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National Emission Standards for Hazardous Air Pollutants Calendar Year 2002

June 2003

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

DISCLAIMER

DOE/NV/11718—806

National Emission Standards for Hazardous Air Pollutants Calendar Year 2002

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TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

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)
Ci	Curie
CFR	Code of Federal Regulations
CY	Calendar Year
DAF	Device Assembly Facility
DCG	Derived Concentration Guide
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
FFACO	Federal Facilities Agreement and Consent Order
GIS	Geographical Informational System
HTO	Tritiated Water
JASPER	Joint Actinide Shock Physics Experimental Research
LLW	Low-level Radioactive Waste
MDC	Minimum Detectable Concentration
MEDA	Meteorological Data Acquisition System
MEI	Maximally Exposed Individual
MIDNET	Meteorological Data Network
NAFR	Nellis Air Force Range
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	Nuclear Regulatory Commission
NTS	Nevada Test Site
RWMS	Radioactive Waste Management Site
RWMS-3	Radioactive Waste Management Site, Area 3
RWMS-5	Radioactive Waste Management Site, Area 5
SNM	Special Nuclear Material
STAR	Stability Array - (grouping of meteorological data)
TRU	Transuranic - (nuclides with atomic numbers greater than uranium)
UCC	Yucca Flat Meteorological Observatory

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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)
Calendar Year (CY) 2002

Site Name: Nevada Test Site

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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 km (65 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 (Nellis Air Force Range [NAFR]) 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 150 km (93 mi) of the NTS is only about 0.5 persons per square kilometer, excluding the Las Vegas area. 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). Limited non-nuclear testing includes spills of hazardous materials at 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, and handling is restricted to transport, storage, and assembly of nuclear explosive devices 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 CY 2002 were releases from (1) evaporation of tritiated water (HTO) from containment ponds that receive drainage water from E Tunnel in Area 12, (2) onsite radioanalytical laboratories, (3) the Area 5 RWMS (RWMS-5) facility, and (4) diffuse sources of tritium and re-suspension of plutonium and americium. 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, operated for NNSA/NSO by Bechtel Nevada (BN), there was an unusual occurrence in 1995 that led to a very small potential exposure to an offsite person. The incident involved the release of tritium as HTO. 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 method of calculating the effective dose equivalent (EDE) for offsite exposure are set forth in Appendix A.

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 (Energy Research and Development Administration [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 ^{3}H (as HTO). Calculation of the source term 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). However, during CY 2002, no water containing tritium was pumped into containment ponds.

Laboratories

Radiological analyses were conducted in laboratories located in Building 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. In the past, evaporation and spills from samples containing HTO, radioiodines, or noble gases were conservatively estimated by assuming all such materials were released, although they were not. This year only actual emissions are reported, such as 40 micro-curies (μCi) of tritium gas which was used by laboratory personnel during the year at Area 6 CP-50 while calibrating analytical equipment. The source terms for these laboratories and the EDE resulting from the 40 μCi emission is 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 (CFR 2002).

Radioactive Waste Management Sites

The RWMSs in Area 3 (RWMS-3) and in Area 5 (RWMS-5) 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 RWMS-5, only packaged, dry wastes are accepted for disposal. The facility is considered a diffuse source of radiological effluents. The only radioactive emission detected by the various types of samplers surrounding the site and attributed to site operations was HTO in atmospheric moisture. The calculation of the HTO source term for these emissions is explained in Appendix D. Since the RWMS-3 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.

Joint Actinide Shock Physics Experimental Research (JASPER)

The construction and startup phase for a hydrogen gas gun in Building 5100 in Area 27 was completed in June 2000. Equation-of-state experiments with the two-stage light gas gun will be conducted under the Project JASPER Facility using special nuclear materials (SNM) and other actinide materials as target material. Approval by the U.S. Environmental Protection Agency (EPA) has been obtained for the project, and a stack monitoring system was installed to assure that the experimental emissions are in conformance with National Emission Standards for Hazardous Air Pollutants (NESHAPs) once operations with radioactive materials begin. During CY 2002, an integrated testing program using only surrogate materials (non-SNMs) was conducted; no radioactive materials were used.

