium associated with these cratering tests quickly oxidized into tritiated water which remains in the surrounding soil until it is brought to the surface through evapotranspiration. Tritium emanation from the Sedan and Schooner craters was detectable in atmospheric moisture samples collected on molecular sieves by special air samplers. Derivation of the tritium emissions for these locations is described in Appendix D.

Surface soils in some areas on the NTS were contaminated with plutonium and/or tritium from past nuclear device safety, atmospheric, or cratering tests, using nuclear explosives. An investigation of these areas during the Nevada Applied Ecology Group studies, updated by the Desert Research Institute (DOE, 1991), developed an inventory of radionuclides (Table 1.0). The inventory is an estimate of the curies (Ci) of each radionuclide in surface soil, where surface soil is defined as soil within 0–30 centimeters (cm) (0-12 inches [in.]) of the surface within each study area.

These contaminated areas on the NTS 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. Figure 2.0 shows the approximate locations of the contaminated areas based upon an aerial survey conducted in 1994. These areas are considered diffuse sources of radioactive emissions. The derivation of the radioactive emissions for these NTS contaminated areas is described in Appendix E.

BEEF

High explosives experiments are conducted at BEEF. Some of these may incorporate depleted uranium (DU) or tritium. Only about five percent of the depleted uranium used in experiments is aerosolized, but all of the tritium can be assumed to escape to the atmosphere. Preoperational predictions of the dispersion of DU and tritium using the EPA recommended Clean Air Package 1988 (CAP88-PC) model indicated

that the potential maximum EDE for DU was 0.0014 mrem/yr offsite and only 0.0042 mrem/yr for tritium at 50 km (31 mi) from the release point. The dose estimate for an offsite MEI from CY 2008 DU emissions is described in Appendix F.

Table 1.0 Inventory of ^{241}Am, ^{238}Pu, and $^{239+240}$Pu in Surface Soil[(a)] at the NTS

NTS Administrative Area Studied	Study Site Area in mi^2 / Percent of Total Administrative 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 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.

Programs and Activities with No Radioactive Emissions in CY 2008

Programs and activities that deal with radioactive materials but did not have emissions to air during CY 2008 are described below. These are provided for information of other potential sources of air emissions.

U1a

Subcritical experiments are conducted at U1a. However, it is improbable that radioactive emissions would be released into the atmosphere during the preparation and performance of subcritical experiments due to their deep underground location and the small amount of radioactive materials involved.

Environmental Restoration
Under the *Federal Facility Agreement and Consent Order* (FFACO) between the DOE, the U.S. Department of Defense, and the State of Nevada (FFACO, 1996), radioactive soil contamination generated by historical NTS activities is addressed. NTS Environmental Restoration projects that involved the removal and haulage of materials and soil containing low concentrations of radioactivity are evaluated for potential radionuclide emissions to air and potential dose offsite. These are performed in accordance with 40 CFR 61, Subpart H requirements (CFR, 2008a). Projects conducted during CY 2008 had NESHAP evaluations which were reported in the 2007 annual report (NSTec, 2008). No new projects were evaluated during CY 2008.

Laboratories
Radiological analyses were conducted in laboratories located in Area 23 Buildings 650 and 652 (in Mercury), Building CP-95A (in Area 6), and the Device Assembly Facility (in Area 6). But because these facilities process environmental samples, very little radioactivity passes through them. In CY 2008 no radionuclides were released to air from NTS laboratories. Non-volatile radioactive standards and sealed radiation sources were controlled in accordance with Title 10 Code of Federal Regulations (CFR) Part 835, *Occupational Radiation Protection* (CFR, 2008b). More details on these potential sources are listed in Appendix C.

JASPER
Approval by the U.S. Environmental Protection Agency (EPA) was obtained in June 1999 for construction of the JASPER gas gun in Building 5100 in Area 27. Beginning in 2003 experimentation began using special nuclear material and other actinide materials as targets. As required by EPA Region 9, a stack monitoring system was installed downstream of high-efficiency particulate air (HEPA) filters to assure that the emissions are in conformance with NESHAP. Analyses of samples from this stack monitoring system detected no radioactive emissions from experiments conducted during CY 2008.

Borehole Management Project
The current primary objective of the Borehole Management Project is to plug NTS legacy boreholes for which there is no future use. During the course of executing the field work, there is a potential for encountering radiological contamination that may become airborne. Operations during CY 2008 did not result in measurable emissions of radioactivity.

Research Projects
Multiple research projects are conducted on the NTS by national laboratories or other outside organizations. Many of these involve the use of radioactive sources (sealed radioactive sources in most cases). No such research conducted during CY 2008 resulted in a release of radioactivity to the air.

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SECTION II
AIR EMISSIONS DATA

Each potential source of NTS emissions was characterized by one of the following methods:

- monitoring methods using procedures previously developed at the NTS;
- measuring radionuclide inventory in laboratories and identifying losses of radionuclides that were released to the environment;
- measuring HTO concentrations in liquid effluents discharged to containment ponds and assuming all the effluent evaporates over the course of the year to become an air emission;
- using re-suspension calculations; and
- using a combination of environmental measurements and the CAP88-PC air dispersion model (EPA, 2006) to calculate the emissions.

In accordance with 40 CFR 61.93 (b)(4)(ii) (CFR, 2008a), no credit was taken for pollution control equipment in determining air emissions. The emissions for NESHAP reporting are listed in Table 2.0. Appendices A through E describe the methods used to determine the emissions from the sources listed in Table 2.0.

Table 2.0 Summary of CY 2008 Air Emissions Data by Source

Source Type[(a)]	Type of Emissions Control	Distance to Nearest Member of the Public	Nuclide	Annual Quantity (Ci)
Point Sources				
Building A-1, NLVF [(a)]	None	0.1 km (0.06 mi)	^{3}H	0.011
DPF Facility	None	36 km (22 mi)	^{3}H	300
Area Sources				
E Tunnel Ponds	None	50 km (31 mi)	^{3}H[(b)]	9.1
Area 3 RWMS	None	47 km (29 mi)	^{3}H[(c)]	27
Area 5 RWMS	None	36 km (22 mi)	^{3}H[(c)]	2.1
Schooner	None	20 km (12 mi)	^{3}H[(c)]	33
Sedan	None	50 km (31 mi)	^{3}H[(c)]	68
Well UE-2ce	None	58 km (36 mi)	^{3}H[(b)]	0.035
Well U-4u PS #2A	None	56 km (35 mi)	^{3}H[(b)]	0.44
Well U-19ad PS #1A	None	44 km (28 mi)	^{3}H[(b)]	1.0
Area 5 Sewage Lagoon	None	36 km (22 mi)	^{3}H[(b)]	0.00069
BEEF	None	59 km (37 mi)	DU[(d)]	0.060
Grouped Area Sources				
All NTS Areas	None	20-60 km (12 – 37 mi)	^{241}Am[(e)]	0.047
All NTS Areas	None	20-60 km (12 – 37 mi)	^{238}Pu[(e)]	0.050
All NTS Areas	None	20-60 km (12 – 37 mi)	$^{239+240}Pu$[(e)]	0.29

(a) All locations are at the NTS except Building A-1 in North Las Vegas.
(b) Emission based on tritiated water discharged into containment pond(s) or on the ground.
(c) Emission based on environmental surveillance results and CAP88-PC software
(d) Conservative emission based on source-term; see Appendix C.
(e) Sum of emissions estimated from re-suspension model; see Table E.1 for individual area estimates.

