DOE/NV--1609

Nevada National Security Site
&
North Las Vegas Facility

National Emission Standards for Hazardous Air Pollutants – Radionuclide Emissions Calendar Year 2024

June 2025

Prepared for

U.S. Department of Energy,
National Nuclear Security Administration
Nevada Field Office
Under Contract Number
DE-NA0003624

Prepared by

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NEVADA NATIONAL NNSS SECURITY SITES

National Nuclear Security Administration

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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: Betty L. Huck,
Manager, NNSA/NFO

Signature and Date: BETTY HUCK Digitally signed by BETTY HUCK Date: 2025.06.12 11:52:18 -07'00'

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EXECUTIVE SUMMARY

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

To protect the public from harmful levels of manmade radiation, the Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAP), specifically the National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities (40 CFR 61, Subpart H) limits the release of radioactivity from a DOE facility to that which would cause a 10 millirem per year (mrem/y) effective dose equivalent (EDE) 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 Japan's Fukushima nuclear power plant, which was damaged in 2011.

NNSA/NFO is in compliance with the NESHAP standard as demonstrated by environmental measurements of radionuclide air concentrations at critical receptor (CR) locations on the NNSS. This alternative approach was proposed and formally submitted to the U.S. Environmental Protection Agency (EPA) in 2001 (EPA 2001a) and has been used to demonstrate compliance with the 40 CFR 61.92 dose standard since 2002. Six locations on the NNSS have been established to act as CR locations to demonstrate compliance with the NESHAP limit. These locations are closer to radionuclide releases than where the public resides, so they act as protective substitutes for public receptor locations. Compliance is demonstrated if the measured annual average concentration is less than the NESHAP Concentration Level (CL) for Environmental Compliance listed in Table 2 of 40 CFR 61, Appendix E. 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. The EPA-approved air transport model, called the Clean Air Package 1988 (CAP88-PC) is also used to calculate the EDE to the maximally exposed individual (MEI) from NNSS air emissions. CAP88-PC was also used to calculate the population dose, or the collective EDE (expressed as person-rem [roentgen equivalent man] per year [person-rem/y]) for all individuals combined who reside within 80 kilometers (km) of NNSS emission sources.

In 2024, the potential dose from radiological emissions to air from both current and past NNSS activities was well below the 10 mrem/y dose limit. This is demonstrated by both the air sampling data collected at CR air monitoring stations and CAP88-PC modeling. The average concentrations of radioactivity at on-site air CR stations ranged from 0.3% to a maximum of 11.3% of the NESHAP limit. CAP88-PC modeling of all 2024 NNSS radionuclide emissions showed the MEI to be on the Nevada Test and Training Range. This individual, if they were a year-around resident, would have received a potential dose of 0.065 mrem/y. The collective population dose was calculated to be 0.31 person-rem/y for the 557,100 people who lived within 80 km of NNSS emission sources.

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List of Acronyms and Abbreviations

General Acronyms and Abbreviations

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)
CFR	Code of Federal Regulations
Ci	curie(s)
CL	Concentration Level
CR	critical receptor
CY	calendar year
d	day(s)
DAF	Device Assembly Facility
DOE	U.S. Department of Energy
DRA	Desert Rock Meteorological Observatory
E	east
EDE	effective dose equivalent
EPA	U.S. Environmental Protection Agency
ft^3/min	cubic feet per minute
h	hour(s)
HEPA	high efficiency particulate air
JASPER	Joint Actinide Shock Physics Experimental Research
km	kilometer(s)
km^2	square kilometer(s)
L	liter(s)
LANL	Los Alamos National Laboratory
LLW	low-level waste
m	meter(s)
mCi	millicurie(s)
mCi/y	millicurie(s)/year
MEDA	Meteorological Data Acquisition
MEI	maximally exposed individual
MIDNET	Meteorological Integrated Data Network
min	minute(s)
mrem/y	millirem per year
µrem/y	microrem per year
N	north
NCERC	National Criticality Experiments Research Center
NESHAP	National Emission Standards for Hazardous Air Pollutants
NLVF	North Las Vegas Facility
NNSA/NFO	DOE, National Nuclear Security Administration Nevada Field Office
NNSS	Nevada National Security Site
NOAA	National Oceanic and Atmospheric Administration
NPTEC	Nonproliferation Test and Evaluation Complex
NTTR	Nevada Test and Training Range

List of Acronyms and Abbreviations (continued)

General Acronyms and Abbreviations

pCi	picocurie(s)
pCi/L	picocurie(s) per liter
pCi/m^3	picocurie(s) per cubic meter
PULSE	Principal Underground Laboratory for Subcritical Experimentation
RIDP	Radionuclide Inventory and Distribution Program
rem	roentgen equivalent man
RNCTEC	Radiological/Nuclear Countermeasures Test and Evaluation Complex
RWMS	Radioactive Waste Management Site
s	second(s)
S	south
STAR	Stability Array (grouping of meteorological data)
UCC	Yucca Flat Meteorological Observatory
UGTA	Underground Test Area
W	west
y	year(s)
ZEBRA	ZEUS Broad Research Area (formerly the Dense Plasma Focus Facility)
ZEUS	Z-pinch Experimental Underground System

Elements, Isotopes and Compounds

Am	americium
Ar	argon
Ba	barium
Co	cobalt
Cs	cesium
DU	depleted uranium
Eu	europium
^3H	tritium
HTO	tritiated water in the form of $^3H^3HO$ or ^3HHO
I	iodine
Kr	krypton
La	lanthanum
Pu	plutonium
PuE	plutonium-equivalent
Sb	antimony
Sm	samarium
Sr	strontium
Te	tellurium
TRU	transuranic (nuclides with atomic numbers greater than uranium)
U	uranium
Xe	xenon

Report Information

U.S. Department of Energy
National Nuclear Security Administration
Nevada Field Office
Air Emissions Annual Report
(under Subpart H, Title 40 Code of Federal Regulations [CFR] 61.94)
Calendar Year (CY) 2024

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SECTION I
FACILITY INFORMATION

SITE DESCRIPTION

The Nevada National Security Site (NNSS) is operated by the U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Field Office (NNSA/NFO) as the site for maintaining and enhancing the safety, security, reliability, and performance of the U.S. nuclear weapons stockpile; reducing global danger from weapons of mass destruction; and responding to nuclear and radiological emergencies in the U.S. and abroad. The NNSS is also an operational site for environmental restoration, low-level radioactive waste management, and groundwater characterization activities. Located in Nye County, Nevada, the site's southeast corner is about 67 kilometers (km) northwest of the city limits of the major population center, Las Vegas, Nevada. The NNSS covers about 3,523 square kilometers (km^2) and is 46 to 56 km east to west and 64 to 88 km north to south. The NNSS is surrounded, except on the south side, by the Nevada Test and Training Range (NTTR), a public exclusion area that provides 24 to 104 km between the NNSS and publicly accessible land (Figure 1).

The NNSS is characterized by desert valley and Great Basin mountain topography, with climate, flora, and fauna typical of the southwest deserts. Based on the most recent population estimates (U.S. Census Bureau website and Clark County Department of Comprehensive Planning website), there were about 557,700 people residing within 80 km of the NNSS boundary. Of these, about 557,100 were within 80 km of NNSS emission sources. The distribution of this population is concentrated in the metropolitan areas of Las Vegas and North Las Vegas (90%) to the southeast and in the town of Pahrump (8%) to the south (Figure 1). These more populated areas drive the overall average offsite population density up to about 13.1 persons/km^2, but the majority of the area within 80 km of the NNSS is uninhabited. The nearest populated location to the NNSS boundary is the north end of Amargosa Valley, which extends to within 3.4 km of the southwest corner of the NNSS and includes multiple businesses, such as gas stations, convenience stores, and a fireworks store. Four mines are marked on Figure 1, but not all are active. Dose is calculated for populated areas near active mines where workers likely reside. Though facilities on the NTTR are classified as a business, dose is still calculated for them as if they were residences because people may reside there for extended periods of time.

During 2024, one large dairy was in operation in Amargosa Valley, about 16.1 km from the NNSS boundary, and one small goat dairy operated in Pahrump, about 39.6 km south of the NNSS. Agriculture around the NNSS is sparse and consists primarily of alfalfa mainly in Amargosa Valley, Pahrump, around the north end of the NTTR, and locations between Alamo and Hiko. There was a honey production establishment, and two winery businesses operating in Pahrump in 2024. These are about 44 km south of the NNSS boundary. One 60-acre farm in Las Vegas, 73.3 km east-southeast of the NNSS, operated in 2024. This farm sells produce directly to the public. Sparse livestock production may occur throughout the area around the NNSS on a relatively small scale.

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

SOURCE DESCRIPTION

The NNSS was originally established in 1950, as the "Nevada Proving Ground" for the purpose of testing the nation's nuclear explosive devices. In 1954 it was renamed the "Nevada Test Site" and in 2010 it was renamed the "Nevada National Security Site." Full scale testing of nuclear explosives continued from 1951 to 1992. Historical testing included (1) atmospheric testing in the 1950s and early 1960s, (2) underground testing between 1951 and 1992, and (3) open-air nuclear reactor and rocket engine testing between 1959 and 1973. No nuclear tests have been conducted since September 23, 1992 (U.S. Department of Energy [DOE] 2013). The

environmental legacy of nuclear weapons and other testing on the NNSS is the primary source of radionuclides that are released into the air. They are characterized as non-point (diffuse) sources and include (1) areas of radioactively contaminated surface soils, (2) contaminated groundwater that is pumped or flows naturally to the surface, (3) radioactive waste storage and burial sites, and (4) radiologically contaminated structures and materials being decommissioned, demolished, and/or managed.

Surfaces contaminated with plutonium (Pu), americium (Am), tritium (^{3}H), fission and activation products from past nuclear device safety, atmospheric, or cratering tests could become sources of radionuclide exposure to the public if the radionuclides were to be re-suspended, for example, through evaporation or transpiration of ^{3}H in water, by wind, surface cleanup, construction, vehicular travel, or similar process for radionuclides associated with particulates. In 1981, DOE began a project known as the Radionuclide Inventory and Distribution Program (RIDP). After five years of field work and three years of data analysis, the result was a report that identified the inventory and described the distribution of radionuclides in the soil in parts of the NNSS affected by NNSS operations (DOE 1991) (Table 1). The inventory includes an estimate of the curies (Ci) of the manmade radionuclides detected and reported by the RIDP. Though the inventory includes cobalt-60 (^{60}Co), strontium-90 (^{90}Sr), cesium-137 (^{137}Cs), and the europium (Eu) isotopes ^{152}Eu, ^{154}Eu, and ^{155}Eu, they collectively contribute less than 10% to total dose, which is the threshold for required measurement per Title 40 Code of Federal Regulations (CFR) 61.93. Figure 2 shows areas of elevated exposure rates in NNSS soils as measured by an aerial survey conducted in 1994 (Hendricks and Riedhauser 1999). These areas are generally described as Legacy Contamination Sites in this document.

Table 1. Inventory of Manmade Radionuclides in NNSS Surface Soil[(a)]

	Radionuclide inventory (Ci)[(b)]								
Area[(c)]	^{60}Co	^{90}Sr	^{137}Cs	^{152}Eu	^{154}Eu	^{155}Eu	^{238}Pu	$^{239+240}$Pu	^{241}Am
1	0.01	6.53	3.98	2.56	0.01	0.00	4.95	23.98	6.16
2	0.01	20.03	10.86	2.39	0.00	0.00	6.55	21.98	4.75
3	0.01	14.37	5.43	3.07	0.01	0.00	2.36	36.96	7.72
4	0.02	5.66	5.43	1.55	0.00	0.00	9.90	39.96	9.89
5	0.01	0.39	0.18	1.71	0.01	0.00	0.08	4.80	1.00
6	0.00	1.52	1.27	0.00	0.00	0.00	2.51	8.39	2.37
7	0.01	4.01	2.35	3.76	0.01	0.00	0.46	15.98	3.54
8	0.06	10.89	19.00	0.75	0.00	0.00	6.09	109.89	26.10
9	0.01	5.66	3.94	3.93	0.01	0.00	1.67	88.91	12.08
10	0.10	23.95	38.00	0.38	0.02	0.03	14.46	109.89	27.99
11	0.00	0.13	0.23	0.00	0.00	0.00	0.38	28.97	5.76
12	0.01	7.40	9.05	0.00	0.00	0.00	6.47	38.96	8.94
15	0.00	9.58	8.60	0.00	0.00	0.00	5.94	62.94	13.30
16	0.00	1.61	1.31	0.00	0.00	0.00	1.14	3.70	1.00
17	0.01	8.28	6.79	0.00	0.00	0.00	3.43	17.98	4.29
18	0.01	7.40	4.52	0.19	0.01	0.01	4.26	99.90	27.08
19	0.01	13.50	16.29	0.00	0.00	0.00	24.36	139.86	32.61
20	0.08	1.87	2.49	2.22	0.10	0.03	22.84	40.96	25.49
25	0.00	0.04	0.09	0.07	0.00	0.00	0.00	0.00	0.00
30	0.01	0.57	0.68	0.12	0.01	0.00	3.43	13.99	4.30

(a) Source of inventory from DOE (1991) and includes radionuclides in soil within 0–30 centimeters of the surface with most activity in the top 5 centimeters.
(b) Decay corrected to the middle of calendar year 2024 (July 2, 2024), with ingrowth of ^{241}Am from ^{241}Pu included.
(c) Areas not listed have negligible amounts of manmade radionuclides in surface soil.

