DOE/NV/11718--1065

Calendar Year 2004

National Emission Standards for Hazardous Air Pollutants

June 2005

Prepared for:
U.S. Department of Energy
National Nuclear Security Administration
Nevada Site Office

Prepared by:
Bechtel Nevada
Post Office Box 98521
Las Vegas, NV 89193-8521

NNSA

DISCLAIMER

DOE/NV/11718--1065

National Emission Standards for Hazardous Air Pollutants Calendar Year 2004

By
Robert F. Grossman

June 2005

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Prepared by:

Bechtel Nevada
Post Office Box 98521
Las Vegas, Nevada 89193-8521

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TABLE OF CONTENTS

LIST OF FIGURES

Page

LIST OF TABLES

Page

LIST OF ACRONYMS

Am	Americium
ARL/SORD	Air Resources Laboratory, Special Operations and Research Division
BN	Bechtel Nevada
CAP88-PC	Clean Air Package 1988 (EPA software program for estimating doses)
CFR	Code of Federal Regulations
Ci	Curie
cm/yr	centimeters/year
CY	Calendar Year
DAF	Device Assembly Facility
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DRA	Desert Rock Meteorological Observatory
EDE	Effective Dose Equivalent
EPA	U.S. Environmental Protection Agency
ERDA	Energy Research and Development Administration
F	Fahrenheit
FFACO	Federal Facilities Agreement and Consent Order
GIS	Geographical Informational System
H^3	tritium
HEPA	High Efficiency Particulate Air
HTO	Tritiated Water
in/yr	inches/year
JASPER	Joint Actinide Shock Physics Experimental Research
km^2	square kilometers
km	kilometers
L	liters
LLW	Low-level Radioactive Waste
MDC	Minimum Detectable Concentration
MEDA	Meteorological Data Acquisition System
MEI	Maximally Exposed Individual
mi	miles
mi^2	square miles
MIDNET	Meteorological Data Network
mrem	milli-roentgen equivalent man
mrem/yr	milli-roentgen equivalent man per year
NESHAP	National Emission Standard for Hazardous Air Pollutants
NLVF	North Las Vegas Facility
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NOAA	National Oceanic and Atmospheric Administration
NRC	U.S. Nuclear Regulatory Commission
NTS	Nevada Test Site
NTTR	Nevada Test and Training Range
Pu	plutonium
Rn	radon
RWMS	Radioactive Waste Management Site
s	second

SNM	special nuclear materials
STAR	Stability Array (grouping of meteorological data)
Th	thorium
TRU	Transuranic (nuclides with atomic numbers greater than uranium)
UCC	Yucca Flat Meteorological Observatory
µCi	micro-curie
µrem/yr	micro-roentgen equivalent man per year
Xe	Xenon

U.S. Department of Energy
National Nuclear Security Administration
Nevada Site Office
Air Emissions Annual Report
(under Subpart H, Title 40 Code of Federal Regulations [CFR] 61.94)
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Site Name: Nevada Test Site

Office Information

Office: U.S. Department of Energy, National Nuclear Security Administration
Nevada Site Office

Address: P. O. Box 98518

Las Vegas, NV 89193-8518

Contact: Kenneth A. Hoar Phone: (702) 295-1428

Director, Environment, Safety and Health Division

Site Information

Operator: Bechtel Nevada

Address: P. O. Box 98521

Las Vegas, NV 89193-8521

Contact: Wayne F. Johnson Phone: (702) 295-0473

Assistant General Manager, Environmental Management

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SECTION I
FACILITY INFORMATION

SITE DESCRIPTION

The Nevada Test Site (NTS) is operated by the U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Site Office (NNSA/NSO) as the site for nuclear weapons testing, now limited to readiness activities, 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 km^2 (1,375 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 1.0 persons/km^2 (2.6 person/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. Surface waters are scarce on the NTS, and slow-moving groundwater is present hundreds to thousands of feet below the land surface.

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 (DOE, 1996a). No nuclear tests have been conducted since September 23,1992 (DOE, 2000), however; radionuclides remaining on the soil surface in many NTS areas after several decades of radioactive decay are re-suspended into the atmosphere at concentrations that can be detected by air sampling.

Limited non-nuclear testing includes spills of hazardous materials at the Non-Proliferation Test and Evaluation Complex (formerly called the Hazardous Materials Spill Center), private technology development, aerospace and demilitarization activities, and site remediating activities.

Processing of radioactive materials is limited to laboratory analyses; handling, transport, storage, and assembly of nuclear explosive devices or radioactive targets for the Joint Actinide Shock Physics Experimental Research (JASPER) gas gun; and operation of radioactive waste management sites (RWMSs) for low-level radioactive and mixed waste (DOE, 1996a). Monitoring and evaluation of the various activities conducted onsite indicate that the potential sources of offsite radiation exposure in calendar year (CY) 2004 were releases from (1) evaporation of tritiated water (HTO) from containment ponds that receive drainage water from E Tunnel in Area 12 and water pumped from wells used to characterize the aquifers at the sites of past underground nuclear tests, (2) onsite radioanalytical laboratories, (3) the Area 3 and Area 5 RWMS facilities, and (4) diffuse sources of tritium (H^3) and re-suspension of plutonium ($^{239+240}Pu$) and americium (^{241}Am) at the sites of past nuclear tests. The following sections present a general description of the present sources on the NTS and at the North Las Vegas Facility (NLVF).

At the NLVF, parts of Building A-1 were contaminated with tritium by a previous contractor in 1995. The incident involved the release of tritium as HTO. This unusual occurrence led to a very small potential exposure to an offsite person. The HTO emission has continued at lower levels (probably re-emanation from building materials), even after cleanup activities in November and December 1997. A description of the incident and the potential effective dose equivalent (EDE) for offsite exposure are set forth in Appendix A.

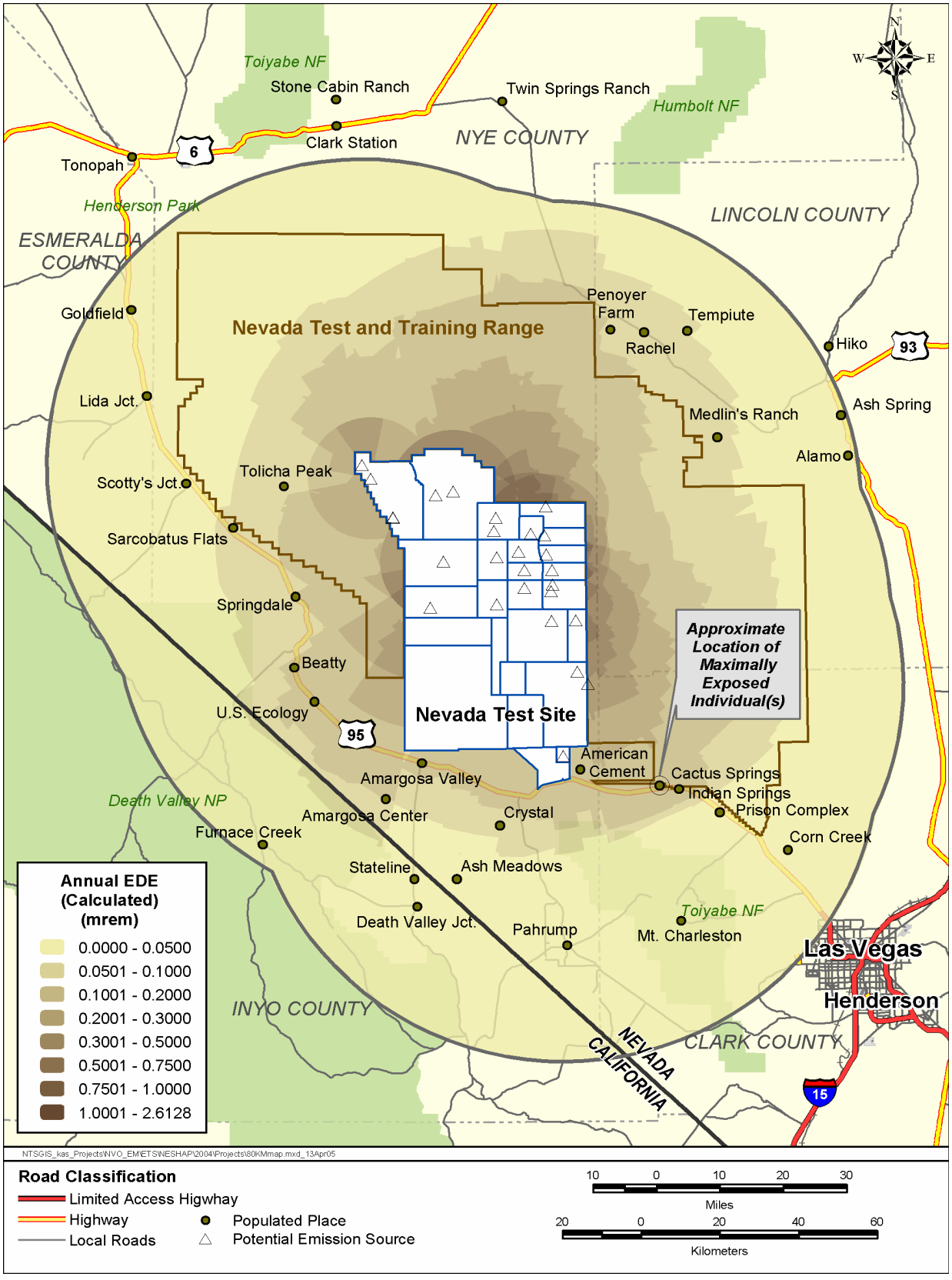

Figure 1.0 Map of the NTS and Surrounding Areas Showing Annual EDEs within 80 km of Emission Sources