A summary of the NTS total CY 2008 emissions for NESHAP reporting, by radionuclide, is provided in Table 3.0. A summary of the NLVF total CY 2008 emissions is provided in Table 4.0.

Table 3.0 Total Estimated NTS Emissions for CY 2008

Radionuclides	2008 Total Quantity (Ci)
^{3}H	440
DU	0.060
^{241}Am	0.047
^{238}Pu	0.050
$^{239+240}Pu$	0.29

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

Table 4.0 Total Estimated NLVF Emissions for CY 2008

Radionuclide	2008 Total Quantity (Ci)
^{3}H	0.011

SECTION III
DOSE ASSESSMENTS

DOSE ASSESSMENT METHOD

The NTS demonstrates compliance with dose limits using environmental measurements of radionuclide air concentrations near the NTS 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 NTS in 2001 (EPA, 2001) 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 2.0.

- 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, but they are used as such to conservatively represent hypothetical offsite critical receptors.

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 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 5.0). If multiple radionuclides are detected, then 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 comparisons for CY 2008 air sampling results from the six compliance stations are presented in Table 5.0.

COMPLIANCE ASSESSMENT

Table 5.0 lists the average concentrations of detected radionuclides and their fraction of the NESHAP compliance level for each of the six NTS critical receptor stations. The concentration average for each detected man-made radionuclide was below two percent of the CLs except for the tritium average at the Schooner sampler station, which was about 19 percent of the CL. The average concentration of tritium is high at Schooner because the air sampler is only 269 meters (m) (883 feet [ft]) from the center of the crater and located within the area that received ejecta from the cratering experiment (Figure 3.0). At the Schooner station, the highest sum of the fractions of measured annual concentrations divided by the NESHAP CL for each radionuclide was 0.19, well below 1.0 and therefore in compliance with NESHAP. Scaling this sum of fractions to the 10 mrem/yr limit gives an estimated EDE of only 1.9 mrem/yr from air emissions for a hypothetical individual living year-round at this station. The MEI, in a sense, may now be considered to hypothetically reside at the onsite Schooner critical receptor location, a much more conservative assumption for public exposure to NTS radionuclide air emissions. Figure 4.0 displays the sum of fraction results for the Schooner station from 2001 to 2008.

No one resides at Schooner or along the borders near the air sampling stations. The dose at offsite populated locations 20–80 km (12–50 mi) from the Schooner station would be much lower due to wind

dispersion, and likely much less than 1 mrem/yr. For comparison, MEI dose estimates made using CAP88-PC software from 1992 through 2004 are displayed in Figure 5.0.

Table 5.0 Average Radionuclide Concentrations at NTS Critical Receptor Stations and Fraction of Compliance Level (CL), CY 2008

Location	Radionuclide	Average Concentration in Air (pCi/m^3)[(a)]	CL[(b)] (pCi/m^3)	Average Concentration as Fraction of CL
Yucca	^{3}H	0.32×10^{-0}	1500	0.0002
Gate 700		0.41×10^{-0}		0.0003
Substation 3545		0.24×10^{-0}		0.0002
Schooner		279.87×10^{-0}		0.1866
Mercury		0.20×10^{-0}		0.0001
Gate 510		0.09×10^{-0}		0.0001
Yucca	^{241}Am	4.49×10^{-6}	0.0019	0.0024
Gate 700		2.37×10^{-6}		0.0012
Substation 3545		0.59×10^{-6}		0.0003
Schooner		4.52×10^{-6}		0.0024
Mercury		1.37×10^{-6}		0.0007
Gate 510		0.74×10^{-6}		0.0004
Yucca	^{238}Pu	3.02×10^{-6}	0.0021	0.0014
Gate 700		1.65×10^{-6}		0.0008
Substation 3545		0.48×10^{-6}		0.0002
Schooner		5.11×10^{-6}		0.0024
Mercury		-0.75×10^{-6}		0.0000
Gate 510		2.70×10^{-6}		0.0013
Yucca	$^{239+240}Pu$	24.82×10^{-6}	0.0020	0.0124
Gate 700		6.78×10^{-6}		0.0034
Substation 3545		1.67×10^{-6}		0.0008
Schooner		3.54×10^{-6}		0.0018
Mercury		3.56×10^{-6}		0.0018
Gate 510		1.60×10^{-6}		0.0008
Yucca	Sum of Fractions by Location			0.0164
Gate 700				0.0057
Substation 3545				0.0015
Schooner				0.1932
Mercury				0.0026
Gate 510				0.0026

(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, 2008a)