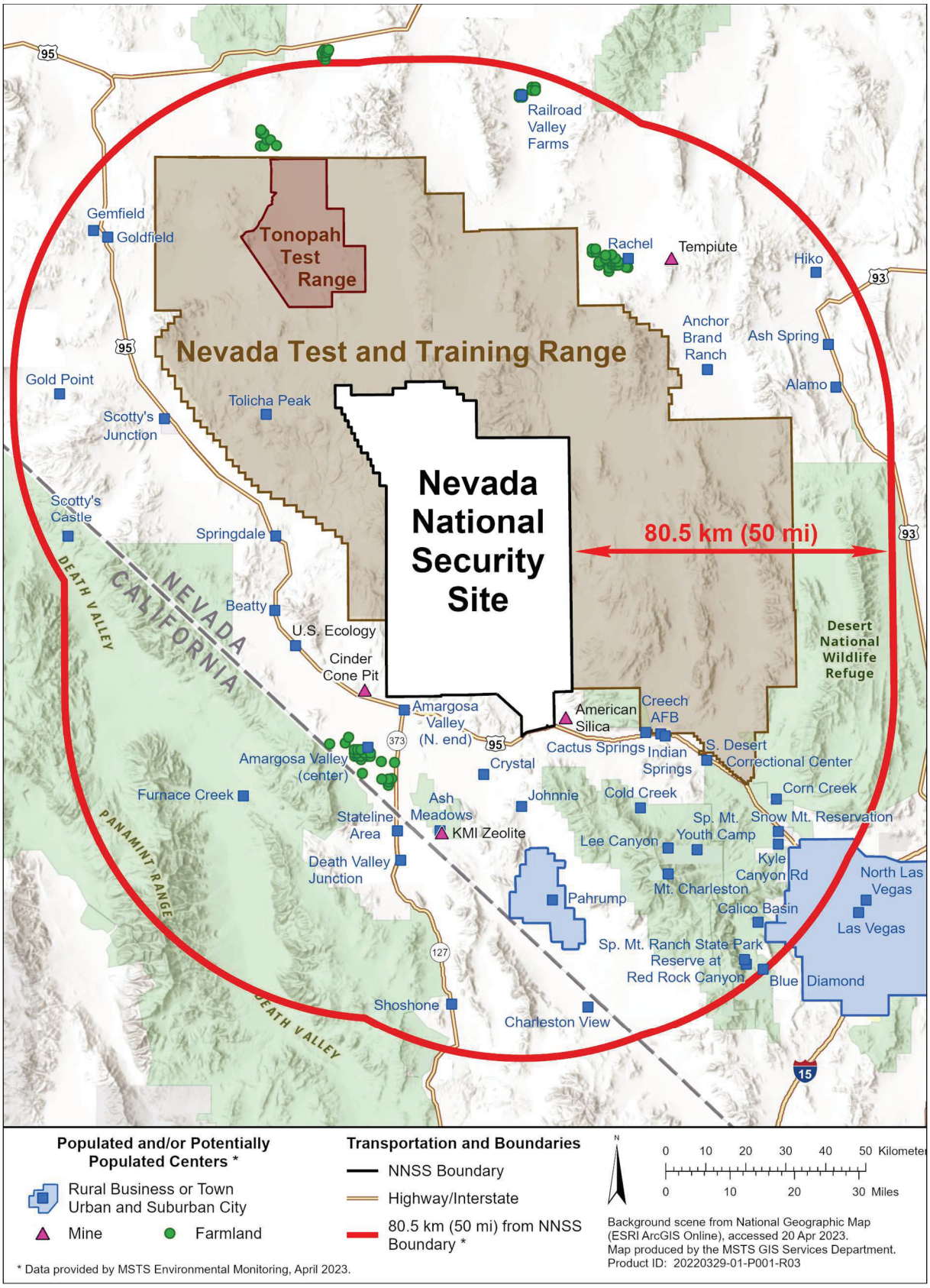

Figure 1. Populated and potentially populated areas within 50 miles (80.5 km) of the NNSS

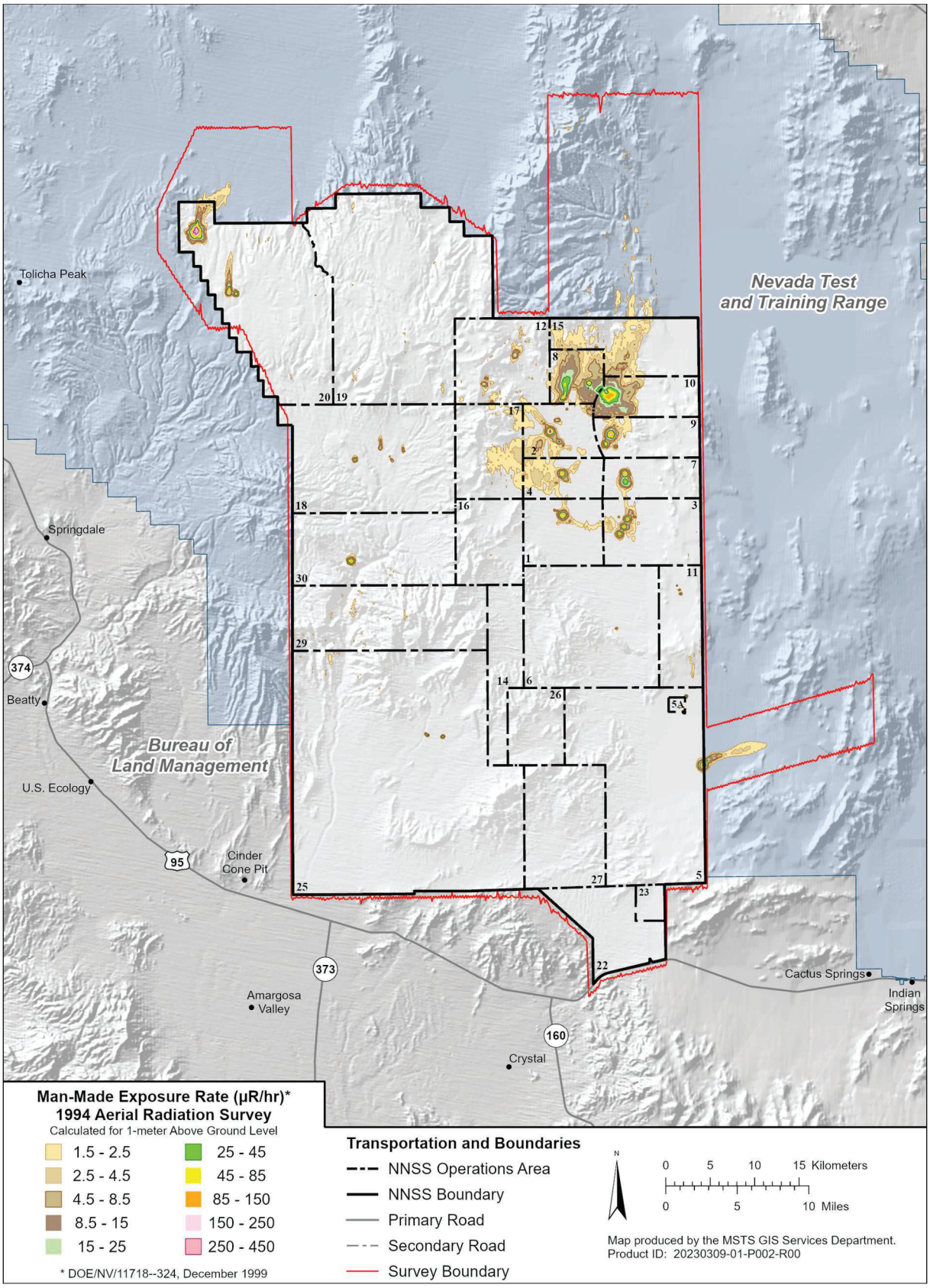

Figure 2. Legacy Contamination Sites Illustrated by Elevated Exposure Rates

Current missions of the NNSS are to help ensure the security of the United States and its allies by supporting the stewardship of the nuclear deterrent stockpile, providing emergency response capability and training, and contributing to key nonproliferation and arms control initiatives. Activities include (1) conducting high-hazard operations in support of defense-related nuclear and national security experiments; (2) supporting 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 of radioactive wastes. Some of the programs and experiments at the NNSS use or handle radioactive materials. In all such locations, radioactive materials are controlled in accordance with 10 CFR Part 835, "Occupational Radiation Protection". The facilities that have key NNSA/NFO missions which may have unsealed radioactive material and are potential sources for radiological air emissions are shown in Figure 3. Radionuclides potentially present at these locations include various isotopes of Pu, Am, and U, as well as ^{3}H, ^{60}Co, ^{137}Cs, and various short-lived activation and fission products. Radioactive emissions are not necessarily produced from these locations in a given year, but all have the potential for radioactive emissions. The key locations and programs with potential NNSS sources are categorized by general organization and listed below.

- Environmental Management
  - Environmental Restoration
  - Management of radioactive contamination from historic nuclear weapons-related activities (Legacy Contamination Sites)
  - Radioactive Waste Management Complex
    - Area 3 Radioactive Waste Management Site (RWMS)
    - Area 5 RWMS
  - Underground Test Area (UGTA) Activity
- Stockpile Operations
  - Device Assembly Facility (DAF)
    - National Criticality Experiments Research Center (NCERC)
  - ZEUS (Z-pinch Experimental Underground System) Broad Research Area (ZEBRA) formerly the Dense Plasma Focus Facility
  - Big Explosives Experimental Facility (BEEF)
  - Joint Actinide Shock Physics Experimental Research (JASPER)
  - Principal Underground Laboratory for Subcritical Experimentation (PULSE)
- Global Security
  - Nonproliferation Test and Evaluation Complex (NPTEC)
  - Radiological/Nuclear Countermeasures Test and Evaluation Complex (RNCTEC)
  - Counter Terrorism Operations Support Center for Radiological Nuclear Training (T1 Training and Exercise Area)
  - Tumbleweed Test Range
  - Tunnel operations
- Mission Support
  - Buildings where radioactive material may be surveyed, processed, and/or analyzed include 23-180, 23-600, 23-650, 23-652, and 23-703. All of these are in Mercury in Area 23 (Figure 3). Handling of radioactive material in these buildings is limited and consists primarily of environmental samples and laboratory standards. Although the amounts of radioactive material in the environmental samples and laboratory standards are low, and therefore the potential emissions from them are also very low, they are still included as sources.

All facilities and activities from which radionuclides were released to air in calendar year (CY) 2024 are listed in Section II, Table 2, and their source information is listed in Appendix A, Table A.1. There are no individual sources of radionuclide emissions on the NNSS that require specific monitoring specified in 40 CFR 61.93(b)(4)(i), and 40 CFR 61.93(e). Because of the intermittent nature of emissions for some operations on the NNSS, Table A.2 is included in Appendix A which presents emission sources over time.

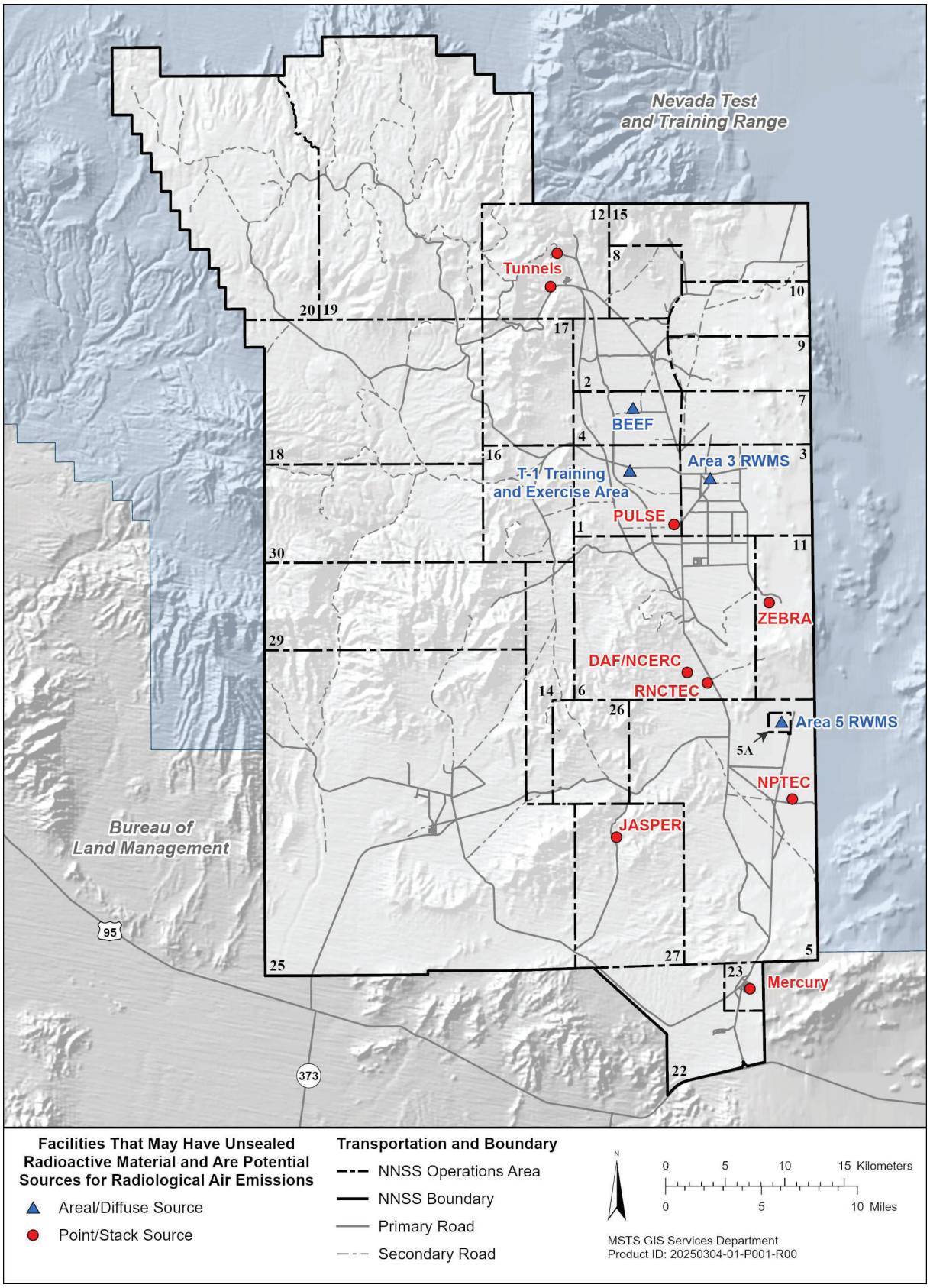

Figure 3. Facilities with Potential to Release Radionuclides to Air

SECTION II
AIR EMISSIONS DATA

Locations and operations from which radionuclides were released to the atmosphere during CY 2024 are listed in Table 2, and their source information is in Appendix A. Their locations are displayed in Figure 4. Releases for the year are grouped into five general source categories: (1) Environmental Management Sites; (2) Stockpile Operations; (3) Global Security; (4) Mission Support, and (5) North Las Vegas Facility. CY 2024 emission sources by category are described below.