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 is 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 americium and plutonium 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 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 effluents 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 americium and plutonium from contaminated areas is explained in Appendix E.

Area 52 (Tonopah Test Range) and Area 13 were not included in the dose evaluations this year as these areas are now the responsibility of the Sandia National Laboratories and the U. S. Air Force.

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 (FFACO 1996), contamination generated by historical NTS activities is being addressed. Two surface areas northwest of the NTS on the NAFR and 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 2002, no further remediation work was required in these areas.

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

Onsite Areas Studied [a]				
Area	Area (mi^2)	^{241}Am(Ci)	^{238}Pu(Ci)	^{239}Pu(Ci)
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]

N/A Not available.
(a) (DOE 1991).
(b) The above referenced report indicated that these levels were probably the result of fallout from nuclear tests in surrounding areas.

SECTION II
AIR EMISSIONS DATA

Each potential source of NTS emissions was characterized by one of the following methods: (1) monitoring methods and 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 air dispersion model (CAP88-PC) (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. In accordance with 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 Control	Distance to Nearest Receptor	Nuclide	Quantity (Ci)
Point Sources				
CP-50, Area 6	None	42 km	^{3}H	0.000040
Building A-1[a]	None	0.1 km	^{3}H	0.20
Area Sources				
E Tunnel ponds	None	50 km	^{3}H[b]	13
RWMS-5	None	36 km	^{3}H[c]	5.3
SCHOONER	None	20 km	^{3}H[c]	230
SEDAN	None	50 km	^{3}H[c]	40
Grouped Area Sources				
All NTS Areas	None	20-60 km	^{241}Am[d]	0.047
	None	20-60 km	$^{239+240}Pu$[d]	0.29

(a) All locations 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) Sum of emissions estimated from resuspension model and CAP88-PC software; see Table E.1 for individual area estimates.

A summary of the NTS total CY 2002 emissions for NESHAP's reporting, by radionuclide, is provided in Table 3.0.

Table 3.0 Total Estimated NTS Emissions for CY 2002 (Multiply Ci by 37 to obtain GBq)

Radionuclide	Annual Quantity (Ci)
^{3}H	290
^{241}Am	0.047
$^{239+240}Pu$	0.29

Note: This table includes all worst-case point and diffuse source releases.

SECTION III
DOSE ASSESSMENTS

SUMMARY OF INPUT PARAMETERS

CAP88-PC 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. All emissions were assumed to occur at an even 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 December 2000 and January 2001 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 term estimated for this emission source is contained 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 2002. Only one source was identified, a tank of tritium gas, from which 40 μCi was used at CP-50 in Area 6 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 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 for each area are listed 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 minimum detectable concentration.

The individual source terms, whose sums are listed in Tables 2.0 and E.1, were used with stability array (STAR) data files as input to CAP88-PC. The Air Resources Laboratory Special Operations and Research Division (ARL/SORD) methodology used 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 40 CFR Part 61.93(b)(5), the measurement of radionuclide air concentrations at EPA-approved critical receptor locations 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 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 40 CFR 61, Appendix E, and the sum of fractions resulting from dividing each measured concentration by the value in Table 2 (40 CFR 61) for each radionuclide is less than one.

Table 4.0 lists the average radionuclide concentrations and their percentage of the NESHAPs compliance level for each of the compliance stations. All concentration averages were below 1 percent of the compliance levels except for the tritium (^3H) average at the SCHOONER sampler station, which was 27 percent. The average concentration 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 (see 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 (0.29) 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 americium and plutonium, 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. As shown by Table 5.0, the EDEs for each location were summed for all conservatively estimated emissions for the year. The location of the MEI was Cactus Springs, Nevada, where a population of approximately 10 persons each received a calculated EDE of 0.11 mrem/yr, which is only 1.1 percent of the 10 mrem/yr standard of NESHAPs. American Cement actually had an EDE that was slightly higher (0.12 mrem/yr); however, due to workers occupying the area a half day at the most instead of a full day, as assumed by the CAP880-PC software, the EDE could be less than half this value.