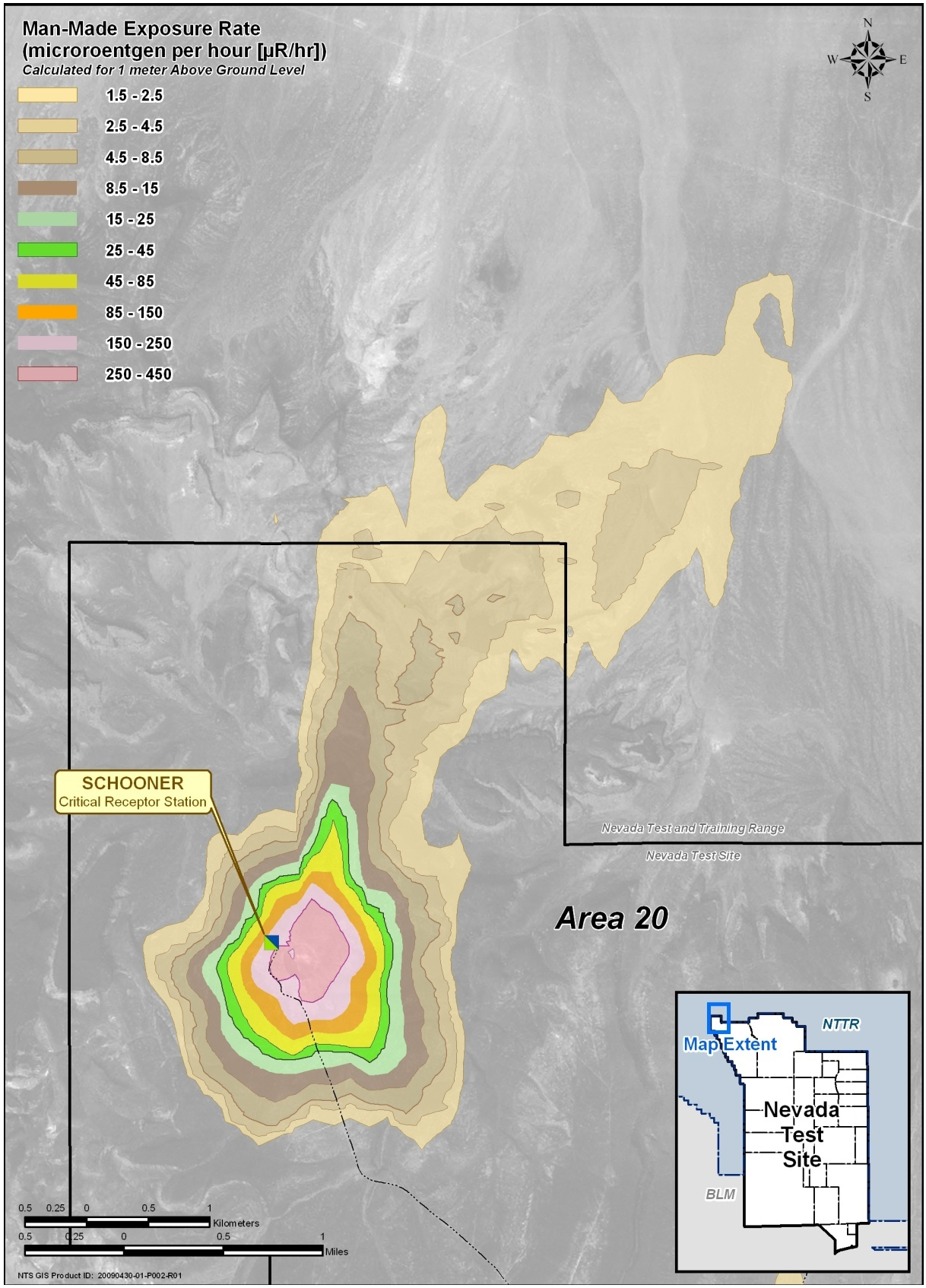

Figure 3.0 Schooner Critical Receptor Air Sampling Station

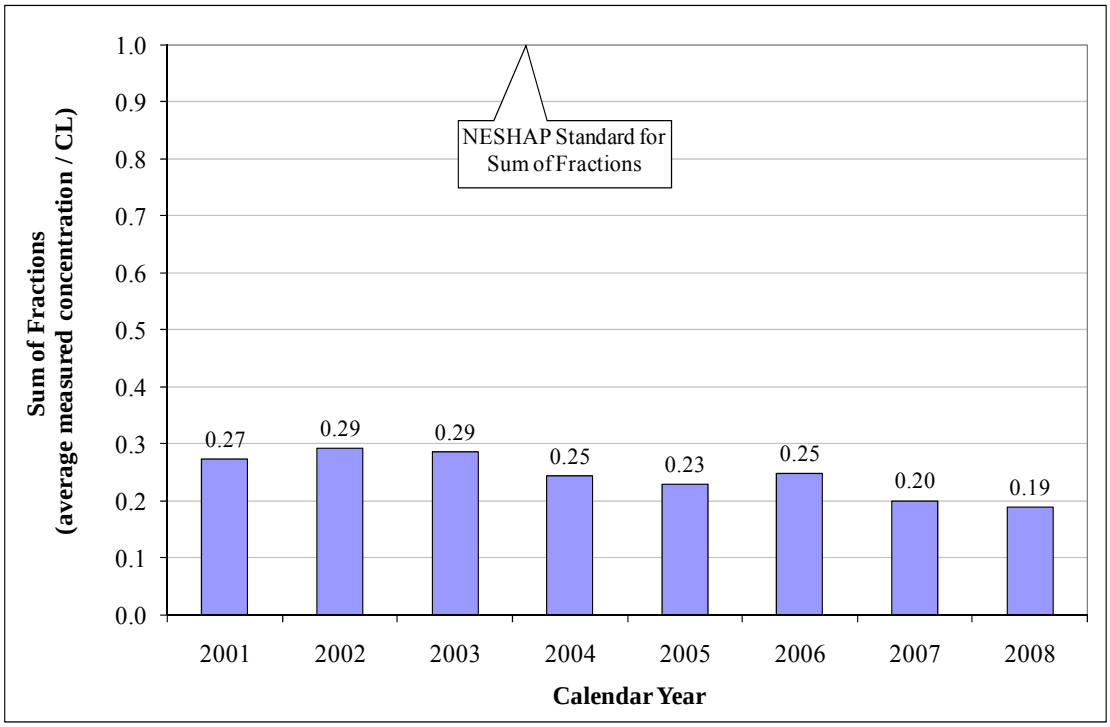

Figure 4.0 Sum of Fractions (Annual Average Radionuclide Concentrations Divided by CLs) for the Schooner Critical Receptor Location, CY 2001 to CY 2008

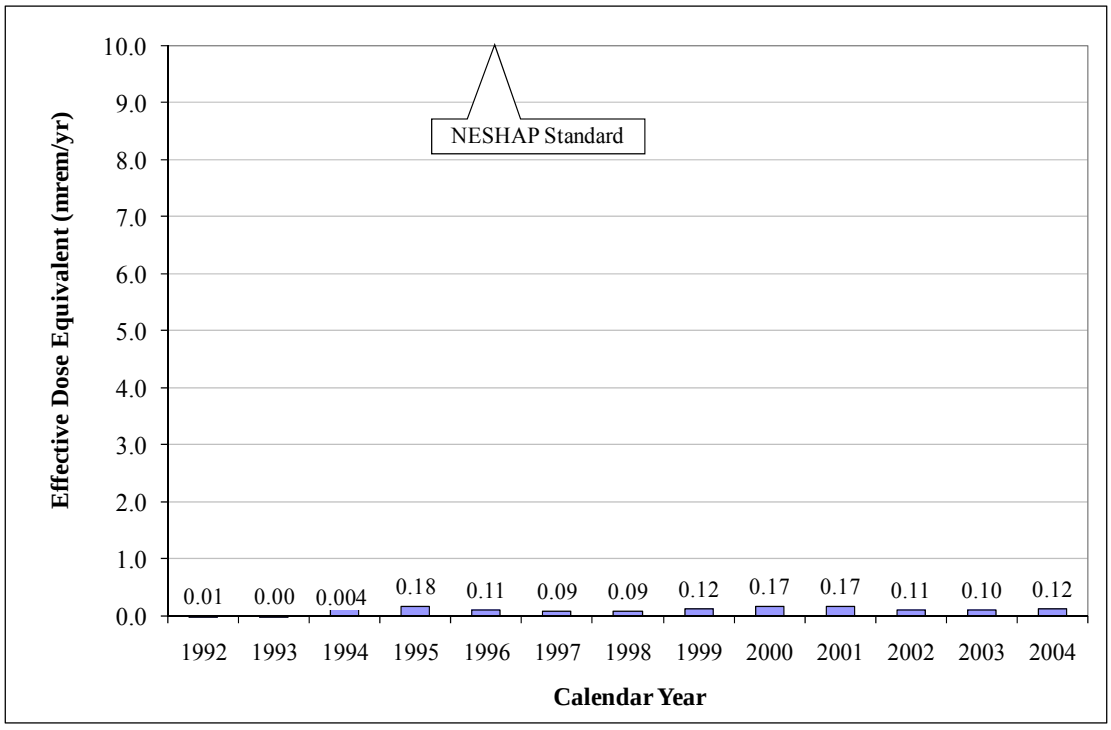

Figure 5.0 Effective Dose Equivalent to Offsite MEI prior to use of On Site Critical Receptor Stations