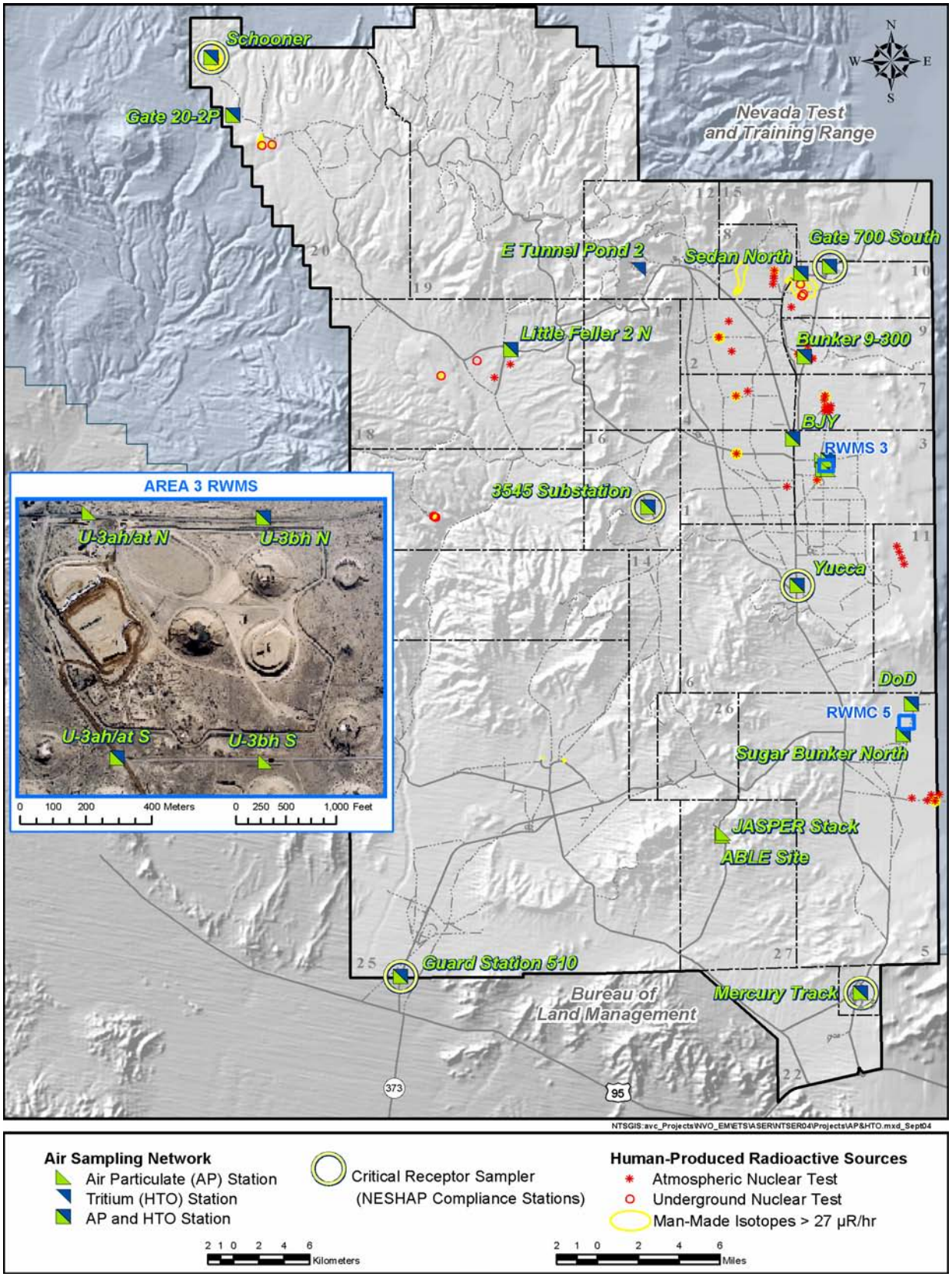

Figure 2.0 Sources of Radioactive Contamination and Air Sampling Network on the NTS

Tunnel Operations

Nuclear explosive tests have been conducted within tunnel complexes mined into the Rainier Mesa region and in Areas 15 and 16. When these tests were conducted, purging gases from the tunnels occasionally resulted in releases of radioactivity, and contaminated water drained from the tunnels into containment ponds (ERDA, 1977). No nuclear testing activities have occurred since 1992.

Containment Ponds

Water contaminated with radionuclides seeped from the tunnels in Area 12 and was collected in containment ponds resulting in water evaporation and seepage into the soil. The tunnels have been sealed, but water continues to seep from E Tunnel. A photograph of the tunnel containment ponds at E Tunnel is provided in Figure 3.0. The only radiological contaminant which produces a measurable air emission from evaporation of the water is tritium (as HTO). Calculation of the source term and offsite effective dose equivalents (EDEs) for this emission is described in Appendix B.

To characterize the groundwater regime under the NTS, suitable wells are being drilled and existing wells re-completed in the vicinity of certain underground tests and at other locations on the NTS, as determined by hydrologists. During these drilling operations, if the tritium level exceeds 2×10^5 pCi/L, contaminated water is pumped from the wells and diverted to lined containment ponds, as required by the state and explained in the Underground Test Area Program (DOE, 1996a). During CY 2004, water containing tritium was pumped from Wells U-3cn PS#2, U-19ad PS#1, ER-20-5 #1, and ER-20-5 #3 into lined containment ponds. Calculations of the tritium emissions from these sources and offsite EDEs are described in Appendix B.

Laboratories

Radiological analyses were conducted in laboratories located in Area 23 Buildings 650 and 652 (Mercury); Building CP-95A (Area 6); and the Device Assembly Facility (DAF) (Area 6). Because these facilities process environmental samples, very little radioactivity passes through them. However, there is potential for some radionuclides to be discharged into the atmosphere from the hood ventilation systems during sample processing, particularly of spiked samples, or from loss of radioactive standards in liquid or gaseous form. This year the only laboratory emission was 42 µCi of tritium gas which was used by laboratory personnel at Area 23 Building 650, while calibrating analytical equipment. The source term and the EDE resulting from the emission are described in Appendix C.

Non-volatile radioactive standards were controlled by keeping their inventory below the possession limits set forth in Title 40 Code of Federal Regulations (CFR) 61, Subpart H (National Emission Standards for Emissions of Radionuclides Other Than Radon from DOE Facilities) (CFR, 2002).

Radioactive Waste Management Sites

The Area 3 RWMS and the Area 5 RWMS are used for the disposal of low-level radioactive wastes (LLW). The RWMS-5 is also used for accumulation of mixed waste and storage of transuranic (TRU) and mixed TRU wastes. Disposal is accomplished by the use of pits and trenches. Concrete pads are used for temporary storage of certain wastes. At the Area 5 RWMS, only packaged, dry wastes are accepted for disposal. The facility is considered a

Figure 3.0 Photograph of E Tunnel Containment Ponds (07-23-1997)

diffuse source of radiological effluents. The only radioactive emission detected by the various types of samplers located downwind of the site and attributed to site operations was HTO in atmospheric moisture. The calculation of the HTO source term for these emissions and the EDEs to offsite residents is explained in Appendix D. Since the Area 3 RWMS LLW site is in a location where the surrounding surface soil has been contaminated by past nuclear tests, the re-suspension of this soil by wind or vehicular activity results in above background levels of plutonium being detected in air samples collected outside the perimeter fence. Due to recent and future disposal of waste containing tritium planned for the Area 3 RWMS, air samplers for tritium were installed at the northeast and southwest corners of the perimeter fence on November 8, 2004.

Joint Actinide Shock Physics Experimental Research (JASPER)

Approval by the U.S. Environmental Protection Agency (EPA) was obtained in June 1999 for the construction of a hydrogen gas gun in Building 5100 in Area 27 using special nuclear material and other actinide materials as targets. To assure that the emissions are in conformance with National Emission Standards for Hazardous Air Pollutants (NESHAP), a stack monitoring system was installed downstream of high efficiency particulate air (HEPA) filters. In June 2000, the construction and startup phase was completed. Beginning in June 2003, equation-of-state experiments, with the two-stage light gas gun, were begun using plutonium as target material. From the results of the stack monitoring system, no radioactive emissions from the eight experiments conducted during CY 2004 were detected by the stack sampling system.

The plutonium targets used by project JASPER were prepared in a glove box located in the Area 6 DAF. The glove box ventilation system was exhausted through HEPA filters to assure that no air emission would occur during the preparation of the targets.

Surface Areas Contaminated with Tritium, Plutonium, or Americium

Tritium emanation from the cratering tests SEDAN and SCHOONER was detectable in atmospheric moisture samples collected on molecular sieves by special air samplers. Derivation of the source terms for these locations and calculation of the offsite EDEs are described in Appendix D.

Surface soils in certain areas on the NTS were contaminated with plutonium and/or tritium from either 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 the inventories of plutonium shown in Table 1.0. These areas could become sources of exposures to ^{241}Am and $^{239+240}$Pu if the contaminated soils were to be re-suspended, e.g., during windy conditions, surface cleanup, construction, vehicular travel, or similar activities. Figure 2.0 is a map showing the approximate locations of the above ground or near surface nuclear tests on the NTS. There are air samplers at or near most of these onsite areas. Analyses of the glass-fiber filters from these samplers indicate that the majority of the plutonium results are less than the minimum detectable concentration (MDC), and in most, detectable cases are less than the two standard deviation (2s) counting error above the MDC. The results >MDC are usually from air samplers in areas where operational activities can cause contaminated surface soil to become re-suspended. These areas are considered diffuse sources of radioactive emissions resulting in the detection of americium and plutonium in the majority of air samples collected at nearby locations. The derivation of the source term for and the reason for selection of 241Am and 239+240Pu from contaminated areas is explained in Appendix E.

Table 1.0 Inventory of ^{241}Am, ^{238}Pu, and $^{239+240}Pu$, in Surface Soil (0 to 5 cm) at Studied Sites

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

(a) (DOE, 1991)
(b) The above referenced report indicated that these levels were probably the result of historical fallout from nuclear tests in surrounding areas.