Table 6.0 summarizes the contributions to the EDEs from the locations of the emissions and the radionuclide sources for Cactus Springs. As shown by this table, the diffuse tritium sources and the laboratory sources contributed little to the total dose; the re-suspension of americium and plutonium from all areas contributed virtually the entire dose. 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.

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 accomplished 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 2002. As shown in this graphic, all populated areas beyond the NTS are in areas that received calculated EDEs less than 0.2 mrem/yr.

Table 4.0 Measured Radionuclide Concentrations at Compliance Air Sampling Locations

Radio-nuclide	Area	Location	Average Concentration (pCi/m3)	Percent of Samples with Concentration s > MDC	Concentration as Percent of Compliance Level
	6	Yucca	1.42×10^{0}	35	0.095
	10	Gate 700 South	0.84×10^{0}	16	0.056
	16	Substation 3545	0.46×10^{0}	3.8	0.031
	20	SCHOONER	4.34×10^{2}	100	29.000
	23	Mercury	0.37×10^{0}	13.5	0.025
^{3}H	25	Guard Station 510	0.38×10^{0}	13.5	0.025
	6	Yucca	6.71×10^{-6}	21	0.353
	10	Gate 700 South	4.63×10^{-6}	27	0.244
	16	Substation 3545	4.47×10^{-6}	29	0.235
	20	SCHOONER	2.49×10^{-6}	8.3	0.131
	23	Mercury	4.29×10^{-6}	31	0.226
^{241}Am	25	Guard Station 510	4.19×10^{-6}	17	0.221
	6	Yucca	2.84×10^{-6}	4.2	0.135
	10	Gate 700 South	3.49×10^{-8}	3.8	0.002
	16	Substation 3545	4.93×10^{-7}	0	0.023
	20	SCHOONER	2.42×10^{-6}	25	0.115
	23	Mercury	8.71×10^{-7}	7.7	0.041
^{238}Pu	25	Guard Station 510	5.07×10^{-7}	0	0.024
	6	Yucca	7.03×10^{-6}	29	0.352
	10	Gate 700 South	4.91×10^{-6}	39	0.246
	16	Substation 3545	4.04×10^{-6}	21	0.202
	20	SCHOONER	8.10×10^{-7}	8.3	0.041
	23	Mercury	2.21×10^{-6}	9.6	0.111
$^{239+240}Pu$	25	Guard Station 510	3.83×10^{-6}	25	0.192
	6	Yucca		0.009	
	10	Gate 700 South		0.005	
	16	Substation 3545		0.005	
Sum of Ratios for All Radio-nuclides	20	SCHOONER		0.293	
	23	Mercury		0.004	
	25	Guard Station 510		0.005	