SECTION IV
ADDITIONAL INFORMATION

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

No new construction or modifications were conducted on the NTS that increased the rate of radionuclide emissions to air. Two projects, however, were evaluated during CY 2008 to determine if they 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 point-source operational monitoring. Periodic confirmatory measurements are required by 40 CFR Section 61.93 (b) (4)(i) (CFR, 2008a) to ensure an emission source is still a minor source. Summaries of these assessments are listed below with a more detailed description of the dose evaluations in Appendix F.

- BEEF conducted experiments that emitted DU to air. The CAP88-PC dose estimate conservatively assumed all DU used went airborne as respirable particles when in reality the vast majority ended up as large particulates that quickly settled to the ground. It also assumed that the wind was blowing 100 percent of the time towards the nearest offsite resident. Even with these conservative assumptions, the dose estimate was 0.048 mrem/yr at Amargosa Valley, 58 km (36 mi) south-southwest of BEEF.

- A periodic confirmatory assessment was made to determine whether unfiltered air pumped from the confinement chamber at the JASPER facility is still a minor source. This re-assessment was prompted primarily by the new potential for re-suspension of surface contamination in the confinement chamber during the evacuation of air. Using updated estimates of target material to be used at JASPER with the 10^{-6} emission factor [per 40 CFR 61 Appendix D for solids (CFR, 2008a)] and survey results of surface contamination in the chamber, a CAP88-PC dose estimate was conducted. With the conservative assumption that the wind blew 100 percent of the time towards the nearest offsite resident, the dose estimate was 0.0013 mrem/yr at Amargosa Valley 29 km (18 mi) west-southwest of the JASPER facility.

UNPLANNED RELEASES DURING CY 2008

No unplanned releases occurred during CY 2008.

SOURCES OF EMISSIONS

In summary, all sources of radionuclide emissions from the NTS and the NLVF that were identified and characterized in CY 2008 include the following:

- Tritium emission from Building A-1 basement ventilation system (see Appendix A)

- Evaporation of tritium contaminated groundwater from

    - Area 5 Sewage Lagoon, which received liquid effluents from the Building A-1 basement at the NLVF (see Appendix B)
    - E Tunnel containment ponds in Area 12, which received water seeping from the Tunnel complex (see Appendix B)

  - UGTA well pumping activities (see Appendix B)
  - Evaporation of tritiated water from the Building A-1 basement source well at the NLVF (see Appendix B)

- Release of tritium gas during operations at the DPF Facility (see Appendix C)

- Evapotranspiration of tritium from the Sedan and Schooner craters and from the Area 3 and Area 5 RWMSs (see Appendix D)

- Re-suspension of ^{241}Am, ^{238}Pu, and $^{239+240}Pu$ from soil deposits on the NTS areas (see Appendix E)

- Release of DU from BEEF (See Appendix F)

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: 6/16/09

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APPENDICES

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Appendix A

PUBLIC DOSE CALCULATIONS FOR THE RELEASE OF TRITIUM FROM THE A-1 BUILDING, 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-1 at the North Las Vegas Facility (NLVF) area and emitted at least 1 curie 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 2008, air sampling for HTO in the basement was conducted intermittently. For calendar year 2008, the results of two atmospheric moisture samples were 273 picocuries per cubic meter (pCi/m^3) for the sample collected April 14 to April 21, 2008 and 459 pCi/m^3 for the sample collected September 8 to September 16, 2008. As there is a small number of samples collected each year, an average of all samples over the past six years (2003 through 2008) was used to determine the emission rate by multiplying it (995 pCi/m^3) by the ventilation rate (673 ft^3/min) as follows:

$$\frac{995\ pCi}{m^3} \times \frac{673\ ft^3}{min} \times \frac{0.02832 m^3}{ft^3} \times \frac{525{,}600\ min}{yr} \times \frac{1 \times 10^{-9} mCi}{pCi} = 10 \frac{mCi}{yr}$$

An additional 1.1 mCi/yr of tritium was released from Building A-1 by evaporating water from the radiation source well, resulting in a total emission of 11.1 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 2008 gave an estimated EDE to the nearest member of the public outside the perimeter fence of

$$11.1 \frac{mCi}{yr} \times 5.0 \times 10^{-6} \frac{mrem/yr}{mCi/yr} = 0.00006\ mrem/yr$$

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

Table A.1. Comparison of Tritium Emission Rates from Building A-1, NLVF from 1995 to 2008

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

Appendix B

CALCULATION OF TRITIUM EMISSIONS FROM CONTAMINATED GROUNDWATER DISCHARGED TO THE SURFACE OF THE NTS

During calendar year 2008, the air emissions of tritium as tritiated water from Nevada Test Site (NTS) ponds containing tritium were conservatively estimated from the product of the volume of water discharged into the ponds, or to the ground, and measurements of the tritium content of the water using the following formula:

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

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 5 Sewage Lagoon is measured as it is removed from the basement of Building A-1, North Las Vegas Facility. Samples of the water were collected twice during CY 2008 to determine the tritium concentration.

Water from the wells listed in Table B.1 is purge water from UGTA Sub-Project sampling activities. The volume of water purged from each well is calculated by pump rates multiplied by time, and the tritium concentrations of the well water are determined by either Los Alamos National Laboratory or Lawrence Livermore National Laboratory.

Table B-1 lists the values used to make emission estimates.

Table B.1 Tritium Concentrations, Water Volumes, and Estimate Tritium Emissions from Contaminated Groundwater Brought to the Surface at the NTS

Location	Tritium Concentration (pCi/L)[(a)]	Water Volume (L)[(b)]	Tritium Emission (Ci)[(c)]
E Tunnel Ponds	5.84×10^{5}	1.56×10^{7}	9.1
Area 5 Sewage Lagoon	1.91×10^{3}	3.63×10^{5}	0.00069
Well UE-2ce	2.60×10^{5}	1.34×10^{5}	0.035
Well U-4u PS #2A	2.10×10^{7}	2.10×10^{4}	0.44
Well U-19ad PS #1	1.10×10^{7}	9.46×10^{4}	1.0

(a) pCi/L = picocurie(s) per liter
(b) L = liters
(c) Ci = curie(s)

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Appendix C

POTENTIAL RADIONUCLIDE EMISSIONS FROM POINT SOURCES

Building 650

Following the closure of the Analytical Services Laboratory in Area 23, Building 650, all of the standards, check sources, and tracer solutions were stored in the basement pending disposal. From an inventory of these radioactivity sources, only three of them, listed below with their curie (Ci) content assessed during calendar year (CY) 2002, are volatile and could become sources of air emissions.