Federal Facilities Agreement and Consent Order (FFACO)

Under the FFACO between the U.S. Department of Energy, the U.S. Department of Defense, and the state of Nevada (FFACO, 1996), contamination generated by historical NTS activities is being addressed. Two surface areas northwest of the NTS on the NTTR including the Tonopah Test Range have had partial source removal, resulting in a decrease in the offsite EDE. These surface areas are DOUBLE TRACKS, remediated in 1996, and CLEAN SLATE I in 1997. The monitoring plan for such activities required continuous air sampling before, during, and after cleanup operations until the concentration in air returned to background levels. During 2004, no further remediation work or air monitoring was conducted in these areas.

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SECTION II
AIR EMISSIONS DATA

Each potential source of NTS emissions was characterized by one of the following methods: (1) monitoring methods using procedures previously developed at the NTS; (2) a yearly radionuclide inventory of the sources in laboratories, identifying any volatile radionuclides that were released to the environment; (3) the measurement of tritiated water 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; (4) use of re-suspension calculations; and (5) using a combination of environmental measurements and the Clean Air Package 1988 (CAP88-PC) air dispersion model (EPA, 1992) to calculate the emissions. Appendices A through E describe the methods used to determine the emissions from the sources listed in Table 2.0. According to Title 40 CFR 61.93.(b)(4), (CFR 2002) no credit was taken for pollution control equipment in determining air emissions.

The emissions for NESHAPs reporting are listed in Table 2.0. These emissions are conservative (worst-case) and are used in Section III to calculate the EDE to each offsite population within 80 km of each point of emission. The EDEs at each populated location resulting from all emissions is summed to determine the maximally exposed individual (MEI) offsite.

Table 2.0 Summary of Annual Air Emissions Data by Source[(a)] (Multiply Ci by 37 to obtain GBq)

Source Type	Type of Emissions Control	Distance to Nearest Receptor	Nuclide	Annual Quantity (Ci)
Point Sources				
Building 650, Area 23	None	5.5 km	^{3}H	0.000042
Building A-1[(a)]	None	0.1 km	^{3}H	0.011
Area Sources				
E Tunnel ponds	None	50 km	^{3}H[(b)]	12
RWMS-3	None	47 km	^{3}H[(c)]	83
RWMS-5	None	36 km	^{3}H[(c)]	4.9
SCHOONER	None	20 km	^{3}H[(d)]	240
SEDAN	None	50 km	^{3}H[(d)]	200
Well U-3cn PS#2	None	49km	^{3}H[(b)]	0.52
Well U-19ad PS#1A	None	39 km	^{3}H[(b	18
Well ER-20-5 #1	None	29 km	^{3}H[(b)]	4.5
Well ER-20-5#3	None	29 km	^{3}H[(b)]	0.020
Grouped Area Sources				
All NTS Areas	None	20-60 km	^{241}Am[(e)]	0.047
All NTS Areas	None	20-60 km	$^{239+240}Pu$[(e)]	0.29

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

A summary of the NTS total CY 2004 emissions for NESHAP's reporting, by radionuclide, is provided in Table 3.0.

Table 3.0 Total Estimated NTS Emissions for CY 2004 (Multiply Ci by 37 to obtain GBq)

Radionuclide	Annual Quantity (Ci)
^{3}H	560
^{241}Am	0.047
$^{239+240}Pu$	0.29

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

SECTION III
DOSE ASSESSMENTS

SUMMARY OF INPUT PARAMETERS

Version 2.0 of CAP88-PC (EPA, 2000) was used to calculate EDEs to offsite residents. The input parameters were the annual radionuclide emissions listed in Section II as determined from effluent monitoring performed by the contractor, evaporation of HTO, and calculations of diffuse source emissions that are based on environmental monitoring data and plutonium/americium re-suspension. The other input parameters common for all CAP88-PC calculation were (1) annual precipitation of 29 centimeters (11 inches), (2) average temperature of 14 degrees Centigrade (57 degrees Fahrenheit), and (3) a rural food source scenario. Wind files were created from data provided by the Air Resources Laboratory, National Oceanic and Atmospheric Administration (NOAA) for CY 2004. All emissions were assumed to occur at a constant rate through the year.

The estimated release of tritium from Building A-1 at the NLVF was calculated from measurements of tritium in atmospheric moisture samples collected in the basement area in April and September 2004 and the flow rate of the air ventilated from the basement. A detailed description is given in Appendix A.

The amount of HTO evaporated from ponds was calculated from measurements of HTO concentration and water volume discharged into the containment ponds. A description of the source terms estimated for these emission sources is provided in Appendix B.

The inventories of gaseous or liquid radioactive sources used by the NTS laboratories were reviewed to determine if any had contributed to emissions during CY 2004. Only one source was identified, a tank of tritium gas, from which 42 µCi was used at Building 650 Area 23 for the calibration of analytical equipment. It was assumed that this gas was gradually released over the year. Appendix C provides additional details of the source inventories, the estimated emission, and the calculations used for estimating the EDEs to offsite residents.

Several diffuse sources of tritium from past nuclear tests are located at the NTS. The annual source term of such emissions was estimated from environmental air samples collected near the sites of these sources (see Figure 2.0) and CAP88-PC calculations. Appendix D explains the methodology and results.

The source terms from the re-suspension of americium (^{241}Am) and plutonium ($^{239+240}$Pu) deposited on soil from past nuclear testing were calculated from a re-suspension model (Nuclear Regulatory Commission [NRC] 1983) and the radionuclide inventory of ground-surface contamination listed in Table 1.0 (DOE, 1991; DOE, 1992). Appendix E describes the application of the model and the resulting emission source terms for americium and plutonium and lists the results for each area in Table E.1. Dose assessments did not include ^{238}Pu because air sampling results in the past have shown that most of the concentrations in air have been below the MDC.

The individual source terms, whose sums are listed in Tables 2.0 and E.1, were used with stability array (STAR) data files, characterizing wind conditions, as input to CAP88-PC. The methodology used by the Air Resources Laboratory Special Operations and Research Division (ARL/SORD) in developing the STAR files and a figure showing the Meteorological Data Acquisition System (MEDA) station locations are presented in Appendix F.

COMPLIANCE ASSESSMENT

Beginning in July 2001, BN established the following compliance air sampling stations on the NTS (see Figure 2.0) as approved by EPA Region IX (EPA, 2001):

Area 6, Yucca
Area 10, Gate 700 South
Area 16, Substation 3545
Area 20, SCHOONER
Area 23, Mercury Track
Area 25, Guard Station 510

As allowed by Title 40 CFR Part 61.93(b)(5), the measurement of radionuclide air concentrations at EPA-approved critical receptor locations (i.e., compliance stations) is an acceptable alternative to using air dispersion calculations with CAP88-PC software. Although the compliance air sampling stations are on the NTS, they are used to conservatively represent offsite critical receptors. Compliance with NESHAPs is demonstrated if the measured concentration of each radionuclide at each of these locations is less than the concentration levels of Table 2 in Title 40 CFR 61, Appendix E (Compliance Procedures Methods for Determining Compliance with Subpart I) and the sum of fractions resulting from dividing each measured concentration by the value in Table 2 of Title 40 CFR 61, Appendix E for each radionuclide is less than one.

Table 4.0 lists the average radionuclide concentrations and their percentage of the NESHAP's compliance level for each of the compliance stations. All concentration averages were below 1 percent of the compliance levels except for the tritium average at the SCHOONER sampler station, which was 24 percent. The average concentration of tritium is high at SCHOONER because the air sampler is only 269 m from the center of the crater and located within the area that received ejecta from the cratering experiment (Figure 4.0). The highest sum of the ratios for measured annual concentrations to the NESHAP environmental compliance level at this location was less than 1 or 100 if expressed as a percentage in Table 4.0 (25) and is, therefore, in compliance with NESHAPs.

Assessment by Emission Estimates and CAP88-PC Calculations

The source terms listed in Table 2.0 and Table E.1 for the non-point sources from the re-suspension of ^{241}Am and $^{239+240}$Pu were used as input to CAP88-PC calculations in conjunction with the above-mentioned wind files for the appropriate NTS areas to calculate the EDEs to all offsite residents within 80 km of each emission location (Table 5.0). Table 6.0 lists a summation of EDEs for each location for the year. As shown by Table 6.0, the location of the MEI was Cactus Springs, Nevada, where the calculated EDE was 120 µrem/yr, which is only 1.2 percent of the 10,000 µrem/yr or 10 mrem/yr standard of NESHAPs. American Cement actually had an EDE that was slightly higher (130 µrem/yr), and U. S. Ecology had an EDE of 110 µrem/yr; however, since workers generally occupy these areas a half day at the most instead of a full day and use an urban food source, the EDEs at these locations would be less than half of these calculated values. At the location of the MEI, 98 percent of the calculated dose was from estimated ^{241}Am and $^{239+240}$Pu emissions and 2 percent was from tritium emissions. Appendices B through E contain the methods by which the releases of radionuclides were calculated. Evaporative and re-suspension emissions are also compared to EPA suggested methods as a check on the relative values produced.