Table 5.0 Calculated EDEs (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 5 RWMS	Area 6 CP-50	Area 10 SEDAN
	$^{239+240}$Pu and ^{241}Am											(Tritium)		
ALAMO										1.3				0.13
AMARGOSA CENTER	1.5	1.5	1.9	3.1	0.53	0.49	0.47	7.1	7.4	9.8	1.4	0.057		0.33
AMERICAN CEMENT	5.1	3.9	14	9.1	1.9	2.3	4.9	16	16	15	7.3	0.077	13*	0.47
ASH MEADOWS	1.2				0.41	0.45					1.3	0.048	5.5*	
BEATTY	0.82	0.95	1.3	1.3	0.86	0.29	0.32	4.5	1.3	1.8	0.8	0.012	5.5*	0.17
CACTUS SPRINGS	2.9	2.6	10	5.7	0.35	1.8	5.6	13	20	26	6.2	0.051	9.8*	0.52
CLARK STATION					0.077							0.037		
CORN CREEK STA.					0.89	0.92	2.7	7.9	8.6	11	2.6	0.059	6.6*	0.39
CRYSTAL	2.7	1.7	3.6	4.9	0.55							0.044	5.0*	
DEATH VALLEY JCT.														
FURNACE CREEK														
GOLDFIELD														
INDIAN SPRINGS	5.9	2.5	7.8	5.9	0.31	1.7	5.3	12	19	24	5.6	0.049	9.2*	0.51
HIKO														
LATHROP WELLS	2.7	2	3.5	5	0.87	1.1	1.2	9.1	9.6	13	2.9	0.057	5.9*	0.38
LIDA JCT.														
MEDLIN'S RANCH	1.7	0.81	2.7	2.6	0.25	0.66	0.85	5.1	2.6	3.3	2.4	0.047	5.6*	0.16
MT. CHARLESTON					0.11							0.033		
PAHRUMP					0.19							0.04		
PENOYER FARMS	1.6	0.97	1.9	2.6		0.63	0.98	6.7	3.6	7.1	2			0.21
PRISON COMPLEX	4.8		3.9		0.21	0.97	1.7				3.3	0.042	7.9*	
RACHEL	1.5	0.91	1.8	2.4		0.64	0.94	5.2	3.4	6.3	2.1			0.2
SARCOBATUS FLATS	0.76	0.89						4.3	1	1.5				0.14
SCOTTY'S JCT.														
SCOTTY'S CASTLE														
SPRINGDALE	1.1	1.5	0.84	2.6	0.48	0.29	0.34	5.2	1.4	2.1	0.81	0.068	5.5*	0.18
STATELINE					0.61	0.42					1.2	0.052	5.3*	
STONE CABIN RANCH														
TOLICHA PEAK	0.9	1.3	0.79	1.8		0.28	0.5	5.5	1.9	1.9			4.9*	0.15
TONOPAH														
TWIN SPRINGS RN														
U.S. ECOLOGY	0.84	1.7	1.3	1.3	0.95	0.28	0.33	8.1	1.3	4.5	0.78	0.13	5.3*	0.2

Note: * = frem/yr - Units of EDE's for Area 6 due to emissions from tritium

Table 5.0 (Calculated EDEs [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 20 Schooner
	$^{239+240}$Pu and ^{241}Am								(Tritium)	
ALAMO		0.78								
AMARGOSA CENTER	1.8		0.18	3.5	42			11	0.014	
AMERICAN CEMENT	2	7	0.31	1.7	3.4	5.9		0.75	0.014	
ASH MEADOWS			0.095					0.93		
BEATTY	1.3	0.94	0.57	0.4	52	4.8	9.3	1.4	0.014	0.67
CACTUS SPRINGS		12	0.66	0.39				0.44	0.013	
CLARK STATION										
CORN CREEK STA.										
CRYSTAL			0.15	6.9	3.1			0.63	0.019	
DEATH VALLEY JCT.								0.82		
FURNACE CREEK								0.29		
GOLDFIELD							3.4			0.77
INDIAN SPRINGS			0.61	0.37				0.41		
HIKO										
LATHROP WELLS	2.3	5.9	0.26	0.57	13	13	6.6	2.9	0.016	0.71
LIDA JCT.							1.9			0.59
MEDLIN'S RANCH	4.4	2	0.36	0.26	1.9	13			0.031	
MT. CHARLESTON										
PAHRUMP										
PENOYER FARMS	8.1	4.9	0.29	1.6	4.5	28	1.8		0.03	0.5
PRISON COMPLEX			0.49							
RACHEL	6.7	4.4		1.5	4.2	23	1.6		0.031	0.48
SARCOBATUS FLATS	2.3	0.82	0.2	0.32	4.8	12	19	0.94	0.019	1.3
SCOTTY'S JCT.	1.8				3.6	8	5	0.52	0.017	0.61
SCOTTY'S CASTLE										
SPRINGDALE	2.5	1.1	0.77	0.52	9.7	8.1	16	1.4	0.02	0.88
STATELINE			0.11					0.94		
STONE CABIN RANCH										
TOLICHA PEAK	3.5	1	0.24	0.54	8.5	17	15	1.3	0.018	2.3
TONOPAH										
TWIN SPRINGS RN										
U.S. ECOLOGY	1.2	2.2	0.59	0.62			6.7	10	0.014	0.84