Environmental Management Sites

Legacy Contamination Sites

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

Weapon Test and Plowshare Soil Contamination Sites

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

E-Tunnel Ponds

Corrective Action Site 12-59-01, E-Tunnels, has water contaminated from historical nuclear weapons testing flowing into collection ponds (E-Tunnel Ponds) in Area 12. 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 2024 is described in Appendix E.

Waste Operations

The Area 3 and Area 5 RWMS are used for the disposal of packaged, dry, low-level waste which is buried in pits and trenches. Area 5 also has facilities for waste examination and repackaging activities, the accumulation of mixed waste, and the storage of transuranic (TRU) and mixed TRU wastes. Concrete pads are used for temporary storage of these wastes. The only radioactive emission detected by the various types of samplers located downwind of these sites and attributed to waste operations was ^{3}H as HTO in atmospheric moisture. Calculation of the ^{3}H source term for these emissions in CY 2024 is described in Appendix B.

Underground Test Area (UGTA) Activity

UGTA activities include the task of characterizing the aquifers at sites of past underground nuclear tests. To characterize the groundwater regime, suitable wells are drilled, and existing wells re-completed and sampled as determined by hydrologists. During these drilling and sampling operations, water is pumped to the surface. This water is then available for evaporation. The only contaminant producing a measurable air emission from this evaporating water is ^{3}H as HTO. During CY 2024, wells ER-20-5, ER-20-7, and ER-20-12 had water containing ^{3}H pumped to the surface. These locations are displayed in Figure 4. Calculation of the ^{3}H emissions from these sources are described in Appendix E.

Stockpile Operations

The NNSS provides unique resources to maintain the integrity of the United States' nuclear weapons stockpile through weapons testing without nuclear detonation. Nuclear Asset Operations supports this mission through its nuclear and high-hazard facility management.

Certain experiments have the potential for radioactive emissions. Primary locations for such emissions are DAF in Area 6, NCERC (located within the DAF) in Area 6, ZEBRA in Area 11, PULSE in Area 1, BEEF in Area 4, and JASPER in Area 27.

During CY 2024 the BEEF was the only location known to have radioactive emissions. Calculated possible air emissions from DAF and NCERC are also included in Table 5 as a source for CY 2024.

Global Security

This category can be generally described as global security activities conducted to strengthen national security by providing real-world testing, evaluation, and training venues. Certain activities have the potential for radioactive emissions. The primary locations for this are the T1 Training and Exercise Area in Area 1, RNCTEC in Area 6, NPTEC in Area 5, the Tumbleweed Test Range in Area 6, and tunnel complexes primarily in Area 12. Certain experiments using radioactive materials may also be conducted in remote locations of the NNSS.

During CY 2024 only Tunnel Operations in Area 12 had potential radioactive emissions.

Mission Support

Mission Support buildings described in Section I have the potential to emit low quantities of radionuclides from handling or processing contaminated material (primarily samples) or from the preparation of ^{3}H standards that are used for quality assurance purposes. Also, the Radiological Control Department has the responsibility of conducting receipt surveys of any radioactive materials arriving at the NNSS. If packaging is damaged, materials must be handled during repackaging, which creates the potential for low-level air emissions. These activities generally take place in Building 23-180. Of the support buildings, operations in Buildings 23-650 and 23-652 and 23-703 were the only activities known to use unsealed radioactive materials in CY 2024; these buildings are near each other and are referred to as Area 23 Mission Support Buildings in this category in CY 2024.

North Las Vegas Facility (NLVF)

At the NLVF, parts of the Building A-01 basement were contaminated with ^{3}H in 1995. Emanation of tritiated water in the form of $^{3}H^{3}HO$ or ^{3}HHO (collectively referred to as HTO) from these building materials to basement air has persisted at continually decreasing levels. These emissions are exhausted from the building through the ventilation system. There were tritium emissions from this source in CY 2024. A description of the incident and the potential effective dose equivalent (EDE) for offsite exposure during CY 2024 are presented in Appendix D.

Radionuclide emissions from each CY 2024 source were characterized by one of the following methods:

- Facility- or project-reported radionuclide emissions based on operations
- Identifying the radionuclide inventory and determining losses of radionuclides that were released to the environment using 40 CFR 61 Appendix D emission factors
- Measuring the HTO concentrations in liquid effluents discharged and proceeding as if all the effluent evaporates over the course of the year to become an air emission
- Using soil re-suspension calculations
- Using a combination of environmental measurements and the Clean Air Package 1988 (CAP88-PC) air dispersion model (EPA 2019) to calculate the emissions

Distances and directions from all CY 2024 emission sources to the nearest offsite locations of interest are listed in Table 2. Distances ranged from 20 to 72 km from NNSS emission sources and from 0.1 to 0.85 km from the NLVF emission source.

Total CY 2024 emissions, by radionuclide, are shown in Table 3 for the NNSS and in Table 4 for the NLVF. Radionuclide emissions by source are shown in Table 5. Radionuclides from the NNSS that contribute ≥0.01% of the dose for each release location's maximally exposed individual (MEI) are listed. Only two of these radionuclides ($^{239+240}$Pu and ^{241}Am) would contribute more than 10% of the potential EDE to the MEI. The source type, emission control (for example, high efficiency particulate air [HEPA] filters), and description of the nature of each emission are listed in Table A.1 of Appendix A. Appendices B through E describe the methods used to determine CY 2024 emissions.

Table 2. CY 2024 Radionuclide Emission Sources and Distance to Nearest Offsite Locations

Emission Source			Distance[a] and Direction[b] to Nearest Offsite Locations		
			Offsite Residence	Offsite Business/Office	Offsite School
Environmental Management Sites	Legacy Contamination Sites	Sedan	51 km ENE (Anchor Brand Ranch)	21 km ENE (NTTR)	72 km WSW (Beatty)
		Schooner	38 km SSW (Springdale)	20 km WSW (Tolicha Peak)	55 km SSW (Beatty)
		Grouped Area Sources[c]	Various locations ranging from 20 to 74 km		
		E-Tunnel Ponds	57 km WSW (Springdale)	31 km E (NTTR)	66 km SW (Beatty)
	Waste Operations	Area 3 RWMS	56 km SW (Amargosa Valley)	28 km NE (NTTR)	60 km SSE (Indian Springs)
		Area 5 RWMS	37 km SE (Cactus Springs)	40 km SE (Indian Springs)	40 km SE (Indian Springs)
	UGTA	Well ER 20-5	32 km SW (Springdale)	29 km WNW (Tolicha Peak)	47 km SSW (Beatty)
		Well ER 20-7	32 km SW (Springdale)	29 km WNW (Tolicha Peak)	46 km SSW (Beatty)
		Well ER 20-12	34 km SW (Springdale)	22 km WNW (Tolicha Peak)	50 km SSW (Beatty)
Stockpile Operations	BEEF		57 km SSW (Amargosa Valley)	29 km ENE (NTTR)	64 km WSW (Beatty)
	DAF		42 km SW (Amargosa Valley)	42 km SW (Amargosa Valley)	48 km SE (Indian Springs)
	NCERC		42 km SW (Amargosa Valley)	42 km SW (Amargosa Valley)	48 km SE (Indian Springs)
Global Security	Tunnel Operations		55 km WSW (Springdale)	32 km E (NTTR)	63 km SW (Beatty)
Mission Support	Area 23 Mission Support Buildings		24 km SW (Crystal)	24 km SW (Crystal)	30 km (Indian Springs)
NLVF	Building A-01, basement		0.6 km W (N Las Vegas)[d]	0.1 km (at north fence of NLVF)	0.85 km W (N Las Vegas)[d]

(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) All NNSS Areas with large surface soil contamination from past nuclear testing.
(d) City of North Las Vegas.

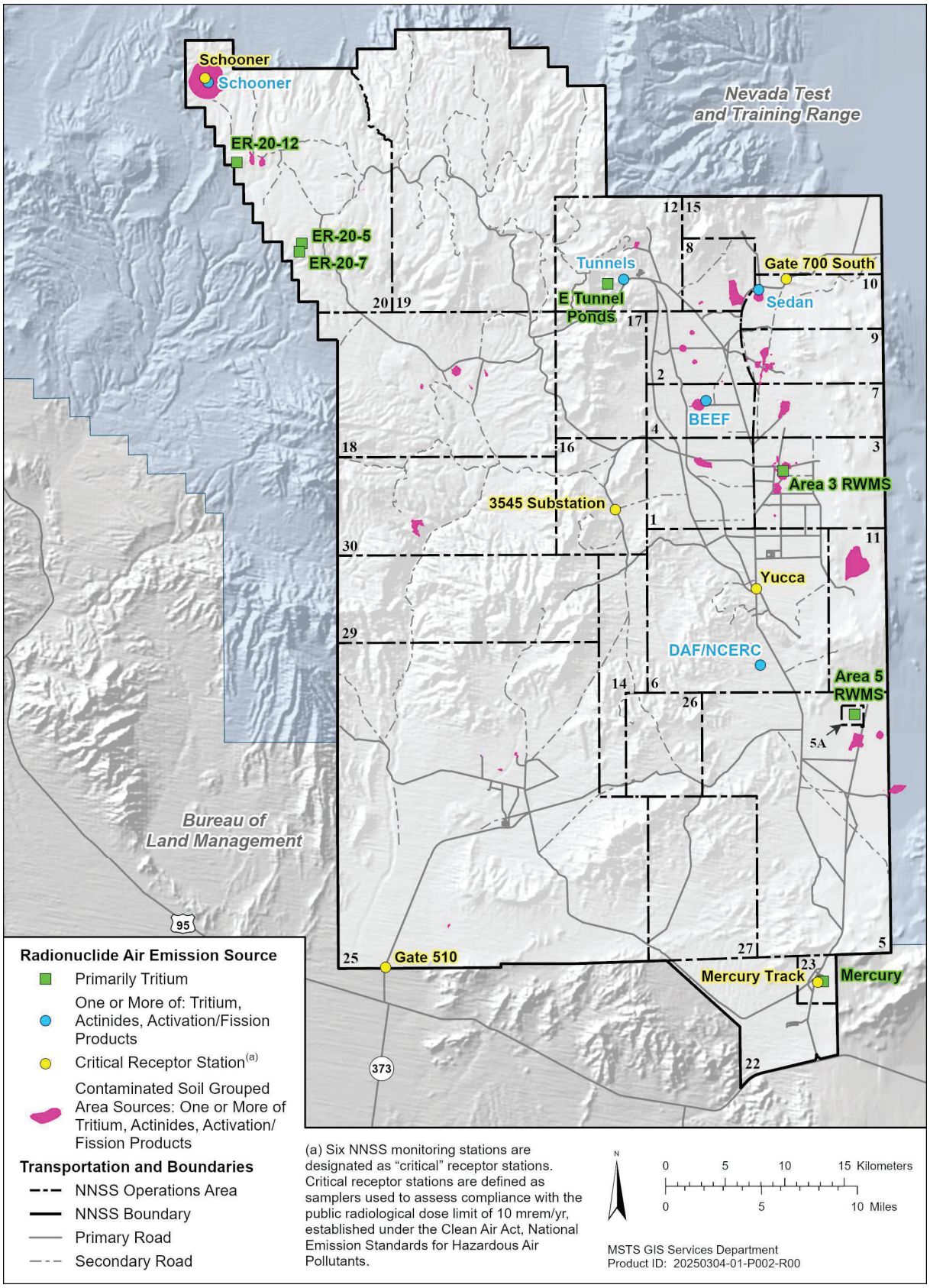

Figure 4. Sources of Radiological Air Emissions and Critical Receptor Air Monitoring Stations on the NNSS in CY 2024