Table 4.0 Measured Radionuclide Concentrations at Compliance Air Sampling Locations

Radio-nuclide	Area	Location	Average Concentration (pCi/m^3)	Percent of Samples with Concentrations > MDC	Concentration as Percent of Compliance Level
^{3}H	6	Yucca	0.76×10^{0}	30	0.051
	10	Gate 700 South	1.02×10^{0}	58	0.068
	16	Substation 3545	0.62×10^{0}	25	0.041
	20	SCHOONER	3.65×10^{2}	100	24.313
	23	Mercury	0.51×10^{0}	15	0.034
	25	Guard Station 510	0.73×10^{0}	19	0.049
^{241}Am	6	Yucca	1.68×10^{-6}	33	0.088
	10	Gate 700 South	5.54×10^{-6}	25	0.292
	16	Substation 3545	2.74×10^{-6}	29	0.144
	20	SCHOONER	2.18×10^{-6}	17	0.115
	23	Mercury	2.96×10^{-6}	21	0.156
	25	Guard Station 510	4.69×10^{-6}	17	0.247
^{238}Pu	6	Yucca	1.68×10^{-6}	18	0.080
	10	Gate 700 South	2.21×10^{-6}	18	0.105
	16	Substation 3545	3.08×10^{-6}	11	0.147
	20	SCHOONER	2.07×10^{-6}	0	0.099
	23	Mercury	1.17×10^{-6}	0	0.056
	25	Guard Station 510	1.76×10^{-6}	9	0.084
$^{239+240}Pu$	6	Yucca	1.60×10^{-5}	36	0.760
	10	Gate 700 South	2.05×10^{-6}	50	0.977
	16	Substation 3545	3.38×10^{-6}	28	0.161
	20	SCHOONER	2.04×10^{-7}	9	0.011
	23	Mercury	1.84×10^{-6}	0	0.088
	25	Guard Station 510	3.07×10^{-6}	14	0.146
Sum by Location	6	Yucca			1.0
	10	Gate 700 South			1.4
	16	Substation 3545			0.5
	20	SCHOONER			24.5
	23	Mercury			0.3
	25	Guard Station 510			0.5

The distribution of the calculated EDEs in the offsite areas is also shown graphically in Figure 1.0 by the different graduated shadings in brown color. This graphic was produced by application of Geographical Information System (GIS) ArcMap using the EDE table outputs from CAP88-PC computer calculations for all postulated emissions of radioactivity from NTS areas and wind files created from ARL/SORD meteorological data recorded for CY 2004. As shown in this graphic, all populated areas beyond the NTS are in areas that received calculated EDEs less than 0.2 mrem/yr.

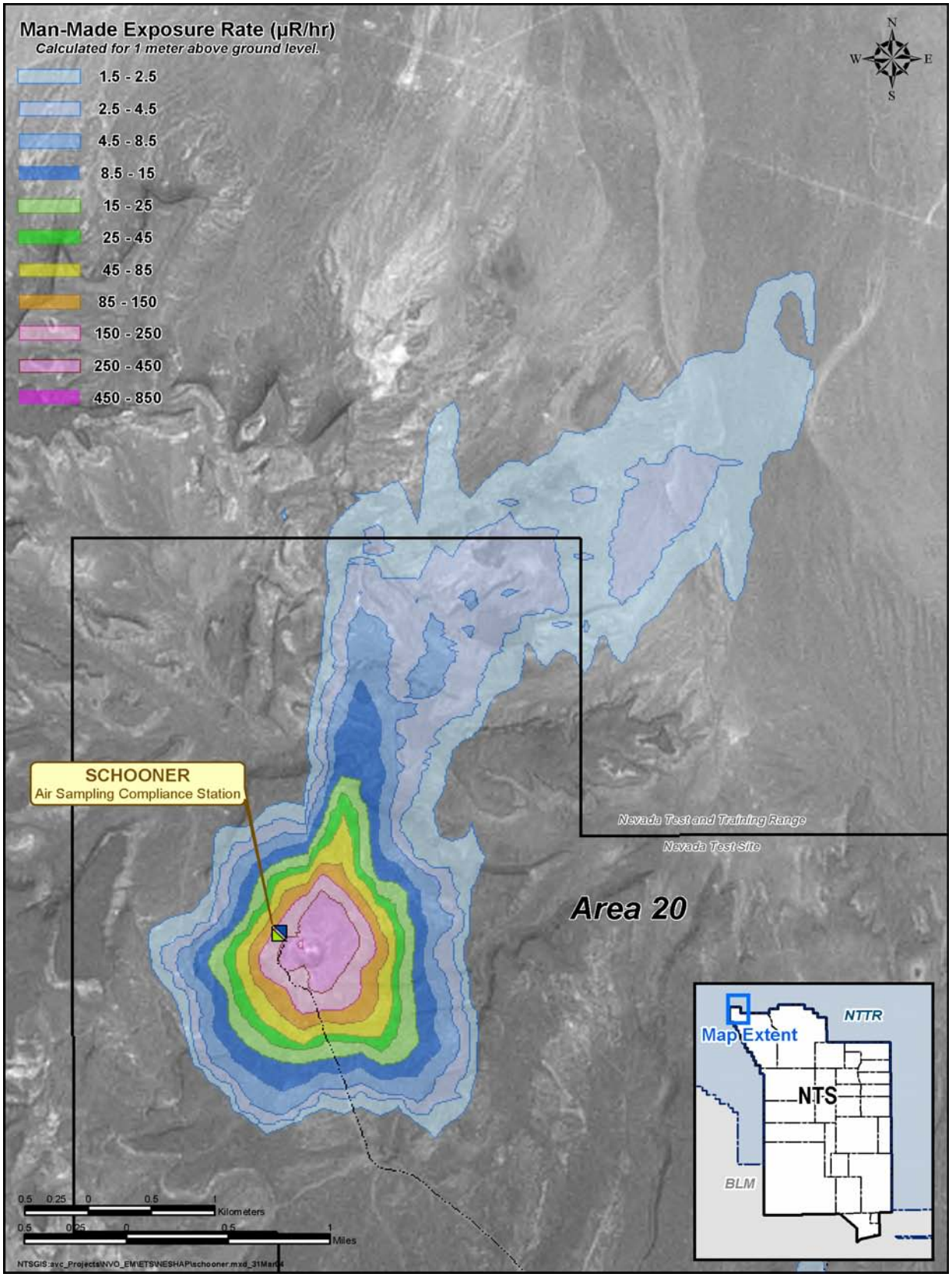

Figure 4.0 SCHOONER Air Sampling Compliance Station

Table 5.0 CY 2004 Calculated EDEs by CAP88-PC (µrem/yr)

Location	EDE (µrem/yr) due to emissions from:														
	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Area 9	Area 10	Area 11	Area 3 Well U-3cn PS#2	Area 3 RWMS	Area 5 RWMS	Area 10 SEDAN
	$^{239+240}$Pu and ^{241}Am											Tritium			
Alamo										1.5					0.42
Amargosa Center	1.6	1.5	1.3	1.8	0.26	0.48	0.5	7	7.8	11	1.4	0.0012	0.26	0.057	0.75
Amargosa Valley*	2.7	1.9	2.2	3	0.5	1	1.4	8.9	10	14	2.7	0.0014	0.3	0.058	0.85
American Cement	4.7	6.3	15	5	6.4	2.7	5.4	26	16	18	8.5	0.00091	0.7	0.2	1.4
Ash Meadows	1.3		2.3		0.41	0.49					1.5		0.32	0.055	
Ash Springs															
Beatty	0.57	1.2	0.78	1.6	0.18	0.34	0.32	5.6	1.4	1.9	0.95	0.00094	0.24	0.057	0.51
Cactus Springs	2.7	4.2	16	3.1	1	1.9	5.3	21	17	23	6.4	0.00069	0.64	0.082	1.5
Clark Station															
Corn Creek					0.21									0.05	
Crystal	3.6	2.7	3.1	7.4	0.95	0.95	3	13	9.7	13	2.7	0.00071	0.38	0.07	1.1
Death Valley Junction					0.21									0.049	
Furnace Creek															
Goldfield															
Indian Springs	4.2	4	13	8.3	0.88	1.6	5	20	16	22	5.8	0.00066	0.61	0.076	1.5
Hiko															
Lida Junction															
Medlin's Ranch	1.3	0.99	1.8	2.4	0.34	0.59	0.89	6.3	3.2	3.9	2.1	0.0012	0.21	0.036	0.5
Mt. Charleston					0.25									0.045	
Pahrump					0.54									0.078	
Penoyer Farm	1.5	1.4	1.9	2.7		0.66	0.92	9.3	4	8	2.1	0.00097	0.2		0.7
Prison Complex	3.4		4.9		0.58	0.96	1.9				3.2	0.00045	0.33	0.063	
Rachel	1.5	1.3	1.8	2.6		0.58	0.88	7.7	3.8	7.1	1.9	0.00096	0.2		0.68
Sarcobatus Flat	1	0.76		1.2				3.7	1.2	1.7					0.48
Scotty's Junction															
Springdale	1.3	1.8	0.74	2.2	0.14	0.35	0.3	6.6	1.5	2.2	0.97	0.00087	0.32	0.046	0.54
Stateline					0.24	0.45					1.3			0.052	
Stone Cabin Ranch															
Tempiute	1.3	0.93	1.7	1.8			0.8	5.3	3.4	2.8		0.00091	0.19		0.45
Tolicha Peak	1.2	0.81	0.87	1.5		0.35	0.38	4.7	2.2	2.2		0.00098	0.27		0.52
Tonopah															
U. S. Ecology	0.58	2	0.80	1.6	0.2	0.31	0.32	9.4	1.4	5.5	0.86	0.00096	0.24	0.06	0.66

* Previously called Lathrop Wells

Table 5.0 (CY 2004 Calculated EDEs by CAP88-PC [µrem/yr], cont.)