Tritium (^{3}H) (as tritiated water)	3.0×10^{-4} Ci
Krypton-85 (^{85}Kr)	8.7×10^{-2} Ci
Iodine-129 (^{129}I)	5.4×10^{-7} Ci

All of the standards and solutions were maintained in accordance with Title 10 Code of Federal Regulations Part 835, *Occupational Radiation Protection*. No portion of these sources were released or consumed during CY 2008. Also, no tritium was released from the Instrument Shop during calibration activities because new equipment was procured that does not require radioactive gas for calibration; therefore, no radionuclide emissions occurred from Building 650 during CY 2008.

Building 652

Potentially contaminated environmental samples are processed in the laboratory in Area 23 Building 652. Some of this processing consists of distillation or enrichment of liquid samples where some small portion of the sample is lost and emitted from the laboratory through hoods or the room's ventilation system. Because these are environmental samples, the concentrations are generally low and therefore these potential emissions are negligible.

Los Alamos National Laboratory Building CP-95A – Area 6
Lawrence Livermore National Laboratory Device Assembly Facility – Area 6

The laboratories in these facilities maintain standards containing xenon-133 (^{133}Xe), iodine-131 (^{131}I), and ^{3}H. The use of the standards during CY 2008 did not result in any release to the atmosphere.

Building 11-102 – Area 11
Dense Plasma Focus Facility

During CY 2008, Nevada Test Site (NTS) operations at the Dense Plasma Focus Facility used a deuterium-tritium reaction to create a neutron flux. The following calculation of the total tritium emission is based upon the change in pressure in a tank of tritium gas used in the experiments:

$$\text{Total emission} = (0.0126 \text{ mol})(24318.26 \text{ Ci/mol}) \approx 300 \text{ Ci released}$$

A 2006 evaluation using CAP88-PC used 2,000 Ci of tritium released. The resultant dose to the MEI was only 0.00086 mrem/yr at Cactus Springs, 46 km (29 mi) south of Building 11-102. The amount of tritium released during CY 2008 is about seven 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.

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Appendix D

TRITIUM EMISSIONS ESTIMATED FROM AIR SAMPLING DATA

BACKGROUND INFORMATION

There are 19 sampling stations referred to as environmental samplers on the Nevada Test Site (NTS). They include 3 stations that have only low-volume air particulate samplers, 1 that has only a tritium sampler, and 15 that have both air particulate and tritium samplers - six of which are designated as critical receptor locations. They are located throughout the NTS in or near the highest diffuse radiation sources. Figure 2.0 of this report shows the current NTS air sampling station locations.

SOURCE TERM ESTIMATES

CAP88-PC was used to estimate the tritiated water (HTO) concentration that would be detected at each NTS air sampler if 1 curie (Ci) of tritium were released from the center of each NTS source location. The total annual emission was then calculated by dividing the annual average concentration of HTO measured at each sampling location by the predicted CAP88-PC concentration for a 1 Ci release.

Table D.1 lists the estimated emissions for each emission source location. Tritium emission from E Tunnel ponds was not estimated from air sampling data because the total volume of water and tritium concentration of the water was known, allowing for an estimate described in Appendix B.

Table D.1 Tritium Emissions from Airborne Tritium Sampling Results during CY 2008

Emission Source	Air Sampler	Tritium Concentration (pCi/m^3)[(a)]	CAP88-PC Concentration for 1 Ci Emission (pCi/m^3)	Tritium Emission (Ci)[(b)]
Area 3 RWMS	BJY	0.85	0.032	27[(c)]
	U-3bh N	1.02	0.685	1.5
	U-3ah/at S	1.06	0.320	3.3
Area 5 RWMS	DoD	0.40	0.19	2.1[(d)]
	Sugar Bunker North	0.59	0.44	1.3[(d)]
Area 10 Sedan	Sedan North	5.62	0.273	21[(d)]
	Gate 700	0.41	0.006	68[(d)]
Area 20 Schooner	Schooner	280	0.447	626[(e)]
	Gate 20-2P	0.23	0.007	33

(a) pCi/m^3 = picocuries per cubic meter
(b) 1 Ci = 37 Gigabecquerels (GBq)
(c) Emission estimate likely biased high due to sampler potentially measuring tritium from other sources. Estimate still used for conservatism.
(d) The higher of the two emission estimates for each location was used for that location.
(e) Emission estimate likely biased high due to sampler being too 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 E

EMISSIONS OF AMERICIUM AND PLUTONIUM FROM LEGACY SITES BASED ON HISTORIC SOIL SURVEY DATA AND SOIL RE-SUSPENSION MODEL

BACKGROUND INFORMATION

Areas 1 through 12 and Areas 15 through 30 on the Nevada Test Site (NTS) contain diffuse sources of radionuclides. Historic soil surveys have identified the location of these sources on the NTS 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 NTS 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 NTS. 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 (curies per second [Ci/s]), 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 NTS. 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}/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 hour/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 E.1.

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

Inventory, Re-suspension Factors, and Calculated Emissions by Area								
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}	0.5	1.32	2.05	7.57
2	2.9	8.6	22	2×10^{-10}	0.5	0.91	2.71	6.94
3	4.6	3.1	37	2×10^{-10}	0.5	1.45	0.98	11.67
4	6.6	13	40	2×10^{-10}	0.5	2.08	4.10	12.61
5	0.6	0.1	4.8	2×10^{-10}	0.5	0.19	0.03	1.51
6	1.7	3.3	8.4	2×10^{-10}	0.5	0.54	1.04	2.65
7	2.2	0.6	16	2×10^{-10}	0.5	0.69	0.19	5.05
8	17	8	110	2×10^{-10}	0.5	5.36	2.52	34.69
9	4.2	2.2	89	2×10^{-10}	0.5	1.32	0.69	28.07
10	19	19	110	2×10^{-10}	0.5	5.99	5.99	34.69
11	3.3	0.5	29	2×10^{-10}	0.5	1.04	0.16	9.15
12	5.7	8.5	39	2×10^{-10}	0.5	1.80	2.68	12.30
15	8	7.8	63	2×10^{-10}	0.5	2.52	2.46	19.87
16	0.7	1.5	3.7	2×10^{-10}	0.5	0.22	0.47	1.17
17	2.8	4.5	18	2×10^{-10}	0.5	0.88	1.42	5.68
18	19	5.6	100	2×10^{-10}	0.5	5.99	1.77	31.54
19	21	32	140	2×10^{-10}	0.5	6.62	10.09	44.15
20	23	30	41	2×10^{-10}	0.5	7.25	9.46	12.93
30	3.2	4.5	14	2×10^{-10}	0.5	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 E.1, the estimated total emissions of ^{241}Am, ^{238}Pu, and $^{239+240}$Pu from historic soil inventory data and from the re-suspension model were 47, 50, and 290 mCi/yr, respectively. These are shown in Table 2.0 of this report (as 0.047, 0.050 and 0.29 Ci/yr), which summarizes all measured or computed emissions from the NTS in CY 2008.