Table 3. Total Estimated NNSS Emissions for CY 2024

Radionuclide[(a)]	Symbol	Half-life	Total Quantity (Ci)
Tritium	^{3}H	12.32 years (y)	3.5E+01
Argon-41	^{41}Ar	109.61 minutes (min)	1.9E-01
metastable Krypton-85	^{85m}Kr	4.48 hours (h)	1.4E+01
Strontium-90	^{90}Sr	28.79 y	4.6E-02
Antimony-125	^{125}Sb	2.76 y	1.4E-04
Tellurium-132	^{132}Te	3.2 d	3.0E+00
Iodine-131	^{131}I	8.02 days (d)	8.6E-01
metastable Xenon-133	^{133m}Xe	2.19 d	1.8E-01
Iodine-133	^{133}I	20.8 h	1.6E+01
metastable Xenon-135	^{135m}Xe	15.29 min	2.4E+02
Iodine-135	^{135}I	6.57 h	4.8E+01
Xenon-133	^{133}Xe	5.24 d	2.6E+00
Xenon-135	^{135}Xe	9.14 h	3.6E+01
Cesium-137	^{137}Cs	30.17 y	4.5E-02
Barium-140	^{140}Ba	12.75 d	1.0E+00
Lanthanum-140	^{140}La	1.6781 d	7.7E-08
Samarium-153	^{153}Sm	46.5 h	1.6E-01
Europium-152	^{152}Eu	13.54 y	7.1E-03
Europium-154	^{154}Eu	8.59 y	5.6E-05
Depleted Uranium	DU	>159,200 y	1.3E-01
Uranium	U	>159,200 y	4.1E-06
Plutonium-238	^{238}Pu	87.7 y	3.8E-02
Plutonium-239+240	$^{239+240}Pu$	24110 y	2.9E-01
Plutonium Equivalent	PuE	>87.7 y	1.7E-03
Americium-241	^{241}Am	432 y	7.0E-02

(a) Estimated emissions include only radionuclides that contribute ≥ 0.01% of the dose for each release location's maximally exposed individual (MEI). Only two of these radionuclides ($^{239+240}Pu$ and ^{241}Am) would contribute ≥ 10% of the potential EDE to the MEI from all NNSS emissions.

Table 4. Total Estimated NLVF Emissions for CY 2024

Radionuclide	Total Quantity (Ci)
^{3}H	9.4E-04

Table 5. Summary of CY 2024 Air Emissions Data by Source

Emission Source[a]			Emission Control	Radionuclide	Quantity (Ci/y)
Environmental Management Sites	Legacy Contamination Sites	Sedan[b]	None	^{3}H	1.5E+01
		Schooner[b]	None	^{3}H	6.7E+00
		Grouped Area Sources[c]	None	^{90}Sr	4.5E-02
				^{137}Cs	4.4E-02
				^{152}Eu	7.1E-03
				^{154}Eu	5.6E-05
				^{238}Pu	3.8E-02
				$^{239+240}$Pu	2.9E-01
				^{241}Am	7.0E-02
		E-Tunnel Ponds[d]	None	^{3}H	3.3E+00
	Waste Operations	Area 3 RWMS[b]	Soil cover over waste	^{3}H	5.5E+00
		Area 5 RWMS[b]	Soil cover over waste	^{3}H	3.9E+00
	UGTA	Well ER 20-5	None	^{3}H	5.2E-03
		Well ER 20-7	None	^{3}H	5.6E-01
		Well ER 20-12	None	^{3}H	7.6E-03
Stockpile Operations	BEEF[e]		None	DU	5.5E-02
	DAF[e]		HEPA filter	PuE [f]	1.7E-03
	NCERC[e]		HEPA filter	^{3}H	4.9E-06
				^{41}Ar	1.9E-01
				^{85m}Kr	1.4E+01
				^{90}Sr	1.1E-03
				^{125}Sb	1.4E-04
				^{132}Te	3.0E+00
				^{131}I	8.6E-01
				^{133}I	1.6E+01
				^{135}I	4.8E+01
				^{133}Xe	2.6E+00
				^{133m}Xe	1.8E-01
				^{135}Xe	3.6E+01
				^{135m}Xe	2.4E+02
				^{137}Cs	1.2E-03
				^{140}Ba	1.0E+00
				^{140}La	7.7E-08
				^{153}Sm	1.6E-01
				U	4.1E-06
Global Security	Tunnel Operations[e]		None	DU	7.5E-02
Mission Support	Area 23 Mission Support Buildings [g]		None	^{3}H	4.8E-07
NLVF	Building A-01, basement[h]		None	^{3}H	9.4E-04

(a) All locations are on the NNSS except for Building A-01.
(b) Emission based on samples and CAP88-PC; see Appendix B.
(c) Emissions from soil re-suspension model; see Table C.1.
(d) Emission based on HTO discharged into containment pond(s) or onto the ground; see Appendix E.
(e) Emission based on potential release reported by project personnel.
(f) Potential emission as plutonium-equivalent (PuE) from facility safety limit (modeled as ^{239}Pu).
(g) Calculated from activity in samples handled in Building 23-652 during 2023 which is higher than 2024 due to more biota samples.
(h) Based on air concentrations and ventilation system; see Appendix D.

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SECTION III
DOSE ASSESSMENTS

CRITICAL RECEPTOR AIR MONITORING

One of the ways the NNSS demonstrates compliance with dose limits is by comparing environmental measurements of radionuclide air concentrations near the NNSS borders and near the center of the NNSS with compliance level concentrations. This critical receptor (CR) method [40 CFR 61.93 (b)(5) and (g)] was proposed and formally submitted to the U.S. Environmental Protection Agency (EPA) Region 9 for use on the NNSS in 2001 (EPA 2001a) and has been used to demonstrate compliance with the 40 CFR 61.92 dose standard since 2002. The six approved CR 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 South
- Area 16, 3545 Substation
- Area 20, Schooner
- Area 23, Mercury Track
- Area 25, Gate 510

No changes to the critical receptor or routine air monitoring locations occurred during CY 2024 (Figure 5).

The six CR locations can be thought of as the worst case for an offsite receptor because these samplers are much closer to emissions sources. Table 6 displays the distances and direction between the CR monitoring stations and offsite locations where members of the public potentially live, work, and/or go to school. The distance and direction between emission sources and the CR sampling locations are listed in Table 7. The shortest distance between where a member of the public resides, and a CR monitoring station is 4 km. This is between the Gate 510 sampler, in the SW corner of the NNSS, and the northern edge of the community of Amargosa Valley. The shortest distance between an NNSS radionuclide emission source and a CR monitoring station is 0.2 km. This is between Building 23-652 and the Mercury Track sampler. The Schooner sampler, in the NW corner of the NNSS, is 0.3 km from the center of the Schooner Crater and is within the area contaminated by the nuclear test. Therefore, this station generally has the highest radionuclide concentrations of the six CR stations. The distance between the Schooner sampler and the closest member of the public (Tolicha Peak) is 20 km; 100 times greater distance than the sampler is from the emission source.

Compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) public air pathway dose limit of 10 mrem/y is demonstrated if the measured annual average concentration of each detected radionuclide at each of the six CR locations is less than the NESHAP Concentration Level (CL) for Environmental Compliance (40 CFR 61, Appendix E, Table 2). The CL represents the annual average concentration of each radionuclide that would result in an effective dose equivalent (EDE) of 10 mrem/y (see Table 8). 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 2024 air sampling results for all manmade radionuclides detected from the six compliance stations are presented in Table 8. Concentration ratios for all NNSS air samplers are listed in Table 9. Presentation of air monitoring results in relation to the CL for non-CR locations in Table 9 is provided as informational only.

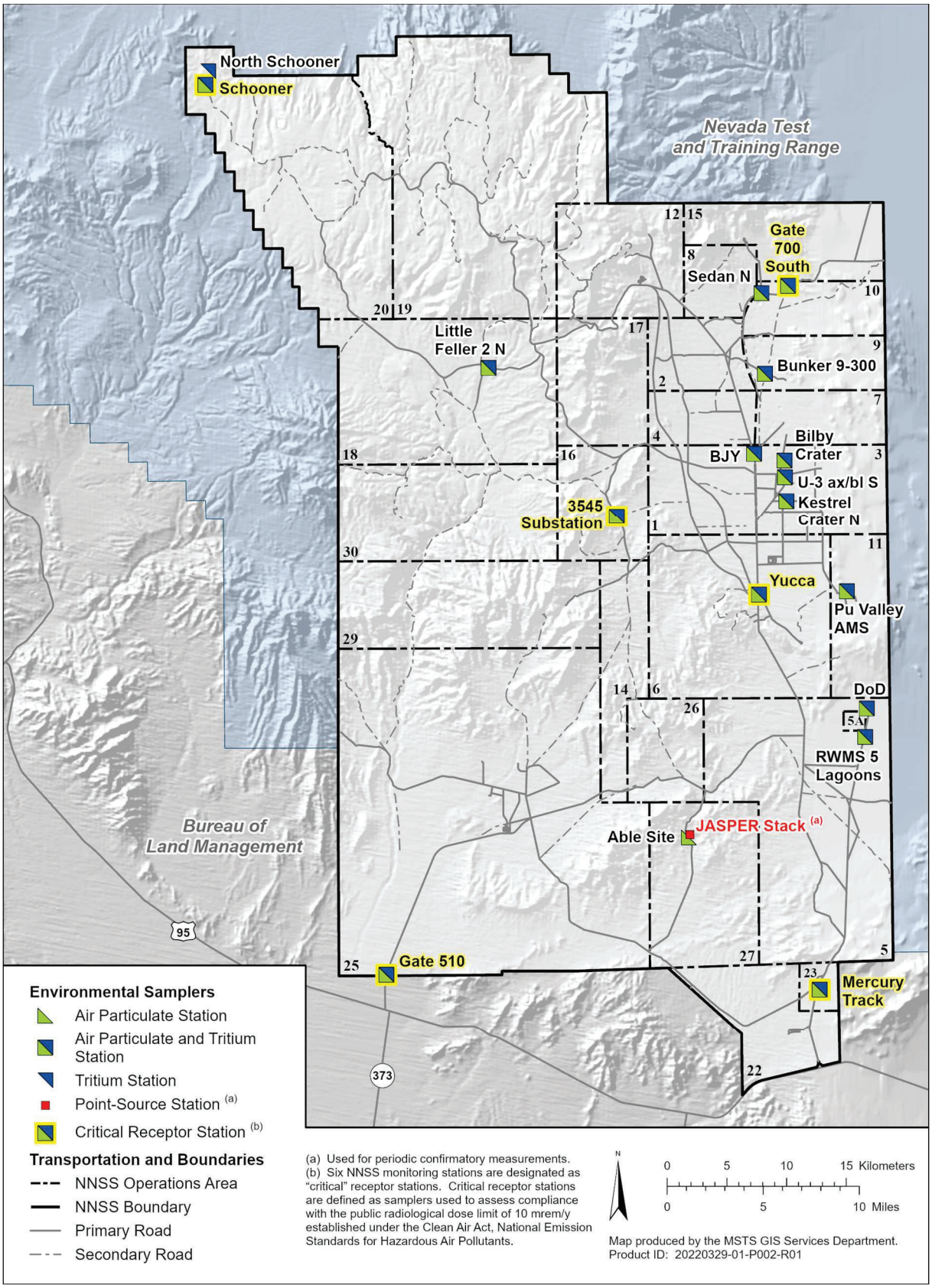

Figure 5. Air Sampling Network on the NNSS

Table 6. Distance and Direction from CR Stations to Offsite Points of Interest

Area	Critical Receptor Station	Distance[a] and Direction[b] to Nearest Offsite Locations		
		Offsite Residence	Offsite Business/ Office	Offsite School
6	Yucca	47 km SW (Amargosa Valley)	38 km SSE (American Silica)	54 km SE (Indian Springs)
10	Gate 700 South	49 km ENE (Anchor Brand Ranch)	56 km NNE (Rachel)	75 km SSE (Indian Springs)
16	3545 Substation	46 km SSW (Amargosa Valley)	46 km SSW (Amargosa Valley)	58 km SSW (Amargosa Valley)
20	Schooner	36 km WSW (Sarcobatus Flat)	20 km WSW (Tolicha Peak)	56 km SSW (Beatty)
23	Mercury Track	24 km SW (Crystal)	6.0 km SE (American Silica)	31 km SSW (Indian Springs)
25	Gate 510	4 km S (Amargosa Valley)	3.5 km S (Amargosa Valley)	15 km SW (Amargosa Valley)

(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. Distance[a] and Direction[b] from Emission Sources to CR Stations