Location	EDE (µrem/yr) due to emissions from:													
	Area 12	Area 15	Area 16	Area 17	Area 18	Area 19	Area 20	Area 30	Area 12 E Tunnel	Area 19 Well U-19ad PS#1A	Area 20 Schooner	Area 20 ER-20-5 #1	Area 20 ER-20-5 #3	Area 23 Bldg 650
	$^{239+240}$Pu and ^{241}Am									Tritium				
Alamo		1.5												
Amargosa Center	1.8		0.2	5.8	37			9.3	0.015	0.025		0.01	0.000044	3.3E-07
Amargosa Valley*	2.3	6.4	0.29	9	13	3.7	5.5	2.7	0.016		0.53	0.0093	0.000048	3.2E-07
American Cement	1.2	8	0.36	0.96	4.6			0.99	0.015					1.8E-06
Ash Meadows			0.140					0.99						5.6E-07
Ash Springs		0.80												
Beatty	5	0.97	0.57	0.89	51	19	7.3	1.7	0.03	0.049	0.46		0.000041	2.1E-07
Cactus Springs		11	0.69	0.68				0.57	0.013					3.1E-07
Clark Station														
Corn Creek Station														2.3E-07
Crystal			0.23	1.2	4.1			0.8	0.015					8.8E-07
Death Valley Junction								0.87						4.7E-07
Furnace Creek								2.9						2.7E-07
Goldfield							4.5				0.69			
Indian Springs			0.64	0.64				0.53						2.8E-07
Hiko														
Lida Junction							2.4			0.033	0.74	0.012	0.000051	
Medlin's Ranch	3.5	2.3	0.4	0.36	1.7	10			0.022	0.03				
Mt. Charleston														3.0E-07
Pahrump														5.6E-07
Penoyer Ranch	7.4	5.3	0.26	2	5	22	1.7		0.025	0.038	0.39	0.0087	0.000038	
Prison Complex			0.51											2.5E-07
Rachel	5.2	4.9			4.6	18	1.5		0.024	0.035	0.37	0.0083	0.000036	
Sarcobatus Flat	2.4	0.92	0.19	0.57	5.8	12	15	0.83	0.02	0.036	0.92	0.011	0.000049	
Scotty's Junction	1.9				3.3	8.4	4.8	0.48	0.017	0.031	0.58	0.0095	0.000041	
Springdale	3.7	1.1	0.74	1.2	11	32	12	1.6	0.027	0.061	0.58	0.016	0.00007	2.1E-07
Stateline			0.12					0.99					0.000111	5.0E-07
Stone Cabin Ranch														
Tempiute	4.5	2.1		0.82		15			0.022	0.032				
Tolicha Peak	3.7	1.2	0.22	0.87	7.6	19	15	1.4	0.029	0.046	1.5	0.024		
Tonopah														
U. S. Ecology	4.8	2.6	0.59	5.3	48	8.5	5.6	9.9	0.03	0.025	0.62	0.0087	0.000038	2.1E-07

* Previously called Lathrop Wells

Table 6.0 Summary of CY 2004 Calculated EDEs by CAP88-PC

Location[a]	EDE Sum (µrem/yr)[b]		
Alamo	3.4		
Amargosa Center	89.9		
Amargosa Valley[c]	90.8		
American Cement	132.4		
Ash Meadows	7.5		
Ash Springs	0.8		
Beatty	102.6		
Cactus Springs[d]	116.8		
Clark Station	0.0		
Corn Creek Station	0.3		
Crystal	68.0		
Death Valley Junction	1.1		
Furnace Creek	2.9		
Goldfield	5.2		
Indian Springs	104.8		
Hiko	0.0		
Lida Junction	3.2		
Medlin's Ranch	42.9		
Mt. Charleston	0.3		
Pahrump	0.6		
Penoyer Ranch	77.5		
Prison Complex	15.8		
Rachel	64.7		
Sarcobatus Flat	48.7		
Scotty's Junction	19.5		
Springdale	83.0		
Stateline	3.2		
Stone Cabin Ranch	0.0		
Tempiute	41.1		
Tolicha Peak	65.6		
Tonopah	0.0		
U. S. Ecology	109.9		
EDE to MEI: 0.12 mrem/yr Location: Cactus Springs, NV	Contribution to MEI EDE from Following Sources, mrem/yr		
	Tritium	Lab. Sources	^{241}Am and $^{239+240}$Pu
	0.0022	3.10E-07	0.115

(a) Location of residences and communities around the NTS are shown in Figure 1.0

(b) µSv/yr = 100 µrem/yr; mSv/yr = 100 mrem/yr

(c) Previously called Lathrop Wells

(d) Cactus Springs was selected as the location of the MEI because the personnel at American Cement and U.S. Ecology do not live at their work place and have an urban food source scenario which would result in a reduction of 50 percent or more in the EDE.

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SECTION IV
ADDITIONAL INFORMATION

NEW CONSTRUCTION/MODIFICATION ACTIVITIES AT THE NTS

Plans were begun for the construction of the Radiological/Nuclear Countermeasures Test and Evaluation Complex in Area 6. This facility will be handling sealed radioactive sources during the development of techniques for the remote detection of radioactive materials that could be transported and used by terrorist activities in the United States. As special nuclear materials (SNM) were originally proposed, an evaluation of the quantities of SNM that could be used was conducted according to Title 40 CFR 61, Appendix D. However, there are no plans to stage SNMs at this time.

UNPLANNED RELEASES DURING CALENDAR YEAR (CY) 2004

No unplanned releases occurred on NTS during 2004. There was a likely detectable release at the Atlas Facility, located in North Las Vegas, that was a continuance of tritium emanation following a 1995 incident (see Appendix A for a description).

SOURCES OF DIFFUSE OR FUGITIVE EMISSIONS

This year these sources included the following:

- Evaporation from containment ponds that receive liquid effluents from E Tunnel in Area 12 and water discharges from four UGTA wells.
- Re-suspension of ^{241}Am and $^{239+240}$Pu from soil deposits on the NTS areas listed in Table 1.0.
- Evapro-transpiration of tritium from the SEDAN and SCHOONER craters.
- Low-level waste packages buried at the RWMS-3 and RWMS-5.

The EDE to the MEI (0.12 mrem/yr at Cactus Springs) was principally due to the diffuse americium and plutonium sources (98 percent). The EDEs from point sources and diffuse tritium sources were negligible. The methods used to determine the emissions from these diffuse sources are described in the Appendices A-E.

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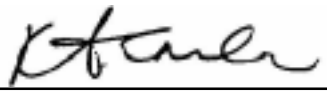
CERTIFICATION

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: Kathleen A. Carlson, Manager, NNSA/NSO

Signature:  Date: 6/2/05

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APPENDICES

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APPENDIX A

PUBLIC DOSE CALCULATIONS FOR THE RELEASE OF TRITIUM FROM THE A-1 BUILDING, NLVF

ENVIRONMENTAL SURVEILLANCE

As reported in the 1995 NESHAPs report (DOE, 1996b), a container of tritium foils was opened in the Atlas Facility at the North Las Vegas Facility (NLVF) area and emitted about 1 Curie (Ci) of tritium into a basement area used as a fixed radiation source range. Environmental surveillance began on Friday, July 14, 1995, 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 began, the environmental samplers were removed, but the basement air sampler continued operation through January 5, 1998, at which time, samples were collected once each quarter. The 1996, 1997, and 1998 results and offsite effective dose equivalent (EDE) to the maximally exposed individual (MEI) offsite at the perimeter fence (0.25 micro-rems [µrem], 0.53 µrem, and 0.08 µrem respectively) were reported in the annual National Emission Standard for Hazardous Air Pollutants (NESHAP) reports.

During 1999, 2000, 2001, 2003, and 2004, sampling for HTO in the basement was conducted intermittently. For calendar year (CY) 2004, the results of two samples collected March 29 to April 6, 2004 (1,240 pico-curies per cubic meter [pCi/m^3]) and September 1 to September 7, 2004 (910 pCi/m^3), and the basement ventilation rate of 673 cubic feet per minute (ft^3/min), were used to estimate the annual tritium emission: (1,240 + 910)/2 pCi/m^3 x 673 ft^3/min x 0.02832 m^3/ft^3 x 525,600 min/year(yr) x 10^{-9} milli-curies (mCi)/pCi = 11mCi/yr. A comparison of the past and current emission rates are presented in Table A.1.

Table A. 1 Comparison of Tritium Emission Rates from 1995 - 2004

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)	-
2003	9.3	-
2004	11	-

The average tritium concentration in the basement (1,075 pCi/m^3) was less than the annual average concentration (1,500 pCi/m^3) that would deliver an EDE of 10 milli-rems [mrem]/yr (Title 40 CFR Part 61, Appendix E, Table 2). Therefore, the radiation dose to the maximally exposed individual, located100 meters from the point of emission, would be even less due to atmospheric diffusion.

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APPENDIX B

EMISSIONS FROM CONTAINMENT PONDS

E TUNNEL PONDS

The effluent water discharge rate from the Area 12 E Tunnel was measured monthly. During October 2004, a water sample was analyzed for tritium (as tritiated water [HTO]). The total amount of radioactive liquid effluent from the tunnels was calculated from the concentration of tritium in the water and the total volume of water discharged during the year, based on the monthly flow-rate measurements.

In order to calculate doses with the Clean Air Package 1988 computer program (CAP88-PC), an airborne source term must be known. By assuming that the total amount of tritium (as HTO) measured in the liquid effluent during the year evaporates and becomes airborne, a conservative estimate of the airborne source term is obtained. It is unlikely that this is a true source term for the containment pond, but it is an upper limit of HTO which could be released. During calendar year (CY) 2004, 15,062,400 liters (L) of water were discharged from E Tunnel. The October sample had a tritium concentration of 820,000 pico-curies per liter (pCi/L). From these data, it was estimated that 12 Ci of HTO were emitted into the air from the ponds.

From the estimated tritium emitted from E Tunnel ponds, the effective dose equivalents (EDEs) to offsite residents were calculated with CAP88-PC software. As shown in the results (see Table 5.0), the maximally exposed individual (MEI) for the Area 12 emission was found to reside at Beatty, 62 kilometers (38 miles) southwest of the tunnel ponds, where the calculated EDE was 0.030 micro-rems per year (µrem/yr).

WATER DISCHARGED FROM WELLS

Water containing tritium was pumped from four wells, with the water from Wells U-3cn PS#2, U-19ad PS#1A, ER-20-5 #1, and ER-20-5 #3 going into lined containment ponds. The water from each was assumed to be completely evaporated into the atmosphere during CY 2004. The total curies of tritium discharged for each well, listed in Table 2.0, was then used as input into CAP88-PC software to calculate the EDEs to offsite residents. The results for these wells, all less than 1 µrem/yr, are listed in Table 5.0.