OTHER ISOTOPES

The other isotopes that have been found in soil samples in the various areas on the NTS are 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); 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 F

RADIONUCLIDE EMISSIONS FROM ENVIRONMENTAL RESTORATION, WASTE MANAGEMENT, RESEARCH, CONSTRUCTION PROJECTS, AND PERIODIC CONFIRMATORY MEASUREMENTS

ENVIRONMENTAL RESTORATION PROJECTS

No NESHAP evaluations of radioactively contaminated soil or building material removals were conducted during CY 2008. Environmental Restoration work that was conducted during CY 2008 had been previously evaluated and reported in the 2007 NESHAP report (NSTec, 2008).

WASTE MANAGEMENT PROJECTS

No construction/modification activities took place at waste management facilities during CY 2008.

RESEARCH OR CONSTRUCTION PROJECTS

No research or construction projects conducted in CY 2008 resulted in an emission of radionuclides to air.

PERIODIC CONFIRMATORY MEASUREMENTS

Area 4
Big Explosives Experimental Facility (BEEF)

During CY 2008 no tritium was released, but a total of 80 kilograms of depleted uranium (DU) was used in experiments at BEEF. Because there is some contamination in area soils from historic nuclear weapons testing, re-suspension of these at maximum measured concentrations in the area was assumed, resulting in a conservative estimate 1,000 grams (g) of respirable soil (PM-10) suspended. The total amount of activity estimated to have been released is listed in Table F.1. Clean Air Package 1988 (CAP88-PC) modeling was conducted to estimate the offsite dose using the following parameters:

- Wind 4–6 knots (4.6–6.9 miles per hour [mph]), stability class E blowing 100 percent of the time towards offsite resident.
- No precipitation
- Temperature 15.6 degrees Celsius (°C) (60 degrees Fahrenheit [°F])
- Mixing height (height of lid) 1000 meters (m)
- Absolute humidity 5 g per cubic meter (m^3)

Results showed dose to the maximally exposed individual (MEI) predicted by CAP88-PC to be 0.048 millirem per year (mrem/yr) at Amargosa Valley with the contribution from suspended soil making a negligible contribution. Given the very conservative assumptions made when modeling potential dose from BEEF operations and the potential dose being more than two times lower than 0.1 mrem/yr level, it is concluded that BEEF continues to be a minor radionuclide emission source.

Table F.1. Estimated Radionuclide Emissions from BEEF during CY 2008

Nuclide	Curies (Ci) potentially released
^{137}Cs	2.27×10^{-8}
^{152}Eu	6.74×10^{-10}
^{241}Am	2.78×10^{-9}
^{90}Sr	2.95×10^{-8}
$^{233+234}U$	3.00×10^{-2}
^{235}U	4.30×10^{-4}
^{238}U	3.00×10^{-2}
^{238}Pu	5.56×10^{-9}
$^{239+240}Pu$	1.67×10^{-8}

Area 27
Joint Actinide Shock Physics Experimental Research (JASPER)

A reassessment of air emitted from a vacuum system used to evacuate the JASPER primary and secondary confinement chambers was conducted to include current projections of source material used and potential surface contamination found inside the chambers. The total amount of activity potentially released is listed in Table F-2. CAP88-PC modeling was conducted to estimate the offsite dose using the following parameters:

- Wind 4–6 knots (4.6–6.9 mph), stability class E blowing 100 percent of the time towards offsite resident
- Annual precipitation 15.2 centimeters (6 inches)
- Temperature 19°C (66°F)
- Mixing height (height of lid) 1000 m
- Absolute humidity 4 g per m^3

Results showed dose to the MEI predicted by CAP88-PC to be 0.0013 mrem/yr at Amargosa Valley. Given the conservative assumptions made when modeling potential dose from JASPER and the dose being more than 70 times lower than 0.1 mrem/yr level, it is concluded that the vacuum system used to evacuate the JASPER confinement chambers is a minor radionuclide emission source.

Table F.2. Total Potential Emission from JASPER Unfiltered Vacuum Pumps

Potential Annual Emission (Ci)					
^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{241}Am
6.7E-06	7.5E-05	1.8E-05	1.9E-04	2.0E-09	2.1E-05

Appendix G

IDENTIFICATION AND JUSTIFICATION FOR THE DEVELOPMENT OF METEOROLOGICAL DATA USED AS INPUT TO CLEAN AIR PACKAGE 1988 (CAP88-PC)

SITE CHARACTERISTICS

The Nevada Test Site (NTS) is located in southern Nevada, approximately 105 kilometers (km) (65 miles [mi]) northwest of Las Vegas, Nevada, and encompasses an approximate rectangular area of 3,561 square kilometers (km^2) (1,375 square miles [mi^2]). Topography is complex with generally north-south oriented ridges and valleys typical of Nevada. Terrain elevations range from almost 823 meters (m) (2,700 feet [ft]) in the extreme southwest corner of the NTS (Area 25) to almost 2,347 m (7,700 ft) on Rainier Mesa in the northern part of the NTS (Area 12).

In general, terrain slopes gently into broad valleys. In the few areas where steep canyons or cliffs exist, adequate wind and temperature data have been collected and analyzed to provide thorough documentation of the existence of typical up-slope and down-slope wind regimes as a function of time of day.

Meteorological support, observations, and climatological services for the NTS 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.

An arid climate exists over the NTS. Annual precipitation ranges from 12.4 centimeters per year (cm/yr) (4.9 inches/year [in./yr]) at Station No. 5, to 16.8 cm/yr (6.6 in./yr) at Yucca Flat (Station No. 6), to 14.7 cm/yr (5.8 in./yr) at Desert Rock, to 32.5 cm/yr (12.8 in./yr) on Rainier Mesa (Station No. 12).

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 NTS. 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 NTS (Figure G.1). MIDNET has been operated on the NTS for more than 40 years, has undergone several modernizations and upgrades, and serves as a solid basis for deriving climatological information.

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. 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 m [3,304 ft]) located 4.8 km (3 mi) southwest of Mercury, Nevada (Station No. 23) (Figure G.1). Upper-air observations (radiosondes) are taken twice daily from DRA. DRA has been in operation since May 1978.