Emission Source			Area 6, Yucca	Area 10, Gate 700 South	Area 16, 3545 Substation	Area 20, Schooner	Area 23, Mercury Track	Area 25, Gate 510
Environmental Management Sites	Legacy Contamination Sites	Area 1	11.7 SSE	17.0 NNE	8.2 WSW	52.5 NW	44.8 SSE	50.0 SSW
		Area 2	21.1 SSE	10.4 NE	14.7 SSW	46.1 WNW	54.4 SSE	57.7 SSW
		Area 3	9.6 SSW	16.6 N	14.2 WSW	58.8 NW	42.6 S	53.0 SW
		Area 4	16.2 SSE	12.8 NE	11.3 SW	49.7 WNW	49.6 SSE	54.1 SSW
		Area 5	20.5 NNW	44.1 N	33.1 NW	> 80 km	16.9 SSW	44.7 WSW
		Area 6	2.4 NE	28.1 N	13.3 NW	63.2 NW	32.0 SSE	42.1 SW
		Area 7	15.1 S	11.0 N	16.4 WSW	56.0 WNW	48.2 S	57.5 SW
		Area 8	26.5 S	5.7 E	21.5 SSW	46.1 WNW	60.0 S	64.5 SSW
		Area 9	19.3 S	7.0 NNE	17.7 SW	52.5 WNW	52.5 S	60.2 SSW
		Area 10[c]	24.5 S	2.6 NE	21.6 SW	50.2 WNW	57.7 S	64.5 SSW
		Area 11	8.6 WSW	24.5 NNW	20.7 WNW	68.1 NW	35.4 S	52.1 SW
		Area 12[c]	30.6 SSE	13.0 ESE	22.3 S	38.8 WNW	63.8 SSE	64.2 SSW
		Area 15	28.0 S	2.7 SE	24.8 SSW	49.3 WNW	61.3 S	67.8 SSW
		Area 16	15.2 ESE	24.0 NE	1.6 SE	48.4 NW	44.7 SSE	43.5 SSW
		Area 17	22.2 SE	17.5 ENE	11.3 S	41.6 NW	54.1 SSE	52.9 SSW
		Area 18	31.5 SE	29.1 ENE	18.1 SE	32.1 NW	59.9 SSE	50.5 S
		Area 19	42.4 SSE	27.4 ESE	31.0 SSE	24.3 WNW	74.2 SSE	67.8 S
		Area 20[c]	62.8 SE	51.3 ESE	49.7 SE	0.3 WNW	> 80 km	76.0 SSE
		Area 25	24.6 NE	45.9 NNE	22.2 NNE	62.5 NNW	31.7 SE	21.0 SSW
		Area 30	29.2 E	37.2 ENE	16.8 E	41.3 NNW	51.3 SE	37.4 S
	Waste Operations	Area 3 RWMS	10.1 SSW	16.1 N	14.4 WSW	58.6 NW	43.1 S	53.4 SW
		Area 5 RWMS	13.3 NW	36.7 N	26.5 NW	76.3 NW	23.2 S	45.2 WSW
	UGTA	Well ER 20-5	47.9 SE	40.8 E	34.5 SE	16.0 NNW	75.7 SE	61.2 S
		Well ER 20-7	47.7 SE	40.9 E	34.2 SE	16.6 NNW	75.2 SE	60.5 S
		Well ER 20-12	47.7 SE	40.9 E	34.2 SE	16.6 NNW	84.3 SE	68.7 S
Stockpile Operations		BEEF	16.5 SSE	12.1 NE	12.0 SW	49.9 WNW	49.9 S	54.8 SSW
		DAF	16.5 SSE	12.1 NE	12.0 SW	49.9 WNW	49.9 S	54.8 SSW
		NCERC	6.4 N	32.5 N	17.8 NW	67.8 NW	27.1 S	40.4 SW
Global Security	Tunnel Operations		28.3 SSE	12.6 ESE	19.3 S	39.0 WNW	61.3 SSE	61.2 SSW
Mission Support	Area 23 Mission Support Buildings		33.6 N	59.2 N	43.3 NNW	> 80 km	0.2 WNW	36.5 W

(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) Includes emissions from Sedan, E-Tunnel Ponds, and Schooner from Areas 10, 12, and 20, respectively.

Table 8. Average Radionuclide Concentrations at NNSS CR Stations and Fraction of Concentration Level (CL) for CY 2024

Radionuclide	Location	Average Concentration in Air (pCi/m^3) [a]	CL[b] (pCi/m^3)	Average Concentration as Fraction of CL
^{3}H	Yucca	0.29×10^{0}	1500	0.0002
	Gate 700 South	0.28×10^{0}		0.0002
	3545 Substation	0.23×10^{0}		0.0002
	Schooner	35.29×10^{0}		0.0235
	Mercury Track	0.31×10^{0}		0.0002
	Gate 510	0.20×10^{0}		0.0001
^{137}Cs	Yucca	0.00×10^{-6}	0.019	0.0000
	Gate 700 South	17.92×10^{-6}		0.0094
	3545 Substation	0.00×10^{-6}		0.0000
	Schooner	3.90×10^{-6}		0.0021
	Mercury Track	0.00×10^{-6}		0.0000
	Gate 510	0.00×10^{-6}		0.0000
^{238}Pu	Yucca	3.42×10^{-6}	0.0021	0.0016
	Gate 700 South	2.35×10^{-6}		0.0011
	3545 Substation	0.00×10^{-6}		0.0000
	Schooner	3.51×10^{-6}		0.0017
	Mercury Track	0.14×10^{-6}		0.0001
	Gate 510	0.72×10^{-6}		0.0003
$^{239+240}Pu$	Yucca	186.88×10^{-6}	0.0020	0.0934
	Gate 700 South	29.00×10^{-6}		0.0145
	3545 Substation	1.77×10^{-6}		0.0009
	Schooner	6.95×10^{-6}		0.0035
	Mercury Track	3.41×10^{-6}		0.0017
	Gate 510	1.35×10^{-6}		0.0007
^{241}Am	Yucca	32.74×10^{-6}	0.0019	0.0172
	Gate 700 South	7.43×10^{-6}		0.0039
	3545 Substation	4.21×10^{-6}		0.0022
	Schooner	7.69×10^{-6}		0.0040
	Mercury Track	2.93×10^{-6}		0.0015
	Gate 510	3.83×10^{-6}		0.0020
				Sum of Fractions
All Radionuclides by Locations	Yucca			0.1125
	Gate 700 South			0.0291
	3545 Substation			0.0033
	Schooner			0.0348
	Mercury Track			0.0035
	Gate 510			0.0032

(a) picocuries per cubic meter (pCi/m^3)
(b) Source: Table 2 in 40 CFR 61, Appendix E

Table 9. Average Radionuclide Concentration Fraction of Concentration Level (CL) at all NNSS Air Stations, CY 2024

		Annual Average Concentration / Compliance Level					
Area	Sampling Station	^{3}H	^{137}Cs	^{238}Pu	$^{239+240}Pu$	^{241}Am	Sum of Fractions of CLs
1	BJY	0.0002	0.0013	0.0016	0.0794	0.0172	0.0998
3	Bilby Crater	0.0001	0.0000	0.0022	0.1540	0.0184	0.1747
3	Kestrel Crater N	0.0003	0.0067	0.0025	0.1750	0.0340	0.2186
3	U-3ax/bl S	0.0004	0.0027	0.0028	0.1504	0.0303	0.1866
5	DoD	0.0009	0.0003	0.0002	0.0030	0.0020	0.0064
5	RWMS 5 Lagoons	0.0014	0.0000	0.0000	0.0083	0.0042	0.0139
6	Yucca[a]	0.0002	0.0000	0.0016	0.0934	0.0172	0.1125
9	Bunker 9-300	0.0003	0.0021	0.0140	1.1572	0.1604	1.3341
10	Gate 700 South[a]	0.0002	0.0094	0.0011	0.0145	0.0039	0.0291
10	Sedan N	0.0007	0.0221	0.0044	0.0909	0.0192	0.1373
11	Pu Valley AMS	0.0007	0.0000	0.0074	0.4131	0.0930	0.5142
16	3545 Substation[a]	0.0002	0.0000	0.0000	0.0009	0.0022	0.0033
18	Little Feller 2 N	0.0001	0.0066	0.0003	0.0067	0.0039	0.0176
20	North Schooner	0.0007	NM[b]	NM[b]	NM[b]	NM[b]	0.0007
20	Schooner[a]	0.0235	0.0021	0.0017	0.0035	0.0040	0.0348
23	Mercury Track[a]	0.0002	0.0000	0.0001	0.0017	0.0015	0.0035
25	Gate 510[a]	0.0001	0.0000	0.0003	0.0007	0.0020	0.0032
27	Able Site	NM[b]	0.0000	0.0000	0.0009	0.0022	0.0030

(a) CR sample location.
(b) NM = not measured. Only air particulates or atmospheric moisture are sampled at certain locations.

CAP88-PC DOSE ASSESSMENT

The radioactive air emissions from each NNSS source listed in Table 5 were modeled using the Clean Air Package, 1988 model (CAP88-PC, Version 4.1; EPA 2019). Emission locations for Legacy Contamination Sites, Grouped Area Sources, were either the center of the most contaminated location within each of the NNSS operational areas, or the center-point of the operational area if the surface contamination was relatively uniform. Emission locations from operation or project locations were the known release points. Tritium emissions from the E-Tunnel Ponds were included in the Area 12 emission. Wind files containing frequency distributions of wind speed, direction, and stability class from CY 2024 meteorological stations on the NNSS were provided by the National Oceanic and Atmospheric Administration, Air Resources Laboratory, Special Operations and Research Division (Appendix F). CAP88-PC-predicted annual doses (mrem/y) from each emission source to each receptor location are listed in Table 10.

Table 10. CAP88-PC Dose (mrem/y) from NNSS Sources, CY 2024
(" - " indicates receptor is > 80 km [50 mi] from emission)

Location	Grouped Area Sources [a]	Area 3 RWMS	BEEF	Area 5 RWMS	DAF	NCERC	Tunnel Operations	UGTA Well ER-20-5	UGTA Well ER-20-7	UGTA Well ER-20-12	Area 23 Mission Support Buildings	From All NNSS Sources (mrem/y)
NTTR	5.9E-02	1.9E-05	6.7E-04	3.5E-05	3.2E-04	6.0E-04	4.4E-03	5.0E-09	5.5E-07	7.6E-09	1.4E-12	6.5E-02
Amargosa Valley (center)	6.0E-02	1.4E-05	2.9E-04	4.1E-05	3.0E-04	2.3E-04	2.2E-04	7.3E-09	8.1E-07	-	4.8E-12	6.1E-02
Amargosa Valley (N. end)	5.7E-02	1.6E-05	4.6E-04	4.1E-05	4.9E-04	3.5E-04	2.8E-04	7.8E-09	8.6E-07	1.1E-08	-	5.8E-02
Crystal	3.9E-02	1.9E-05	5.8E-04	5.8E-05	5.5E-04	4.6E-04	2.3E-04	-	-	-	1.2E-11	4.1E-02
Beatty	3.8E-02	1.2E-05	1.2E-04	2.9E-05	6.5E-05	9.6E-05	1.7E-04	9.4E-09	1.0E-06	1.4E-08	1.5E-12	3.9E-02
Cactus Springs	3.5E-02	3.3E-05	1.2E-03	5.5E-05	1.0E-03	7.2E-04	2.8E-04	-	-	-	-	3.9E-02
Springdale	3.5E-02	1.2E-05	1.3E-04	2.8E-05	5.9E-05	1.1E-04	2.3E-04	1.7E-08	1.8E-06	2.4E-08	-	3.6E-02
Indian Springs/Creech AFB	2.9E-02	3.2E-05	9.0E-04	5.2E-05	9.1E-04	6.3E-04	-	-	-	-	2.2E-12	3.1E-02
Johnnie	2.4E-02	2.9E-05	5.0E-04	5.4E-05	8.3E-04	7.2E-04	-	-	-	-	5.0E-12	2.6E-02
Rachel	2.5E-02	1.2E-05	2.8E-04	-	-	-	5.7E-04	7.0E-09	-	-	-	2.6E-02
Anchor Brand Ranch	2.3E-02	1.3E-05	3.3E-04	2.8E-05	1.4E-04	1.9E-04	1.8E-03	-	-	-	-	2.5E-02
Tolicha Peak	2.1E-02	1.2E-05	1.2E-04	-	6.2E-05	1.2E-04	3.4E-04	1.9E-08	2.0E-06	2.7E-08	-	2.2E-02
Cold Creek	9.7E-03	2.7E-05	-	5.5E-05	5.3E-04	4.3E-04	-	-	-	-	2.2E-12	1.1E-02
Tonopah Test Range	8.9E-03	-	-	-	-	-	-	1.1E-08	1.2E-06	1.7E-08	-	8.9E-03
Scotty's Junction	4.1E-03	-	-	-	-	-	-	9.5E-09	1.0E-06	1.5E-08	-	4.1E-03
Alamo	3.4E-03	-	-	-	-	-	-	-	-	-	-	3.4E-03
Ash Meadows	2.7E-03	1.7E-05	-	4.6E-05	1.9E-04	2.2E-04	-	-	-	-	-	3.2E-03
Lee Canyon	9.6E-04	-	-	4.8E-05	4.1E-04	3.4E-04	-	-	-	-	1.9E-12	1.8E-03
Ash Spring	1.1E-03	-	-	-	-	-	-	-	-	-	-	1.1E-03
Death Valley Junction	5.5E-04	-	-	-	1.6E-04	1.8E-04	-	-	-	-	-	8.9E-04
Mt. Charleston	9.1E-05	-	-	4.5E-05	3.7E-04	3.0E-04	-	-	-	-	1.8E-12	8.1E-04
Pahrump	9.4E-05	-	-	5.1E-05	3.1E-04	3.1E-04	-	-	-	-	2.3E-12	7.7E-04
Furnace Creek	7.3E-04	-	-	-	-	-	-	-	-	-	2.9E-12	7.3E-04
Gold Point	3.7E-04	-	-	-	-	-	-	-	-	1.2E-08	-	3.7E-04
Goldfield	3.3E-04	-	-	-	-	-	-	-	-	1.6E-08	-	3.3E-04
Kyle Canyon	8.3E-05	-	-	3.4E-05	-	-	-	-	-	-	1.5E-12	1.2E-04
Corn Creek	9.7E-05	-	-	-	-	-	-	-	-	-	1.5E-12	9.7E-05
Snow Mtn. Reservation	8.7E-05	-	-	-	-	-	-	-	-	-	1.5E-12	8.7E-05
Las Vegas	7.6E-05	-	-	-	-	-	-	-	-	-	1.4E-12	7.6E-05

(a) Tritium from Sedan, E-Tunnel Ponds, and Schooner are included in the Grouped Area Sources for Areas 10, 12, and 20, respectively.