EVAPORATION OF WATER - EPA's RECOMMENDATION

A calculation was performed, using the 1992 U.S. Environmental Protection Agency (EPA) methods for estimating diffuse emissions, to estimate tritium emissions from E Tunnel ponds in 1994 (DOE, 1996b). It was concluded that the EPA's methods predicted much lower effluent source terms. Therefore, in order to be conservative, the total water discharged was assumed to evaporate, and the EPA method was not used. The equation used for calculating emissions based on the 1992 EPA method is shown below.

$$E = \frac{20.73 \, x \, P_s \, x \, A^{0.9} \, x \, U^{0.8}}{T^{1.47}}$$

where E = evaporation rate in grams per second (g/s)
A = surface area of pond in square meters (m^2)
U = wind speed in meters per second (m/s)
P_s = equilibrium water vapor pressure at ambient temperature in millimeters of mercury (mm Hg)
T = temperate in degrees Kelvin (^{O}K) where ^{O}K = ^{O}Centigrade + 273.2

Use of the equation resulted in a source term of 2.4 Ci for 1995, when the assumption of total evaporation yielded a more conservative source term estimate of 260 Ci.

APPENDIX C

POTENTIAL RADIONUCLIDE EMISSIONS FROM RADIOANALYTICAL LABORATORIES

Building 650 Source Storage Room

Following the closure of the Analytical Services Laboratory in Area 23 at Building 650, all of the standards, check sources, and tracer solutions were stored in a basement room until all items could be properly disposed. From an inventory of these radioactivity sources, only three of them, listed below with their curie 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 less than the possession limits set forth in Title 40 CFR 61 Appendix E. No portion of these sources were released or consumed during CY 2004, therefore no emissions from these sources was estimated.

About 42 micro-curies (µCi) of tritium gas from a pressurized tank at Building 650 was consumed during the calibration of analytical equipment. In previous years, this tank was kept and used at the CP-50 Laboratory in Area 6. The quantity of tritium gas consumed was used as the source term for a calculation (using the Clean Air Package 1988 computer program [CAP88-PC]) of the hypothetical EDEs that could have been received by offsite residents within 80 kilometers (50 miles) of Building 650. The results from the CAP88-PC calculation are all less than 1.8×10^{-6} micro-rems per year (µrem/yr) (Table 5.0).

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

In previous years, the laboratories in these facilities maintained standards of radioactivity containing xenon-133 (^{133}Xe), iodine-131 (^{131}I), and ^{3}H. Due to the test moratorium that began in 1992, the need for standards was reduced. The use of the standards during the year did not result in any release to the atmosphere, therefore, no emissions were calculated.

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APPENDIX D

TRITIUM EMISSIONS ESTIMATED FROM AIR SAMPLING RESULTS

BACKGROUND INFORMATION

Environmental monitoring for tritium in atmospheric moisture was conducted at ten locations on the NTS until July 2001, when the number of monitoring locations was increased to 14 and when some of the locations were changed to conform to a change in strategy for demonstrating compliance with National Emission Standard for Hazardous Air Pollutants (NESHAP) (see Compliance Assessment in Section III). There were four air samplers around the perimeter of the Area 5 Radioactive Waste Management Site (RWMS) where many curies of tritium (^{3}H) are buried at that facility; however, all four samplers were removed because they were too close to the sources for them to be used with the Clean Air Package 1988 computer program (CAP88-PC) software in estimating the tritium emissions. Instead, air samplers identified as U. S. Department of Defense (DoD) and Sugar Bunker North, were added 1,590 meters (5,216 feet) north and 970 meters (3,182 feet) south, respectively, of the compound within the prevailing downwind sectors of the facility. Other air samplers were operated at the E Tunnel ponds area, near SEDAN crater, and near SCHOONER crater. In November 2004, tritium samplers were installed at U-3bh N and U-3ah/at S near the Area 3 RWMS to monitor for any tritium emissions from waste disposal operations.

SOURCE TERM ESTIMATES

The tritium emissions were estimated by two methods for some of the emission sources. The first method used actual air sampling results from samplers in the vicinity of the sources. The second method used tritium concentrations measured in vegetation samples collected from areas encompassing the emission sources.

The method for estimating the tritium emissions as tritiated water (HTO) from air sampling data requires a CAP88-PC estimate of the air concentration at the location of each air sampler for a 1 Curie (Ci) release from the center of each source location. The total annual emission was then calculated by dividing the annual average concentration of HTO measured at each sampling location by the CAP88-PC concentration for a 1 Ci release.

The second method used the tritium concentrations measured in vegetation samples collected along equally spaced radii and various distances from the centers of the sources for Area 3 RWMS, SEDAN, and SCHOONER. For each of these locations, the UTM coordinates of the sampling locations and the natural logrithm of the tritium concentrations were mapped with quadratic trending using Krigging and computer software to create concentration contours. The geometric mean concentration was determined from the sampling points within each contour area. Emission estimates were determined by multiplying the geometric mean concentration by the area and then by the depth of water (the total precipitation which fell during the year) summing the emissions for all contours. The area accounting for over 99 percent of the emission was considered the emission area.

Table D.1 lists the estimated emissions by both methods for each emission source location. Tritium emission from E Tunnel ponds was not estimated from air sampling data because the estimate from the total water pond influent and measured tritium concentrations, as described in Appendix B, was more conservative.

These emissions were then used as source terms for CAP88-PC calculations to determine the estimated effective dose equivalents (EDEs) for all populated offsite locations within 80 kilometers (50 miles) of each of the sources of emission (see Table 5.0). Where two emission estimates for a location differed, the highest of the two was used for calculation of the EDEs.

Table D. 1 Tritium Emissions from Airborne Tritium and Vegetation Sampling Results During CY 2004

Emission Source	Emission Estimate, Ci [(a)]	
	From Air Sampling	From Vegetation Sampling
Area 3 RWMS	83	0.12
Area 5 RWMS	4.9	-
Area 10 SEDAN	110	200
Area 20 SCHOONER	220	240

(a) 1 Ci = 37 mega-becquerels (MBq)

APPENDIX E

RESUSPENDED AMERICIUM AND PLUTONIUM FROM YUCCA FLAT AND OTHER AREAS

BACKGROUND INFORMATION

Areas 1-12 and 15-30 on the NTS contain diffuse sources of radionuclides. 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 (MDC).

SOURCE TERM FROM RE-SUSPENSION CALCULATIONS

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 Nevada Test Site (NTS). In NUREG/CR-3332 (NRC 1983), page 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 = suspension rate (per second) (fraction of the deposit re-suspended per second)
K = re-suspension factor (per meter [m])
V_g = deposition velocity (meters per second [m/s])

On page 75 of report DOE/NV--357 (DOE, 1992), values of K are given for the NTS. An average of the values given is 2×10^{-10}/m. Deposition velocities in the range of 0.01 to 0.05 m/s are used as conservative estimates. When these values are put into the above equation, the rate of re-suspension is between 2×10^{-12} and 1×10^{-11}/s. To be conservative, the higher re-suspension rate of 1×10^{-11}/s will be used. For Area 3, the source term rate is then calculated from the product of the $^{239+240}$Pu deposition (37 Curies [Ci]) from Table 1.0 and the re-suspension rate, as follows:

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

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

$$370 \text{ pCi/s} \times 3.15 \times 10^7 \text{ s/yr} = 1.17 \times 10^{10} \text{ pCi/yr or 12 milli-curies (mCi)/yr}$$

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. The EDEs due to re-suspension for each of the areas were then determined from CAP88-PC calculations using the individual area emission rates. The results are listed in Table 5.0.

OTHER ISOTOPES

The other predominant isotopes that have been found in soil samples in the various areas on the NTS are strontium-90 (Sr^{90}), cesium-137 (^{137}Cs) and plutonium-238 (^{238}Pu); however, their concentrations in air samples contribute less that 10 percent to the National Emission Standard for Hazardous Air Pollutants (NESHAP) dose limit and therefore they have not been included in evaluations for NESHAP compliance.

Table E. 1 Calculated Emissions from Inventories[(a)] of Plutonium and Americium in NTS Areas

S (Re-suspension in Ci) = Ci x K x Vg x 1E+03 mCi/Ci x 3.15E+07 s/yr						
Area	**^{241}Am (Ci)**	**$^{239+240}$Pu (Ci)**	**K (m^{-1})**	**Vg (m/s)**	**S for ^{241}Am (mCi/yr)**	**S for $^{239+240}$Pu (mCi/yr)**
1	4.2	24	2.E-10	5.E-02	1.32	7.6
2	2.9	22	2.E-10	5.E-02	0.91	6.9
3	4.6	37	2.E-10	5.E-02	1.45	11.7
4	6.6	40	2.E-10	5.E-02	2.08	12.6
5	0.6	4.8	2.E-10	5.E-02	0.19	1.5
6	1.7	8.4	2.E-10	5.E-02	0.54	2.6
7	2.2	16	2.E-10	5.E-02	0.69	5.0
8	17	110	2.E-10	5.E-02	5.36	34.7
9	4.2	89	2.E-10	5.E-02	1.32	28.0
10	19	110	2.E-10	5.E-02	5.99	34.7
11	3.3	29	2.E-10	5.E-02	1.04	9.1
12	5.7	39	2.E-10	5.E-02	1.80	12.3
15	8.0	63	2.E-10	5.E-02	2.52	19.8
16	0.7	3.7	2.E-10	5.E-02	0.22	1.2
17	2.8	18	2.E-10	5.E-02	0.88	5.7
18	19	100	2.E-10	5.E-02	5.99	31.5
19	21	140	2.E-10	5.E-02	6.62	44.1
20	23	41	2.E-10	5.E-02	7.25	12.9
30	3.2	14	2.E-10	5.E-02	1.01	4.4
TOTAL	**140**	**910**			**47**	**290**

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

EPA METHOD FOR ESTIMATING DIFFUSE EMISSIONS

The equation in the U.S. Environmental Protection Agency's Methods for Estimating Diffuse Emissions (unpublished) is shown below and was used for a wind erosion calculation for Area 9. The results can be compared with the Nevada Test Site (NTS) National Emission Standard for Hazardous Air Pollutants (NESHAP) report calculation. The equation used on page 18 of the EPA report is:

$$E' = k \cdot a \cdot I \cdot K \cdot C \cdot L' \cdot V' \cdot A \cdot c$$

where:
- E' = soil particles lost (tons/year [yr])
- k = particle size factor
- a = total suspended fraction lost to wind erosion
- I = soil erodibility (tons/acre-yr)
- K = surface roughness factor
- C = climatic factor - $C = 0.345$ (miles per hour [mph] $^3/PE^2$) where $PE = 0.83$
- L' = unsheltered field width factor
- V' = vegetative cover factor
- A = site area (square meters [m^2]) - used high density of 75.6 Curies (Ci) on 7.5 square miles (mi^2)
- c = conversion factor for tons/acre to kilograms/square meter (kg/m^2) = 0.224

Inputs: Yucca Flat is typical high plain desert with sparse vegetation. Average wind speed is 6.0 knots = 6 x 0.514 meters per second (m/s) = 3.08 m/s = 11.1 kilometers per hour (km/hr) or 6.9 miles per hour (mph).