Table 5.0 (Calculated EDEs [μrem/yr], cont.)

Location	Summary		
	EDE Sum (μrem/yr)	Population	Collective EDE (person-mrem/yr)
ALAMO	2.2	367	0.811
AMARGOSA VALLEY	94.1	1,164	109.499
AMERICAN CEMENT	117.1	(a)	0.000
ASH MEADOWS	4.4	24	0.106
BEATTY	85.8	1104	94.741
CACTUS SPRINGS	108.2	10	1.082
CLARK STATION	0.0	(b)	0.000
CORN CREEK STA.	0.1	4	0.000
CRYSTAL	58.8	77	4.524
DEATH VALLEY JCT.	1.4	7	0.010
FURNACE CREEK	0.3	50	0.015
GOLDFIELD	4.2	498	2.077
INDIAN SPRINGS	92.0	1471	135.272
HIKO	0.0	(b)	0.000
LATHROP WELLS	96.7	30	2.900
LIDA JCT.	2.5	8	0.020
MEDLIN'S RANCH	45.1	2	0.090
MT. CHARLESTON	0.1	792	0.113
PAHRUMP	0.2	26,470	6.088
PENOYER FARMS	78.0	16	1.248
PRISON COMPLEX	15.4	3199	49.303
RACHEL	67.3	105	7.067
SARCOBATUS FLATS	50.3	16	0.805
SCOTTY'S JCT.	19.5	10	0.195
SCOTTY'S CASTLE	0.0	(b)	0.000
SPRINGDALE	57.9	20	1.158
STATELINE	3.3	67	0.223
STONE CABIN RANCH	0.0	(a)	0.000
TOLICHA PEAK	64.4	10	0.644
TONOPAH	0.0	(b)	0.000
TWIN SPRINGS RN	0.0	(b)	0.000
U.S. ECOLOGY	101.4	45	4.562
Total		35566	422.553

	Maximum Individual Dose Calculated from Following Sources - mrem		
Total Population: 35,566 EDE to MEI: 0.11 mrem MEI Location: Cactus Springs, NV Total Person-rem: 0.42	Tritium	Lab. Sources	$^{239+240}$Pu and ^{241}Am
	0.0006	0	0.11

Table 6.0 Summary of CY 2002 CAP88-PC Calculations of EDE to the MEI Offsite at Cactus Springs, Nevada[a]

Source	Distance to Individual and Direction	EDE (mrem)[b]
Tritium (diffuse)		
Area 5 (RWMS)	36 km SE	5.1×10^{-5}
Area 10 (SEDAN)	72 km SSE	5.2×10^{-4}
Area 12 (E Tunnel Ponds)	79 km SSE	1.3×10^{-5} [c]
Subtotal		5.8×10^{-4}
Laboratories		
Area 6 (CP-50)	48 km SE	9.8×10^{-12}
Re-suspension		
Area 1	62 km SSE	2.9×10^{-3}
Area 2	71 km SSE	2.6×10^{-3}
Area 3	62 km SSE	1.0×10^{-2}
Area 4	66 km SSE	5.7×10^{-3}
Area 5	32 km SE	3.5×10^{-4}
Area 6	51 km SSE	1.8×10^{-3}
Area 7	63 km SSE	5.6×10^{-3}
Area 8	74 km SSE	1.3×10^{-2}
Area 9	67 km SSE	2.0×10^{-2}
Area 10	72 km SSE	2.6×10^{-2}
Area 11	48 km SSE	6.2×10^{-3}
Area 15	79 km SSE	1.2×10^{-2}
Area 16	63 km SE	6.6×10^{-4}
Area 17	73 km SE	3.9×10^{-4}
Area 30	75 km SE	4.4×10^{-4}
Subtotal	--	1.1×10^{-1}
Total EDE		0.11 mrem