COMPLIANCE ASSESSMENT

As shown in Table 8, the highest measured sum of fractions was 0.11 at the Yucca CR location. This is less than 1 and therefore, in compliance with the 40 CFR 61.92 standard. The highest fraction of an individual CL was $^{239+240}$Pu at Yucca (0.093), which is less than 10% of the CL.

The last column of Table 10 lists the total CAP88-PC calculated dose to offsite receptors from all NNSS emissions. The maximally exposed individual (MEI) is predicted to be a person residing on the NTTR as they received a calculated EDE of 0.065 mrem/y, well below the NESHAP standard of 10 mrem/y. The fraction of the NESHAP standard for both CAP-88 modeled MEI dose estimates and the highest sum of fractions of the CLs through time are displayed in Figure 6.

Based on the CAP88-PC modeling, the only radionuclides contributing more than 10% to the MEI dose were $^{239+240}$Pu (67.2%) and ^{241}Am (12.9%). ^{238}Pu accounted for 7.4%.

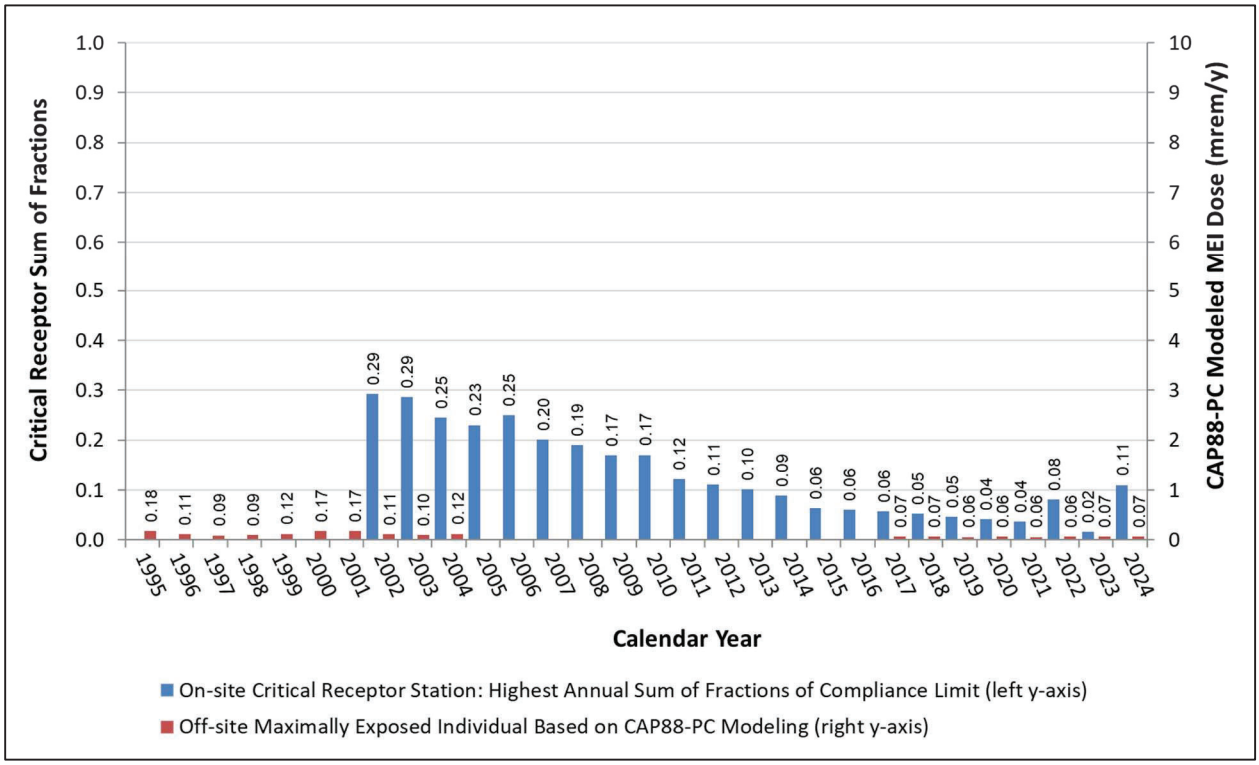

Figure 6. Highest CR Station Monitoring Results and CAP88-PC Modeled MEI Dose through Time

SECTION IV
ADDITIONAL INFORMATION

NEW CONSTRUCTION/MODIFICATION ACTIVITIES

There were no new construction or modification activities as defined in 40 CFR 61.15 during CY 2024.

DOSE EVALUATIONS CONDUCTED DURING CY 2024

The NNSS formal process for new projects or operations requires a dose assessment be conducted for release points to determine if the potential discharge to air would cause an effective dose equivalent (EDE) exceeding 1% of the standard (61.93(b)(4)(i) and (e)). No new projects or operations were initiated that required evaluation during CY 2024.

PERIODIC CONFIRMATORY MEASUREMENTS

NESHAP regulations require periodic confirmatory measurements for release sources that result in less than 1% of the standard to verify low emissions [40 CFR 61.93 (b)(4)(i) and (e)]. On the NNSS, periodic confirmatory measurements are conducted in the form of administrative reviews, engineering calculations, and monitoring at JASPER where stack effluent monitoring equipment exists. 40 CFR 61.93(b)(4)(i) and (e) states that radionuclide emission measurements are not required for release points which have a potential to discharge radionuclides into the air in quantities which could cause an EDE less than 1% of the standard. There is no activity on the NNSS that has a potential release exceeding 1% of the standard. The Memorandum of Understanding between the EPA and DOE states that "engineering calculations and/or representative measurements may be used to comply with periodic confirmatory measurement requirements" (EPA and DOE 1995). This section lists the periodic confirmatory measurements that were conducted for CY 2024 emission sources.

Joint Actinide Shock Physics Experimental Research (JASPER)

A sample of stack effluents was collected, February 13-14, 2024, during a test using special nuclear material. It was analyzed by gamma spectrometry and alpha spectrometry for ^{238}Pu, $^{239+240}$Pu, and ^{241}Am. No radionuclides were detected in the sample. There is no evidence of radionuclide emissions from JASPER operations, which confirms the assessment of this potential source having emission less than 1% of the standard (National Security Technologies, LLC, 2013a).

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

Biannual measurements of ^{3}H concentrations in air in Building A-01 are made as a best management practice. The potential dose from Building A-01 emissions is calculated each year based on this monitoring information. The emissions during CY 2024 were analogous to the past few years and the resultant dose (0.0000047 mrem/y) was well below the 0.1 mrem/y level (1% of the standard) specified in 40 CFR 61.93(b)(4)(i) and (e). A summary of this is presented in Appendix D.

Big Explosives Experiment Facility (BEEF)

Project personnel reported the maximum amount of depleted uranium used at the facility (Table 5). 100% of this (5.5E-02 Ci) was conservatively modeled as an emission using CAP88-PC software. The resultant potential effective dose equivalent to the maximally exposed individual was determined to be 0.0012 mrem/y (Table A-1). This confirms this location continues to have emissions less than 1% of the standard.

National Criticality Experiments Research Center (NCERC)

This research was conducted at the Los Alamos Critical Experiments Facility operated at the Los Alamos National Laboratory (LANL) from 1947 until 1999 when the decision was made to relocate operations to the NNSS. Over the many years of operation at LANL, a correlation had been developed that relates the integrated current from the Linear Channel detectors to the number of fissions in an assembly (other than Godiva). The correlation is based on data obtained from small fission foils irradiated during assembly operations. That data combined with the corresponding Linear Channel data provides a correlation of fissions per Amp-second (6.2E+18 fissions per Amp-second) which is used to calculate the total fissions per year. The Godiva-IV assembly uses a correlation developed over 50 years of operational experience. For a 70 ºC burst, the total number of fissions is 1.1E+16. Multiplying the correlation times the number of bursts in a year provides the annual number of fissions. Emissions were reported annually in the LANL NESHAP reports prior to it being moved to the NNSS. As LANL had an established method to calculate emissions, the same process was initially applied for the operations on the NNSS.

Beginning in 2015, the methodology to estimate emissions was refined to include more activation products in air, fission products, and potential emissions from handling unclad solids. Project personnel provided the number of fissions produced by the assembly machines during CY 2024. The total number of fissions (9.49E+17) were multiplied by the maximum of either the thermal or fast fission yield for uranium-235 (Nichols et al. 2008) to obtain a conservatively high estimate of fission products produced. Activation products in air were calculated from the neutrons (calculated at 3 per fission).

The emission was obtained by multiplying fission products by 40 CFR 61 Appendix D emission factors. While the temperature from most bursts will be less than 100 ºC, a temperature of 850 ºC has been reached in previous research so this temperature (850 ºC) was considered the operating temperature for this emission calculation. The method for evaluation of the physical state of the fission products was based on the Federal Facility Compliance Agreement (1996) between the U.S. EPA Region 6 and the U.S. Department of Energy, Los Alamos Site Office which states: “A radionuclide material that has a boiling point greater than 2000 ºC and is heated to within 1000 ºC of its boiling point or higher, or is intentionally dispersed into the environment, must be considered a gas. If the material is not heated to within 1000 ºC of its boiling point, the material would be considered a solid or a liquid depending on its actual physical state at that temperature.” The adjustment factor for HEPA filters (0.01), as listed in Table 1 of 40 CFR 61 Appendix D, was applied to all particulates. The 40 CFR 61 Appendix D rule (all material greater than 100ºC will be considered a gas) was applied to all radionuclides with a boiling point less than or equal to 2000 ºC. This conservative potential emission (Table 5) was modeled using CAP88-PC software and the resultant potential EDE to the maximally exposed individual (MEI) was determined to be 0.00072 mrem/y (Table A-1).

Other Emission Sources

The basis for estimate of CY 2024 radionuclide emissions (Table 5) other than those listed above can be found in Appendices B, C, and E. The potential doses to the MEI from those emissions are listed in Table A-1. All are much less than 0.1 mrem/y, confirming these locations and activities continue to have emissions less than 1% of the standard.

UNPLANNED RELEASES

There were no unplanned radionuclide releases during CY 2024.

REFERENCES

Clark County Department of Comprehensive Planning. Clark County, Nevada 2024 Population Estimates. Documents "Final_2024_Place_Population.pdf" and "2024_ZipCode_Population.pdf" retrieved from https://webfiles.clarkcountynv.gov//Final_2024_Place_Population.pdf, and https://webfiles.clarkcountynv.gov//2024_ZipCode_Population.pdf on February 25, 2025.

DOE, see U.S. Department of Energy.

EPA, see U.S. Environmental Protection Agency.

Federal Facility Compliance Agreement, 1996. *Federal Facility Agreement Regarding CAA—40 CFR Part 61, Subpart H at the Los Alamos National Laboratory*, 1996. Agreed to by the U.S, Environmental Protection Agency Region 6 and the U.S. Department of Energy Los Alamos Area Office.

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

National Security Technologies, LLC, 2013a. *National Emission Standards for Hazardous Air Pollutants – Radionuclide Emissions Calendar Year 2012*. DOE/NV/25946--1796. U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office, Las Vegas, NV.

National Security Technologies, LLC, 2013b. *Special Analysis for the Disposal of the Consolidated Edison Uranium Solidification Project Waste Stream at the Area 5 Radioactive Waste Management Site, Nevada National Security Site, Nye County, Nevada*. DOE/NV/25946--1678. U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office, Las Vegas, NV.

Nichols, A. L., D.L. Aldama, and M. Verpelli. 2008. *Handbook of Nuclear Data for Safeguards: Addendum, August 2008*. Report INDC(NDS)-0534, International Atomic Energy Agency, International Nuclear Data Committee, Vienna, Austria.

Shinn, J. H. 1993. *The Technical Basis for Air Pathway Assessment of Resuspended Radioactive Aerosols*: LLNL Experiences at Seven Sites Around the World. UCRL-JC-115045. Lawrence Livermore National Laboratory, Livermore, CA.

U.S. Census Bureau. Explore Census Data website https://data.census.gov/cedsci/ accessed on April 4, 2022.

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

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

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

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

U.S. Department of Energy, 2020. *Quality Assurance*. DOE O 414.1D, Chg. 2, Washington, D.C.

U.S. Department of Energy, 2021a. *Radioactive Waste Management*. DOE O 435.1, Chg. 2, Office of Environmental Management, Washington, D.C.