- $k = 0.5$ (fraction of re-suspended soil that is particulate matter with an aerodynamic diameter equal to or less than 10 microns (PM_{10})
- $a = 0.025$ portion of total erosion that is suspended particulates
- $I = 28$ (silty clay loam from Table 7-1, desert pavement decreases erodibility)
- $K = 1$ (surface roughness - desert is smooth)
- $C = 164$ (climatic factor calculated from $C = 0.345\ (mph)^3/(0\ .83)^2$
- $L' = 0.3$ as read from Figure 7-5 (IK = 28 x 0.6=17, L=500 from Table 7-3)
- $V' = 0.95$ (read from Figure 7-6 using V=100 from Table 7-3 and IKCL'= 790)
- $A = 7.5\ mi^2 = 1.9 \times 10^7\ m^2$ (from DOE, 1991)

so $E' = 0.5 \times 0.025 \times 28 \times 1 \times 164 \times 0.3 \times 0.95 \times 0.224 = 3.7\ kg/m^2\text{-yr}$

Area 9 (from McArthur in DOE, 1991):

89 Ci on 20 mi^2 (20 x 2.59 x 10^6 m^2/mi^2) or 5.2 x 10^7 m^2

Total Emission = 3.7 kg/m^2-yr x 5.2 x 10^7 m^2 = 1.9 x 10^8 kg/yr

Plutonium concentration in dust (assuming all plutonium is in top 5 cm):

5.2 x 10^7 m^2 x 10^4 square centimeters (cm^2)/m^2 x 5 cm deep x 1.5 grams per centimeter $(g/cm)^3$ = 3.9 x 10^{12} g

89 Ci x 10^{12} pCi/Ci ÷ 3.9 x 10^{12} g = 23 pCi/g or 23 nano-curies (nCi)/kg

and the source-term becomes:

$$23 \times 10^{-9} \text{ Ci/kg} \times 1.9 \times 10^{8} \text{ kg/yr} = 4.4 \text{ Ci/yr}$$

If the total deposit in Area 9 is 89 Ci and if the E' calculation performed above is correct, then 89 Ci ÷ 4.4 Ci/yr = 20.2 suggests that the deposit would be depleted in little more than 20 years.

In comparison, the re-suspension equation calculation for Area 9 (0.028 Ci/yr) in Table E-1 indicates that it would require about 3,200 years to deplete the deposit.

APPENDIX F

IDENTIFICATION AND JUSTIFICATION FOR THE DEVELOPMENT OF METEOROLOGICAL DATA USED AS INPUT TO 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 approximately 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/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 F.1). MIDNET has been operated on the NTS for over 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 hour/day, 365 days/year 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 F.1). Upper-air observations (radiosondes) are taken twice daily from DRA. DRA has been in operation since May 1978.

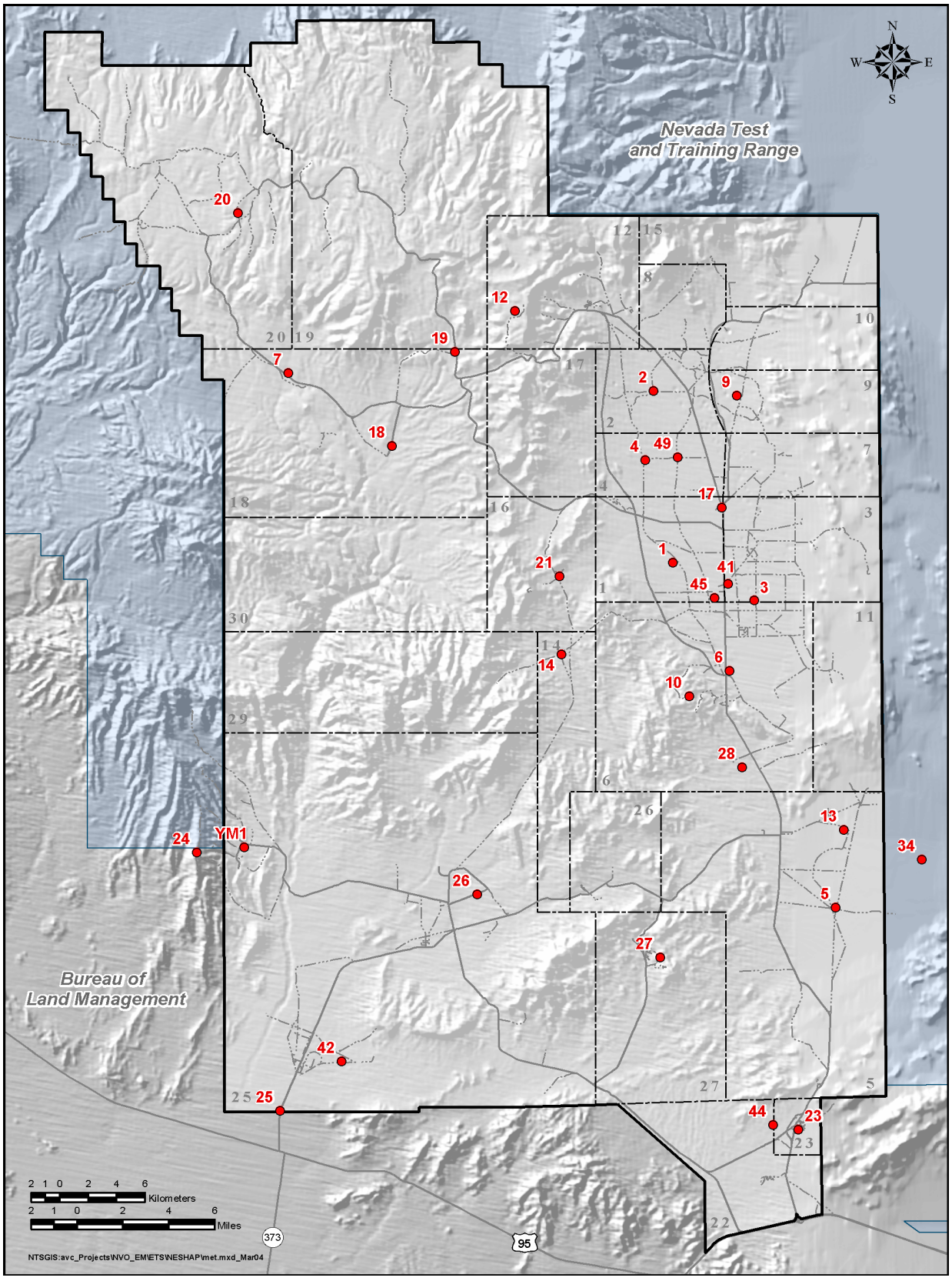

Figure F.1 Locations of MEDA Stations on the NTS in 2004

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, (an electric generator where needed), a microprocessor, and a microwave radio transmitter. Wind speed and direction sensors are located on booms oriented into the prevailing wind direction and at a minimum distance of two tower widths from the tower. Wind sensors are located 10 m above the ground.

Wind and temperature data have been collected on the 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 F.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 MEDA stations are located on or around the NTS (Figure F.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 0.85 mph. Wind data are collected as 5 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 1 degree Fahrenheit (°F) between 0 °F and 110 °F (absolute range for the NTS is -20 °F to 115 °F). 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 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 computer program (CAP88-PC), 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 stability array (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. Beginning in 2002, only weather data for the current year were used in creating the STAR files for the CAP88-PC calculations. Calendar year (CY) 2004 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(s)
meda01.str	1
meda02.str	2, 8
meda04.str	4
meda06.str	6, 11
meda09.str	9, 10, 13, 15
meda12.str	12, 19
meda17.str	3,7
meda18.str	17, 18, 30
meda20.str	20
meda21.str	16
meda23.str	23
meda34.str	5

APPENDIX G

SUPPLEMENTAL INFORMATION

COMPARISON WITH PREVIOUS YEARS' DATA

Nevada Test Site (NTS) Maximum Potential Individual Effective Dose Equivalent (EDE):

2004 - 1.2×10^{-1} millirem (mrem) (1.1 microsievert [µSv])
2003 - 1.0×10^{-1} mrem (1.0 µSv)
2002 - 1.1×10^{-1} mrem (1.1 µSv)
2001 - 1.7×10^{-1} mrem (1.7 µSv)
2000 - 1.7×10^{-1} mrem (1.7 µSv)
1999 - 1.2×10^{-1} mrem (1.2 µSv)
1998 - 9.2×10^{-2} mrem (0.9 µSv)
1997 - 9.0×10^{-2} mrem (0.9 µSv)
1996 - 1.1×10^{-1} mrem (1.1 µSv)
1995 - 1.8×10^{-1} mrem (1.8 µSv)
1994 - 1.5×10^{-1} mrem (1.5 µSv)
1993 - 3.8×10^{-3} mrem (38.0 nSv)
1992 - 1.2×10^{-2} mrem (0.12 µSv)

In 1993, tunnel effluents began decreasing because of sealing the tunnel drainage systems. In 1994, re-suspension of plutonium from surface deposits was calculated. The higher EDE in 1995 was due to an increase in the estimated emission of plutonium from the re-suspension of plutonium. The 1996 decrease is due to decreased emissions and cleanup of areas. The 1997 decrease was due to decreased emissions and cleanup of areas. The small increase for 1998 is due to increased emissions of tritium, and, for 1999, the increase is due to the inclusion of americium-241 (^{241}Am).