(a) Location of residences and communities around the NTS are shown in Figure 1.0.
(b) For mSv, multiply by 10^{-2}.
(c) Assumes evaporation of all tritiated water influents to ponds.

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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: K A Carlson Date: 6/20/03

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SECTION IV
ADDITIONAL INFORMATION

NEW CONSTRUCTION/MODIFICATION ACTIVITIES AT THE NTS

Modification of the DAF in Area 6 is in progress to include a glove box in which ^{238}Pu and $^{239+240}Pu$ targets would be prepared for use in the Project JASPER gas gun. An evaluation of the potential radiation dose to offsite residents was calculated with CAP88-PC software and a source term estimated in accordance with 40 CFR 61 Appendix D. The results of the evaluation indicated that the EDE to the MEI, located at Crystal (46 km south-southwest from the DAF), was 2.3×10^{-7} mrem/yr, therefore no application or notification to EPA was required.

UNPLANNED RELEASES DURING CALENDAR YEAR (CY) 2002

On August 16, 2002, a brush fire occurred in Area 12 resulting in the burning of 300 acres (12 hectares) of vegetation. During efforts to extinguish the fire, field personnel operated high-volume air samplers on August 17, 18, 22, and 23, 2002 to assess the airborne concentrations of radioactive particles which could be re-suspended from the soil suspected of containing low-levels of radioactive fallout from past nuclear tests at the NTS. The glass-fiber filters from the samplers were screened for gross alpha and beta radioactivity immediately after collection and at five days after collection to allow for the decay of the radon progeny. The filters were then composited and dissolved for further analysis by gamma and alpha spectroscopy to determine the concentrations of gamma-emitters, ^{241}Am, and $^{239+240}Pu$. The results of the analyses, summarized below in Table 7.0, found ^{137}Cs, ^{241}Am, and $^{239+240}Pu$ to be present in some of the samples representing average air concentrations that were less than 4 percent of the Derived Concentration Guide (DCG) for a 10 mrem/yr EDE; therefore, the brush fire was not considered a potential source of radiation dose to offsite residents, the closest being Springdale, 53 km WSW of the area.

Table 7.0 Concentrations of Radioactivity in Area 12 Brush Fire

Analysis	Concentration, nCi/m^3				
	Average	Maximum	Minimum	% >MDC	% DCG
Gross Alpha	22.5	44.4	8.39	100	-
Gross Beta	62.8	121	13.8	100	-
^{137}Cs	3.11	18.7	-1.08	11	0.008
$^{239+240}Pu$	0.0345	0.366	-0.114	22	1.7
^{241}Am	0.0687	0.137	0.0258	67	3.4

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.
- Re-suspension of ^{241}Am and $^{239+240}Pu$ from soil deposits on the NTS areas listed in Table 1.0.
- Transpiration of tritium from the SEDAN and SCHOONER craters.
- Low-level waste packages buried at the RWMS-5.

The EDE to the MEI (0.11 mrem/yr at Cactus Springs) was principally due to the diffuse sources (99 percent). The EDE from point sources was negligible. The methods used to determine the emissions from these diffuse sources are described in the Appendices A-E.

There was a likely detectable non-NTS release, at the Atlas Facility, located in North Las Vegas, that was a continuance of a 1995 incident (see Appendix A for a description).