U.S. Department of Energy, 2021b. *Radioactive Waste Management Manual*. DOE M 435.1-1, Chg. 3, Office of Environmental Management, Washington, D.C.

U.S. Environmental Protection Agency, 2001a. Letter from Jack P. Broadbent, EPA Region IX Director, Air Division, to Kenneth A. Hoar, DOE Nevada Field [Operations] Office, Environmental, Safety & Health Division, July 23, 2001.

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

U.S. Environmental Protection Agency, 2019. CAP88-PC Version 4.1 User Guide, Office of Radiation and Indoor Air, Washington, D.C.

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

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APPENDICES

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Appendix A

Radionuclide Air Emission Sources

Table A.1. Facilities or Areas from Which Radionuclides Were Released to Air in Calendar Year (CY) 2024

Emission Source	Emission Type	Radionuclide(s) Emitted	Handling/ Processing	Nature of Emissions	Effluent Controls	MEI Dose[(a)] (Location)	Distance[(b)] and Direction[(c)] to Nearest Air Sampler(s)
Environmental Management - Legacy Contamination Sites							
Sedan Crater, Area 10	Diffuse	Tritium (^{3}H) as tritiated water (HTO), americium (Am), plutonium (Pu), activation and fission products	None	^{3}H as HTO evaporation from soil or transpiration from plants and suspension of contaminated soil by wind	None	0.00019 (Amargosa Valley, 67 km SSW)	• Sedan N: 0.8 kilometers (km) N • Critical receptor (CR) sampler (Gate 700 South): 2.6 km NE
Schooner Crater, Area 20	Diffuse	^{3}H as HTO, Am, Pu, activation and fission products	None	^{3}H as HTO evaporation from soil or transpiration from plants and suspension of contaminated soil by wind	None	0.000056 (Tolicha Peak, 20 km WSW)	• CR sampler (Schooner): 0.3 km WNW
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 are emitted from Sedan and Schooner—see above)	None	Wind causing suspension of soil containing small amounts of historical fallout/legacy radioactive materials	None	0.024[(d)] (Amargosa Valley , 36 to 80 km generally SSW)	• Air samplers range from 0.3 km (Schooner CR sampler) WNW of Schooner Crater to 21 km (Gate 510 CR sampler) SSW of Area 25 area sources
E-Tunnel Ponds, Area 12	Diffuse	^{3}H in groundwater flowing tunnel system	Groundwater drainage to earthen ponds	^{3}H as HTO through evaporation or transpiration	None	0.00004 (NTTR, 31 km E)	• Little Feller 2N: 11.9 km WSW • CR sampler (Gate 700 South): 15 km E
Underground Test Area (UGTA) Wells	Diffuse	^{3}H as HTO	Groundwater pumped to the surface	Evaporation of ^{3}H as HTO	None	0.000002 (Tolicha Peak, 28 km WNW)	• CR sampler (Schooner):17.6 km NNW

(a) mrem/y.
(b) Distance is shown in km. For miles, multiply by 0.62.
(c) N=north, S=south, E=east, W=west in all direction combinations shown.
(d) Includes dose from Sedan Crater (Area 10), Schooner Crater (Area 20) listed above, and E Tunnel (Area 12) listed below.

Table A.1. Facilities or Areas from Which Radionuclides Were Released to Air in Calendar Year (CY) 2024 (continued)

Facility or Area	Emission Type	Radionuclide(s) Emitted	Handling/ Processing	Nature of Emissions	Effluent Controls	MEI Dose[a] (Location)	Distance[b] and Direction[c] to Nearest Air Sampler(s)
Environmental Management Sites - Waste Operations							
Area 3 Radioactive Waste Management Site (RWMS)	Diffuse	^{3}H as HTO	Subsurface burial of waste	^{3}H as HTO through evapotranspiration	Soil cover	0.00003 (Cactus Springs, 58 km SSE)	• U-3ax/bl S: near the center of the Area 3 RWMS • CR sampler (Yucca): 10 km SSW
Area 5 RWMS	Diffuse	^{3}H as HTO (only radionuclide emission attributable to LLW, mixed LLW)	Subsurface burial of waste	^{3}H as HTO through evapotranspiration	Soil cover	0.00006 (Crystal, 45 km SSW)	• DoD: 0.4 km from NE edge of the Area 5 RWMS • CR sampler (Yucca): 14 km to the NNW
Stockpile Operations							
Big Explosives Experiment Facility, Area 4	Diffuse	Depleted Uranium	Explosives	DU released from explosive experiments	None	0.0012 (Cactus Springs, 66 km SSE)	• Bunker 9-300: 5.5 km ENE • CR sampler (3545 Substation) 12.0 km SW
Device Assembly Facility, Area 6	Point (stack)	Emission calculated as plutonium equivalent; dose modeled as ^{239}Pu	Handling materials in support of experiments	Solid particulate fraction released during handling	Exhaust goes through HEPA filtration	0.001 (Cactus Springs, 45 km SE)	• CR sampler (Yucca): 6.4 km N
National Criticality Experiments Research Center, Area 6	Point (stack)	Various activation and fission products (see Table 5)	Critical mass assembly machines at very low power	Activation and fission products (gas and particulate form)	Exhaust goes through HEPA filtration	0.0007 (Johnnie, 53 km S)	• CR sampler (Yucca): 6.4 km N
Global Security							
Tunnel Operations, Area 12	Point (stack)	Depleted Uranium	Research experiments	Material used assumed emitted through stack	None included in dose estimation	0.0044 (NTTR 30 km E)	• Sedan N: 11 km E • CR sampler (3545 Substation):19 km S

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

Table A.1. Facilities or Areas from Which Radionuclides Were Released to Air in Calendar Year (CY) 2024 (continued)

Facility or Area	Emission Type	Radionuclide(s) Emitted	Handling/ Processing	Nature of Emissions	Effluent Controls	MEI Dose[a] (Location)	Distance[b] and Direction[c] to Nearest Air Sampler(s)
Mission Support							
Environmental Monitoring Building 23-652, Area 23	Point (stack)	^{3}H as HTO	Distillation or drying	^{3}H emission during distillation of samples and preparation of standards	None	1.2E-11 (Crystal, 24 km SW)	• CR sampler (Mercury Track): 0.2 km to the ESE
North Las Vegas Facility							
Building A-01	Point (vent on side of building)	Parts of the basement were contaminated with ^{3}H in 1995 including a vacant radiation source well	Air flow through building ventilation system	^{3}H as HTO through emanation from building materials into the air and exhausted from the building through the ventilation system	None	0.000005 (100 m NW of Building A-1)	• Biannual sampling inside room that was contaminated

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

Table A.2. NNSS and NLVF Emission Sources Over Time

Emission Category	Source	2020	2021	2022	2023	2024
Legacy Source	All NNSS Areas	X	X	X	X	X
Legacy Source	Sedan Crater (Plowshare), Area 10	X	X	X	X	X
Legacy Source	Schooner Crater (Plowshare), Area 20	X	X	X	X	X
Legacy Source	E-Tunnel Ponds, Area 12	X	X	X	X	X
Legacy Source	NLVF, Building A-01	X	X	X	X	X
Operations	Area 3 Radioactive Waste Management Site	X	X	X	X	X
Operations	Area 5 Radioactive Waste Management Site	X	X	X	X	X
Operations	Big Explosives Experiment Facility, Area 4		X	X	X	X
Operations	Device Assembly Facility / National Criticality Experiments Research Center, Area 6	X	X	X	X	X
Operations	ZEUS Broad Research Area (formerly Dense Plasma Focus), Area 11	X			X	
Operations	Tunnel Operations, Area 12			X	X	X
Operations	Environmental Monitoring Building 23-652, Area 23	X	X	X	X	X
Operations	Underground Test Area Activity wells (various Areas)	X			X	X

Appendix B

NNSS 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 from waste covers at the Area 3 and Area 5 Radioactive Waste Management Sites (RWMSs), and evapotranspiration of HTO from soil contaminated by atmospheric or near-surface past 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 locations, the Area 3 and Area 5 RWMSs, 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 (Appendix E). For the remaining sites listed, emissions were estimated by scaling concentrations of ^{3}H in air predicted by a modeled 1 curie (Ci) release to concentrations measured at nearby sampling stations. Figure 5 of this report shows the current NNSS air sampling station locations, and Table B.1 lists the samplers near the major diffuse ^{3}H emission locations.

SOURCE TERM ESTIMATES

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

Table B.1. Tritium Emissions from Airborne Tritium Sampling Results during CY 2024

Emission Source	Air Sampler	Annual Average Tritium Concentration (pCi/m^3)[(a)]	CAP88-PC Concentration for 1 Ci Emission (pCi/m^3)	Predicted Tritium Emission (Ci)	Emission Source Average (Ci)
Area 3 RWMS	Bilby Crater	0.2	0.0301	6.64	5.5
	Kestrel Crater N	0.42	0.0965	4.35	
Area 5 RWMS	DOD	1.29	0.279	4.62	3.92
	RWMS 5 Lagoons	2.16	0.671	3.22	
Area 10, Sedan	Gate 700 South	0.28	0.0127	22.05	14.55
	Sedan N	1.03	0.146	7.05	
Area 20, Schooner	North Schooner	1.12	0.168	6.67	6.67

(a) Average concentration in air measured at the listed air sampler.

Appendix C

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

BACKGROUND INFORMATION

Many of the operations areas on the Nevada National Security Site (NNSS) contain large area surface (diffuse) sources of radionuclides. Historical soil surveys have identified the location of these sources on the NNSS and provided estimates of the amounts of radionuclides that remain in the surface soils (U.S. Department of Energy [DOE] 1991; see Table 1 of this report). The soil, and associated radionuclides, may become airborne due to wind. Results from air samples from these areas indicate that only americium-241 (^{241}Am) and plutonium-239+240 ($^{239+240}$Pu) are routinely detected, and those are in concentrations only slightly above the minimum detectable concentrations. The total emissions (in curies [Ci]) produced each year from all known manmade radionuclides in soil at legacy sites on the NNSS are estimated with a mathematical re-suspension model. This appendix describes all the calculations involved in producing the emission estimates.

RE-SUSPENSION CALCULATIONS

The annual emissions to air from these radionuclides were estimated using the average re-suspension rate reported for the NNSS (Table 2 of Shinn, 1993) (9.85 x 10^{-12} rounded up to 1×10^{-11} per s). For example, the emission rate in picocuries (pCi)/s for $^{239+240}$Pu from Area 3 is calculated from the product of the $^{239+240}$Pu inventory (37 Ci from Table 1) and the re-suspension rate as shown below. The estimated total annual emission is expressed in millicuries per year (mCi/y).

$$37\ Ci \times \frac{10^{-11}}{s} \times \frac{3600\ s}{hour} \times \frac{24\ hours}{day} \times \frac{365\ days}{y} = \frac{1.17 \times 10^{-2} Ci}{y}\ or\ \frac{11.7\ mCi}{y}$$

This method was used for calculating the emissions of manmade radionuclides from all other areas. The results are shown in Table C.1.

Table C.1. Emission Estimates from Inventories[(a)] of Manmade Radionuclides in NNSS Surface Soil

	Annual Emission (mCi) Using Emission Factor of 1 x 10^{-11} s^{-1}								
Area	**^{60}Co**	**^{90}Sr**	**^{137}Cs**	**^{152}Eu**	**^{154}Eu**	**^{155}Eu**	**^{238}Pu**	**$^{239+240}$Pu**	**^{241}Am**
1	0.0037	2.10	1.3	0.81	0.0019	0.001	1.6	7.6	1.9
2	0.004	6.3	3.4	0.75	0.00	0.00083	2.1	6.9	1.5
3	0.0034	4.5	1.7	0.97	0.0019	0.001	0.74	12	2.4
4	0.0054	1.8	1.7	0.49	0.00	0.00041	3.1	13	3.1
5	0.002	0.12	0.057	0.54	0.0039	0.00	0.024	1.5	0.32
6	0.00067	0.48	0.4	0.00	0.00	0.00	0.79	2.6	0.75
7	0.0034	1.3	0.74	1.2	0.0039	0.00062	0.14	5	1.1
8	0.019	3.4	6	0.24	0.00	0.0012	1.9	35	8.2
9	0.0024	1.8	1.2	1.2	0.0039	0.00062	0.53	28	3.8
10	0.033	7.6	12	0.12	0.0058	0.01	4.6	35	8.8
11	0.00	0.041	0.071	0.00	0.00	0.00	0.12	9.1	1.8
12	0.004	2.3	2.9	0.00	0.00	0.00	2	12	2.8
15	0.001	3	2.7	0.00	0.00	0.00	1.9	20	4.2
16	0.00034	0.51	0.41	0.00	0.00	0.00	0.36	1.2	0.32
17	0.0034	2.6	2.1	0.00	0.00	0.00	1.1	5.7	1.4
18	0.0024	2.3	1.4	0.06	0.0019	0.0017	1.3	32	8.5
19	0.0037	4.3	5.1	0.00	0.00	0.00	7.7	44	10
20	0.027	0.59	0.78	0.7	0.031	0.0099	7.2	13	8
25	0.00	0.014	0.029	0.022	0.00	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.0027	0.18	0.21	0.038	0.0019	0.00041	1.1	4.4	1.4
Total (mCi/y)	**0.12**	**45**	**44**	**7.2**	**0.056**	**0.028**	**38**	**290**	**71**

(a) Radioactive inventories from Table 5 in DOE/NV/10845--02 (DOE 1991) decay corrected to the middle of CY 2024 (July 2, 2024), with inclusion of ingrowth of ^{241}Am from ^{241}Pu.