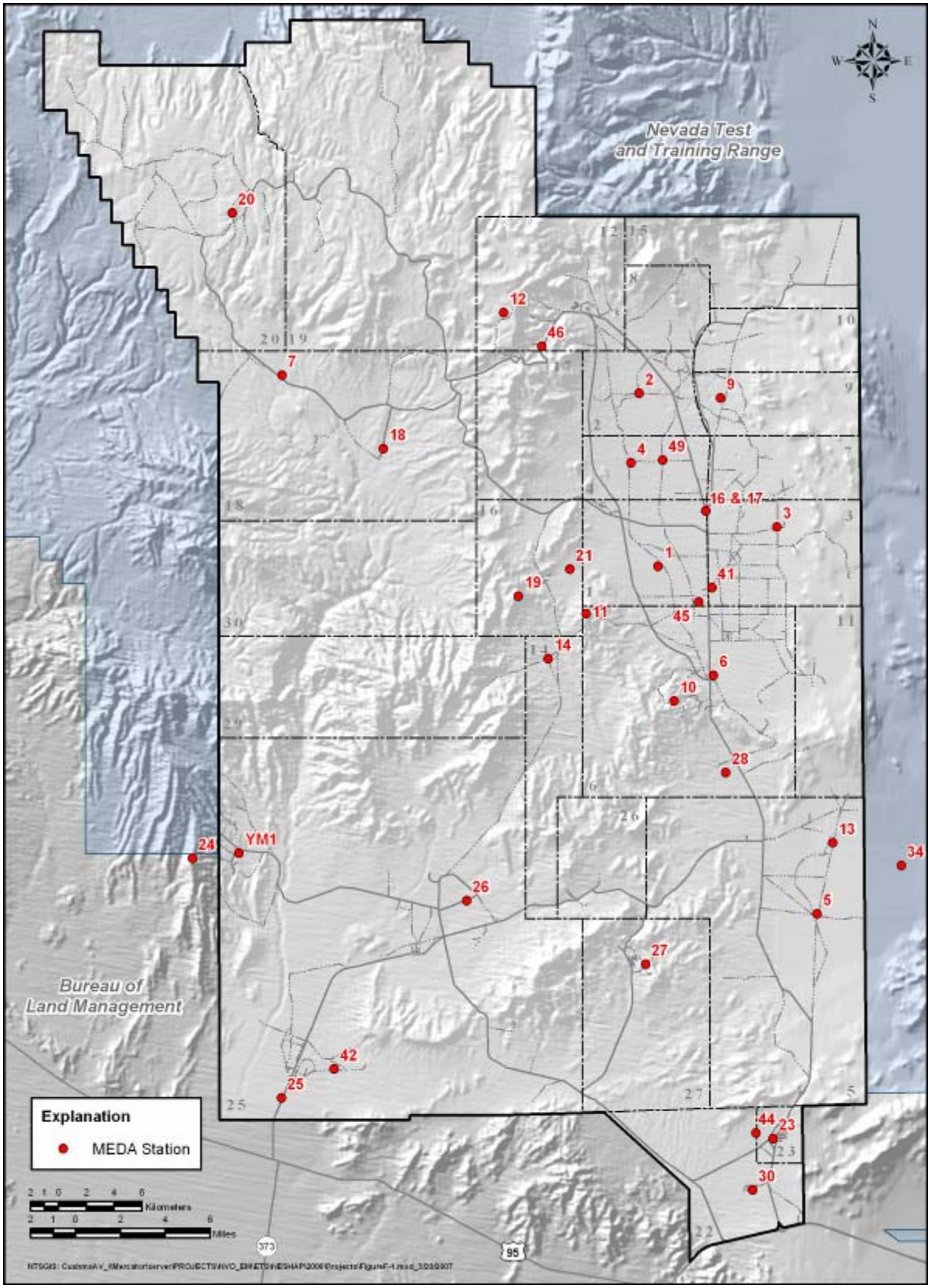

Figure G.1 Locations of MEDA Stations on the NTS in CY 2008

DRA was built to replace a similar observatory that was located at the Yucca Flat Meteorological Observatory (UCC; elevation 3,924 ft, Station No. 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. A MEDA station consists of an enclosed trailer, a portable 10 m (32.8 ft) tower, a microprocessor, and a microwave 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 (32.8 ft) above the ground.

Wind and temperature data have been collected on the NTS for more than 40 years. These and other meteorological data have been compiled into a comprehensive climatological database for the NTS. The MEDA data are especially useful in assessing boundary layer flow regimes on the NTS. 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 (9.8 ft) above ground level. A total of 30 primary MEDA stations are located on or around the NTS (Figure G.1) to ensure that meteorological conditions are thoroughly documented for the complex terrain environment found on the NTS.

Wind direction is measured to two degrees of azimuth, and wind speed is accurate to 0.3 miles per hour. Wind data are collected as 15 minute averages and are transmitted via microwave to a central processor every 15 minutes. These data are checked operationally by the duty forecaster, and quality control is assured by the ARL/SORD climatologist. Plotted wind products are generated every 15 minutes for operational use. The data are stored and archived for climatological purposes.

MEDA temperature is accurate to 0.36 degrees Fahrenheit (°F) (0.2 degrees Celsius [°C]) between -38°F and 140°F (-39°C and 60°C) (absolute range for the NTS is -20°F to 115°F [-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 microwave to a computer for processing, displaying, and archiving.

To utilize the most representative meteorological data available for NTS sources, cloud observations from DRA were melded with the concomitant MEDA winds from Mercury and Pahute Mesa. Similarly, the cloud observations from UCC were melded with MEDA wind data from Yucca and Frenchman Flats. The straight-line distance from DRA to Mercury is 4.8 km (3 mi), from UCC to Frenchman Flat is 19.3 km (12 mi), and from DRA to Pahute Mesa is 64.4 km (40 mi).

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 3.9 tenths 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 NTS.

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 Pahute Mesa. Therefore, atmospheric soundings and cloud cover observations from DRA were melded with MEDA surface wind data from Pahute Mesa for input to the STAR program to provide the very best data for calculating transport and dispersion processes. For sources in Yucca Flat and Frenchman Flat, the cloud cover data from UCC were considered to be the most representative. Yucca Flat and Frenchman Flat are adjoining valleys of similar soil and vegetation types and similar meteorological and climatological conditions.

For sources at Mercury, the cloud observations from DRA are representative. DRA is only 4.8 km (3 mi) from Mercury.

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 NTS. 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 2008 data from the MEDA stations for the NTS areas were used by ARL/SORD personnel to prepare the following STAR files:

STAR File	NTS Area
meda09.str	10
meda05.str	5
meda17.str	3
meda20.str	20

Appendix H

SUPPLEMENTAL INFORMATION

COLLECTIVE EFFECTIVE DOSE EQUIVALENT

As discussed in Section III, the U.S. Environmental Protection Agency has approved the use of critical receptor monitoring locations on the Nevada Test Site (NTS) 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) (50 miles [mi]) of the NTS 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 2008. 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 NTS change whereby this is exceeded, this change will be reconsidered.