Finally, the increase for 2000 was due to the addition of NTS areas not previously included in the re-suspension calculations. The slight decrease in 2002 is probably due to meteorological data.

COLLECTIVE EFFECTIVE DOSE EQUIVALENT

The collective population dose is the sum of the EDEs from each emission source at each location multiplied by the population at each location, which is then summed for all locations. The collective EDE for calendar year (CY) 2004 was 0.47 person-rem/year for approximately 42,871 people who lived within 80 kilometers (50 miles) of the NTS emission sources.

ESTIMATING TRITIUM EMISSIONS FROM SCHOONER AND SEDAN

The tritium emissions from SCHOONER for CY 2001 were calculated assuming that the area of the source [approximately 100,000 square meters (m^2) or 119,600 square yards (yd^2)] was the same as the area of the crater. From the analysis of the tritium content of moisture in vegetation samples collected in a grid pattern around the crater out to 500 meters (m) [1,640 feet (ft)] from the crater rim during 2002, the area of the source term appears to have been under-estimated. For CY 2003 the source-term area was estimated as 492,000 m^2 (588,427 yd^2) which includes the area of the ejecta from the cratering event as determined from an aerial photograph and GIS software. As this places the sampling location (269 m [882 ft] west-northwest) within the source term area (radius of 396 m [1,299 ft]), the Clean Air Package 1988 computer program (CAP88-PC) concentration estimate at the sampler location for a 1 Curie/year (Ci/yr) release has high uncertainty (Figure G.1).

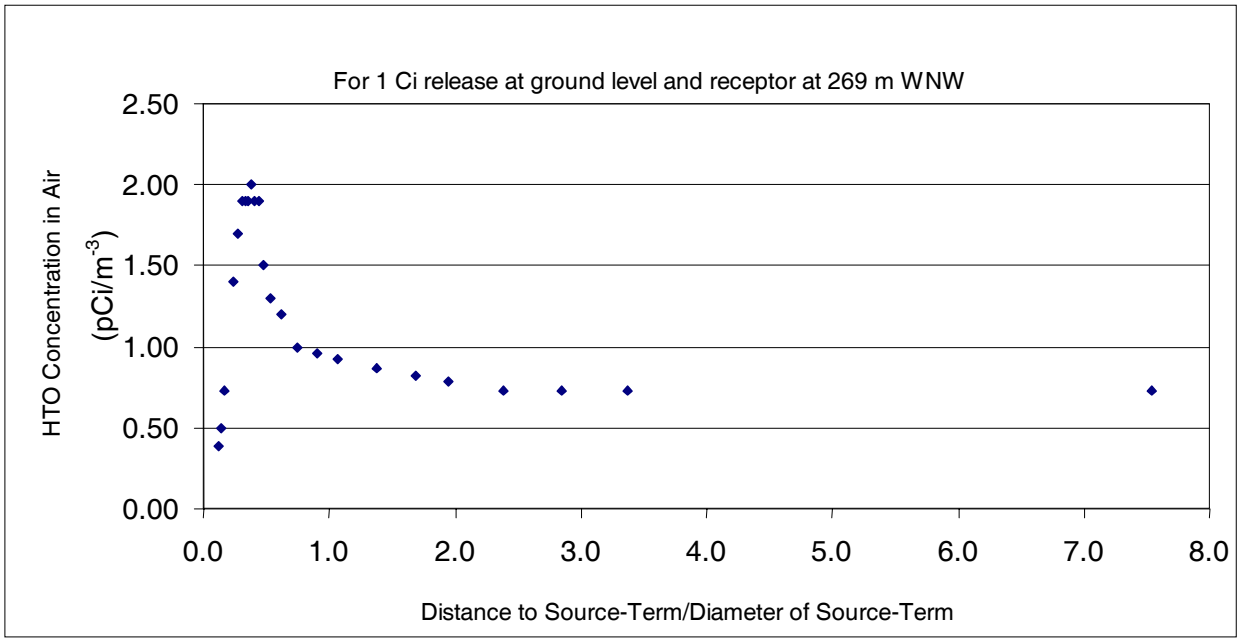

Figure G.1 CAP88 Predicted Air Concentration versus Ratio of Distance-to-Source/ Diameter of Source

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 between 1.3 and 2.5. At a ratio greater than 2.5, the source is assumed to be a point source instead of an area source. In 2002, the ratio was 0.34. To correct this situation, another air sampler was positioned at Gate 20-2p, which is 4,790 meters south-southeast of the crater, at a distance where the area source is treated by CAP88-PC as a point source (ratio of 13). In 2004, additional vegetation sampling was conducted at SCHOONER and also extended to the Area 3 Radioactive Waste Management Site (RWMS) and SEDAN. From the concentrations of tritium in the vegetation samples, another method was used for estimating the tritium emissions from these areas assuming that the tritium concentration in the soil was the same as that in the vegetation and that all the soil moisture from precipitation during the year was transpired to the atmosphere. See Appendix D for a description of the method and the results.

COMPLIANCE WITH SUBPARTS Q AND T, Title 40 CFR 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) and T (National Emission Standards for Radon Emissions from the Disposal of Uranium Mill Tailings). However, Bechtel Nevada includes Subpart Q in its Work Smart Standards. Therefore, radon flux measurements were made during this report period at the Area 3 RWMS and the Area 5 RWMS 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 pico-curies per square meter per second ($pCi/m^2/s$) required by Subpart Q. The results of the most recent study (BN, 2005) showed that the airborne concentrations of radon and the flux measurements of radon were both at 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).

RADON EMISSIONS FROM ^{238}U AND ^{232}Th SOURCES

None of these sources exist on the NTS.

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 National Emission Standard for Hazardous Air Pollutants (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" (EPA, 2001) and the requirements of DOE Order 414.1B, "Quality Assurance" (DOE, 2004) have been implemented in this plan.

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DISTRIBUTION LIST

W. K. Levedahl (Acting), Director, Primaries, Materials, and Test Readiness Division, NA-113.2 FORS, U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585-1290

D. M. Miotla, Director, Office of Facilities Management and ES&H Support, NA-117 GTN, U.S. Department of Energy,1000 Independence Avenue SW, Washington, D.C. 20545-1290

G. A. Vazquez**,** Office of Air, Water and Radiation Protection Policy and Guidance, EH-41 FORS, U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585-1290

R. L. Natoli**,** Office of Air, Water and Radiation Protection Policy and Guidance, EH-41 FORS, U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585-1290

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R. Anderson, Program Manager, Office of Radiation and Indoor Air, U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue NW, Washington, D.C. 20460

D. P. Howekamp, Director, Air Division, Region 9, U.S. Environmental Protection Agency, 75 Hawthorne Street, San Francisco, CA 94103

S. Rosenblum, Air Division, Region 9, U.S. Environmental Protection Agency, 75 Hawthorne Street, San Francisco, CA 94103

M. A. Marelli, Acting Assistant Manager for Safety Programs, National Nuclear Security Administration, Nevada Site Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

D. D. Monette, Assistant Manager for National Security, Nevada Site Office, National Nuclear Security Administration, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

Stephen A. Mellington, Acting Assistant Manager for Environmental Management, National Nuclear Security Administration, Nevada Site Office, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

K. A. Hoar, Director, Environment, Safety & Health Division, Nevada Site Office, National Nuclear Security Administration, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505 (3)

Director, Environmental Restoration Division, Nevada Site Office, National Nuclear Security Administration, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

E. F. DiSanza, Director, Waste Management Division, Nevada Site Office, National Nuclear Security Administration, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505 (3)

B. Hurley, Environment, Safety & Health Division, Nevada Site Office, National Nuclear Security Administration, U.S. Department of Energy, P. O. Box 98518, Las Vegas, NV 89193-8518, M/S 505

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G. Dempsey, Director, Center for Environmental Restoration, Monitoring & Emergency Response, U.S. Environmental Protection Agency, P. O. Box 93478, Las Vegas, NV 89193-3478, M/S 513

D. A. Bedsun, Bechtel Nevada, P. O. Box 98521, Las Vegas, NV 89193-8521, NLV101

S. Marshall, Chief, Radiological Health Section, Bureau of Health Protection Services, 1179 Fairview Drive, Suite 201, Carson City, NV 89701-5405

E. A. Tinney, Bureau of Health Protection Services, 1179 Fairview Drive, Suite 201, Carson City, NV 89701-5405

Terre Maize, Nevada Division of Environmental Protection, 333 W. Nye Lane, Carson City, NV 89706-0866

M. D. McKinnon, Bechtel Nevada, P. O. Box 98521, Las Vegas, NV 89193-8521, NLV083

L. Franks, Bureau of Health Protection Services, 620 Belrose Street, Las Vegas, NV 89158-5242

L. W. Nattrass, Lawrence Livermore National Laboratory, P. O. Box 808, Livermore, CA 94550-9234, M/S L-149

J. M. McAfee, Los Alamos National Laboratory, M/S D420, Los Alamos, NM 87545

W. F. Johnson, Environmental Management, Bechtel Nevada, P. O. Box 98521, Las Vegas, NV 89193-8521, M/S NLV080

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