As shown in Table C.1, the estimated total emissions from soil inventory data and from the re-suspension model are reported to two significant figures (mCi/y). These are shown in Tables 3 and 5 of this report (as Ci/y), which summarizes all measured or computed emissions from the NNSS in calendar year 2024. The spatial relation between these diffuse emission locations and the critical receptor stations can be seen in Figure 4.

Appendix D

Potential Radionuclide Emissions and Dose from the North Las Vegas Facility

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

During the years 1999 through 2024, air sampling for HTO in the basement was conducted intermittently. For CY 2024, the results of two atmospheric moisture samples were 110 picocuries per cubic meter (pCi/m^3) for the sample collected April 9–16, 2024, and 78 pCi/m^3 for the sample collected September 9– 16, 2024. The average of these sample results (94 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/y).

$$\frac{94\ pCi}{m^3} \times \frac{673\ ft^3}{min} \times \frac{0.02832\ m^3}{ft^3} \times \frac{525{,}600\ min}{y} \times \frac{1 \times 10^{-9}\ mCi}{pCi} = \frac{0.94\ mCi}{y}$$

A dose coefficient of 5.0×10^{-6} millirem per millicurie (mrem/mCi) released is used to determine dose to the MEI from NLVF tritium emissions. This is based on earlier results from the Clean Air Package 1988 model using conservative assumptions to maximize dose and observed tritium emissions. This coefficient multiplied by the tritium emission for CY 2024 gave the estimated EDE to the nearest member of the public outside the perimeter fence shown below in both mrem/y and microrem per year (µrem/y).

$$\frac{0.94\ mCi}{y} \times \frac{5.0 \times 10^{-6} mrem}{mCi} = \frac{0.0000047\ mrem}{y}\ or\ \frac{0.0047\ \mu rem}{y}$$

A comparison of the emission rates and radiation dose to the MEI since 2005 is presented in Table D.1. Dose for each year is much less than the 40 CFR 61.92 standard of 10 mrem/y.

Table D.1. Comparison of Tritium Emission Rates from Building A-01, NLVF from 2005 to 2024

Year	Tritium Emission Rate (mCi/y)	EDE to MEI (µrem/y)
2005	20	0.10
2006	13.2	0.07
2007	12.3	0.06
2008	11.1	0.06
2009	8.7	0.044
2010	6.45	0.032
2011	4.83	0.024
2012	4.74	0.024
2013	2.27	0.011
2014	1.72	0.0086
2015	2.39	0.012
2016	2.14	0.011
2017	1.95	0.0098
2018	1.59	0.008
2019	2.35	0.012
2020	2.22	0.011
2021	2.02	0.010
2022	2.25	0.011
2023	1.70	0.0085
2024	0.94	0.0047

Appendix E

Calculation of Tritium Emissions from Contaminated Groundwater Discharges

The calendar year (CY) 2024 air emissions (in curies [Ci]) of tritium, as tritiated water from contaminated groundwater sources, were conservatively estimated. Emissions 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 the tritiated water evaporated.

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

Water flowrate from the E-Tunnel is measured monthly and the tritium concentration in the water is measured annually in support of Water Pollution Control Permit NEV 96021. The total volume of water is determined by multiplying the flowrate by the number of days in the month when the measurement was taken, then summed for all 12 months. Because the tritium concentration is decreasing over time, the value used to determine the emission was the average of the CY 2023 and CY 2024 samples (one sample collected in October 2023 and one sample collected in October 2024).

The volume of contaminated water pumped from wells is measured throughout the purging and sampling process. Samples are collected for analysis of tritium throughout the time during which water is pumped from the wells. The tritium concentration used to determine the emission is an average representative of all water pumped to the surface.

The tritium concentration and volume of groundwater discharges are listed in Table E.1. The volume of water multiplied by the tritium concentration yields the estimated tritium emission to air during 2024 under the assumption that all the water evaporated during 2024.

Table E.1. Tritium Concentrations, Water Volumes, and Estimated 2024 Tritium Emissions from Contaminated Groundwater Brought to the Surface

Location	Tritium Concentration (pCi/L)	Water Volume (L) [a]	Tritium Emission (Ci)
E-Tunnel Ponds	203,500 [b]	16,400,880	3.34
Well ER 20-5	111,291	46,900	0.0052
Well ER 20-7	62,270	9,005,000	0.56
Well ER 20-12	173,864	43,900	0.0076

(a) All water was assumed to evaporate during CY 2024.
(b) Average of results from October 2023 and October 2024 samples.

Appendix F

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

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

METEOROLOGICAL OBSERVATIONS

The ARL/SORD manages, operates, and maintains a meteorological monitoring program that is designed and used to support the NNSA/NFO-authorized activities on the NNSS. This vital program consists of many meteorological monitoring systems that have been brought together under the Meteorological Integrated Data Network (MIDNET). The MIDNET includes a Meteorological Data Acquisition (MEDA) network of 23 meteorological towers located on the NNSS (Figure F.1) and one on Yucca Mountain. The MIDNET consists of communications systems, local area networks, and surface-based instrumentation used to measure wind direction and speed, temperature, relative humidity, atmospheric 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.

Upper-air observations (radiosondes) were taken twice daily from Desert Rock Meteorological Observatory (DRA; elevation 1007 meters [m], located 4.8 kilometers southwest of Mercury, Nevada [Station 30 in Figure F.1]) but were discontinued in October 2010. Upper-air data are currently collected at the National Weather Service office in Las Vegas. DRA had been in operation since May 1978 and was built to replace a similar observatory that was located at the Yucca Flat Meteorological Observatory (UCC; elevation 1,196 m) from January 1962 through mid-May 1978. Consequently, surface, and upper-air observations are also available from UCC for 1962–1978.

A key component of the MIDNET system is the MEDA station. A MEDA station consists of a 10-m tower, a data-logger, meteorological sensors, and a radio transmitter. The 25 MEDA stations located on or near the NNSS (Figure F.1) provide surface weather data for climatology, weather forecasts, and warnings for NNSS operations and emergency response activities. MEDA station locations were selected based on criteria to support NNSS consequence assessment activities, compliance reporting requirements, and general weather and forecasting needs.

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

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

Ambient temperature and relative humidity sensors are located approximately 1.5 and 8.5 m above ground level. MEDA temperature data are accurate to ±0.2 degrees Celsius (°C) (absolute range for the NNSS is −29°C to 46°C). Temperature and relative humidity measurements are 15-minute averages and are also transmitted every 15 minutes via radio to a computer server for processing, review, display, and archiving. Temperature differences are used in determining atmospheric stability which describes how aerosols disperse in the air.

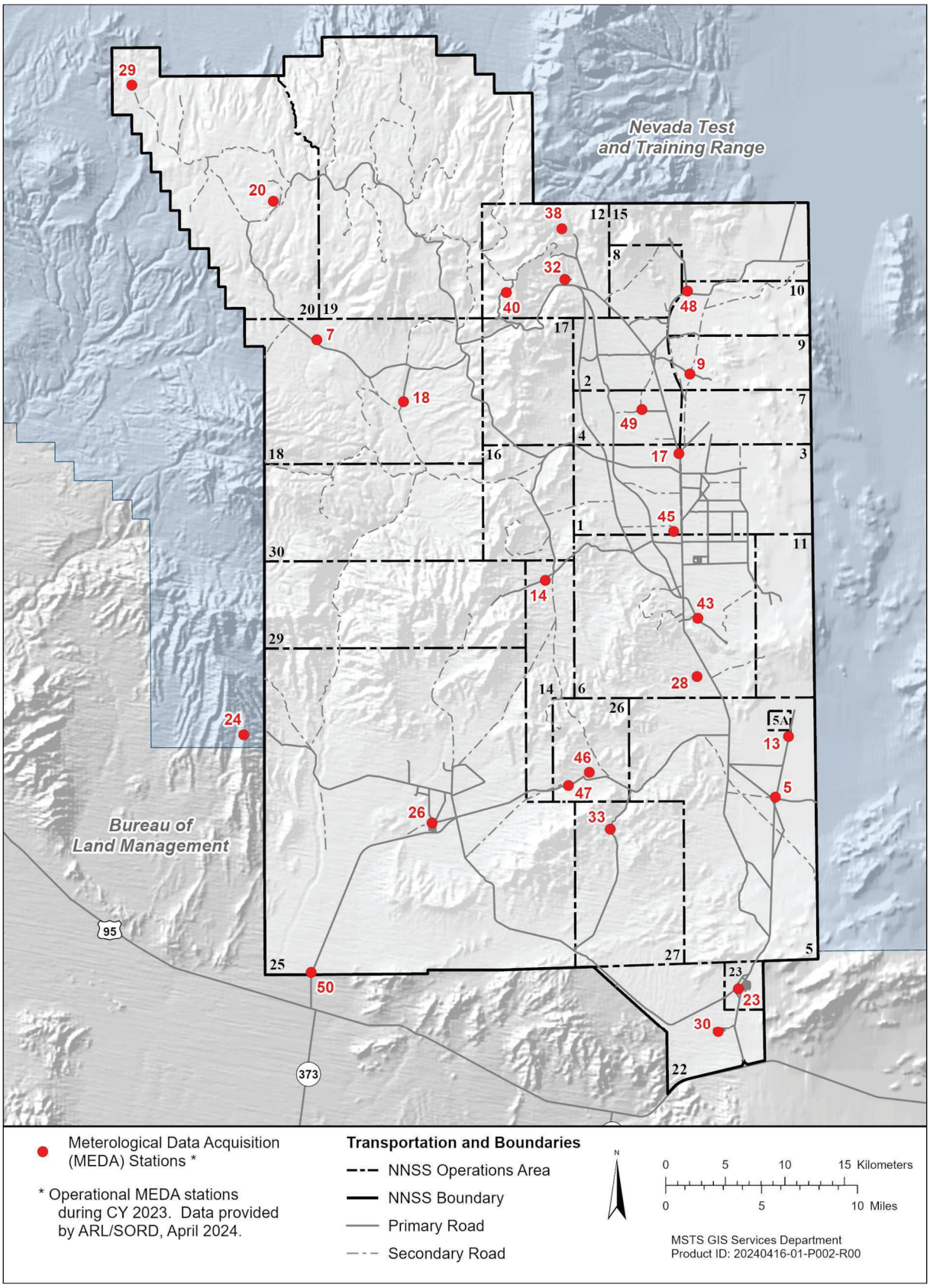

Figure F.1. Locations of MEDA Stations on the NNSS at End of CY 2024

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

APPLICATION TO CAP88-PC INPUT

Based on the above considerations and on the limitations of the CAP88-PC computer program, the cloud cover data from DRA are 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 best data for calculating transport and dispersion processes. The STAR file is a matrix that includes seven Pasquill stability categories (A through G), six wind speed categories, and 16 wind sectors from wind roses calculated for each specified MEDA station on the NNSS. The STAR files are used by a CAP88-PC utility program to create WIND files that are used by CAP88-PC to estimate offsite dose from NNSS emissions (Section III) and to emissions from diffuse tritium sources on the NNSS (Appendix B).

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Appendix G

Supplemental Information

COLLECTIVE EFFECTIVE DOSE EQUIVALENT

The collective effective dose equivalent (EDE) is the sum of the dose predicted by the CAP88-PC at each offsite receptor location multiplied by the population at that location. The collective EDE for CY 2024 was 0.31 person-rem [roentgen equivalent man] per year (y) for the 557,100 people who lived within 80 km (50 mi) of NNSS emission sources.

COMPLIANCE WITH 40 CFR 61, SUBPARTS Q AND T

The NNSS is regulated by Title 40 Code of Federal Regulations (CFR) Part 61, Subpart H ("National Emission Standards for Emissions of Radionuclides Other than Radon from DOE Facilities") but not Q ("National Emission Standards for Radon Emissions from DOE Facilities") or T ("National Emission Standards for Radon Emissions from the Disposal of Uranium Mill Tailings"). However, U.S. Department of Energy Order DOE O 435.1, "Radioactive Waste Management" (DOE 2021a) requires that radioactive waste shall be managed in accordance with DOE M 435.1-1, "Radioactive Waste Management Manual" (DOE 2021b) which includes a limit on radon flux (20 picocuries per square meter per second) from waste disposal facilities. Therefore, radon flux measurements are routinely made at the Area 3 and Area 5 Radioactive Waste Management Sites. The maximum radon flux measurement taken during 2024 was 2.7 $pCi/m^2/s$, at the Area 3 RWMS. An assessment of the potential risks posed by the Area 5 RWMS 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 4,200 years (National Security Technologies, LLC, 2013b).

NON-DISPOSAL/NON-STORAGE SOURCES OF RADON EMISSIONS

None of these sources exist on the NNSS.

QUALITY ASSURANCE PROGRAM FOR NESHAP COMPLIANCE

The quality assurance program for samples collected and analyzed for NESHAP compliance is documented in an environmental monitoring plan (DOE 2003). The applicable requirements of 40 CFR 61, Appendix B, Method 114, "Test Methods for Measuring Radionuclide Emissions from Stationary Sources" (U.S. Environmental Protection Agency 2001b) and of DOE O 414.1D, "Quality Assurance" (DOE 2020) have been implemented in this plan.

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