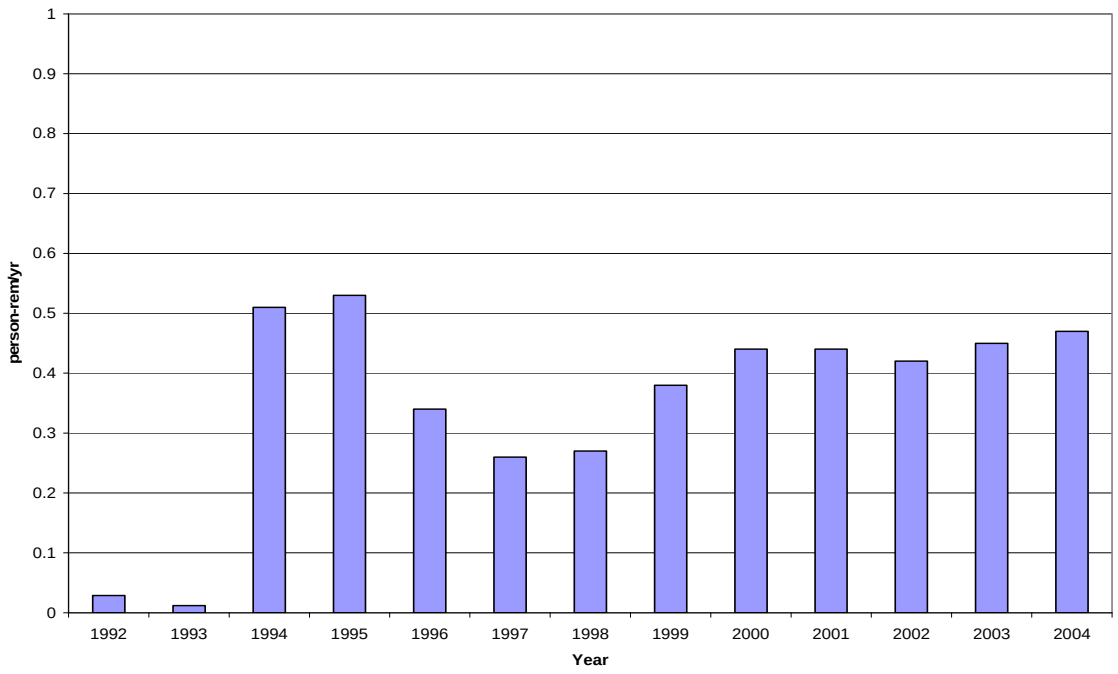

Figure H.1 CEDE to Populations within 80 km (50 mi) of Emission Sources

ESTIMATING TRITIUM EMISSIONS FROM SCHOONER AND SEDAN

Prior to 2002, the areas of diffuse tritium emissions from the Sedan and Schooner sites were assumed to be the sizes of their craters. From the measurement of tritium in vegetation samples collected in 2002 and 2004 at these sites, the areas of emissions appeared to be much larger. Current estimates for these areas are 3.8 x 10^6 square meters (m^2) (4.1 x 10^7 square feet [ft^2]) for Sedan and 3.6 x 10^6 m^2 (3.9 x 10^7 ft^2) for Schooner. As this places the Schooner and Sedan air sampling locations within the source term area, the CAP88-PC concentration estimates at these sampler locations for a 1 curie per year (Ci/yr) release have high uncertainty (Figure H.2).

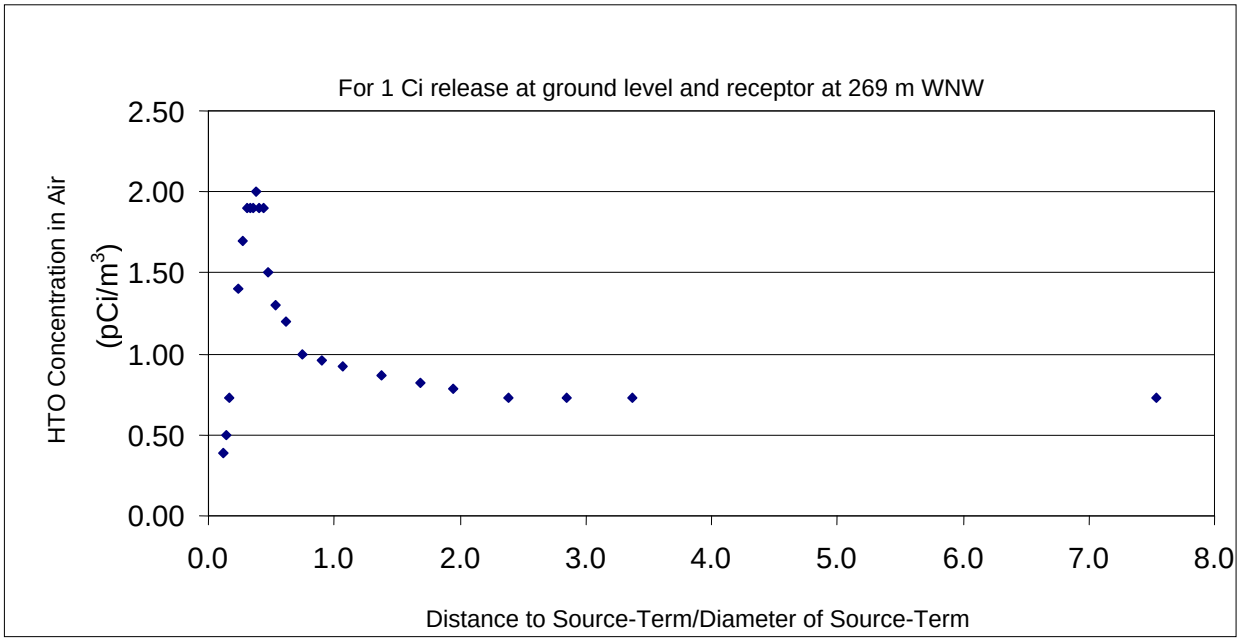

Figure H.2 CAP88-PC Predicted Air Concentration versus Ratio of Distance-to-Source/Diameter of Source

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 m (15,715 ft) south-southeast of the Schooner crater. At this distance, area source is treated by CAP88-PC as a point source (ratio of 13). See Appendix D for a description of the method and results.

COMPLIANCE WITH SUBPARTS Q AND T, Title 40 Code of Federal Regulations Part 61

The NTS is regulated by 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, DOE O 435.1, *Radioactive Waste Management*, (DOE, 1999a) does include limits on radon flux from waste disposal facilities. Therefore, radon flux measurements were made during this report period at the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs) to

confirm inventory records that only trace 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 ($pCi/m^2/s$) required by DOE M 435.1-1, *Radioactive Waste Management Manual*, (DOE, 1999b). The results of the most recent study (National Security Technologies, LLC, 2009) showed that the radon flux was not significantly different from background levels. An assessment of the potential risks posed by the Area 5 RWMS to the public projected that the in-growth of radon-222 (^{222}Rn) from the decay of thorium-230 (^{230}Th) 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 NTS.

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, 2001), and of DOE O 414.1C, *Quality Assurance* (DOE, 2005), have been implemented in this plan.

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