FIGURES

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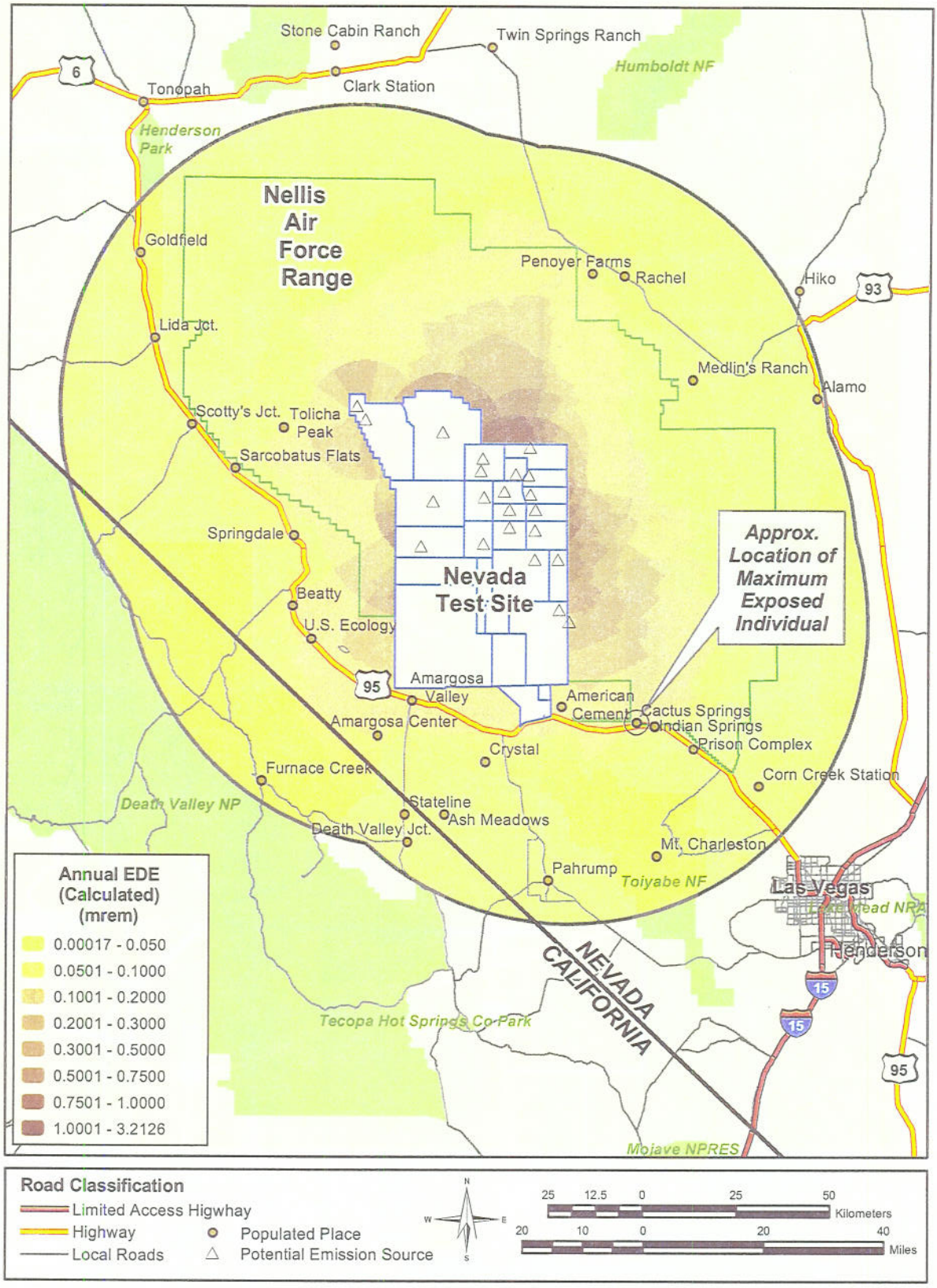

Figure 1.0 Map of the Nevada Test Site Showing Annual EDEs Within 80 Km of Emission Sources

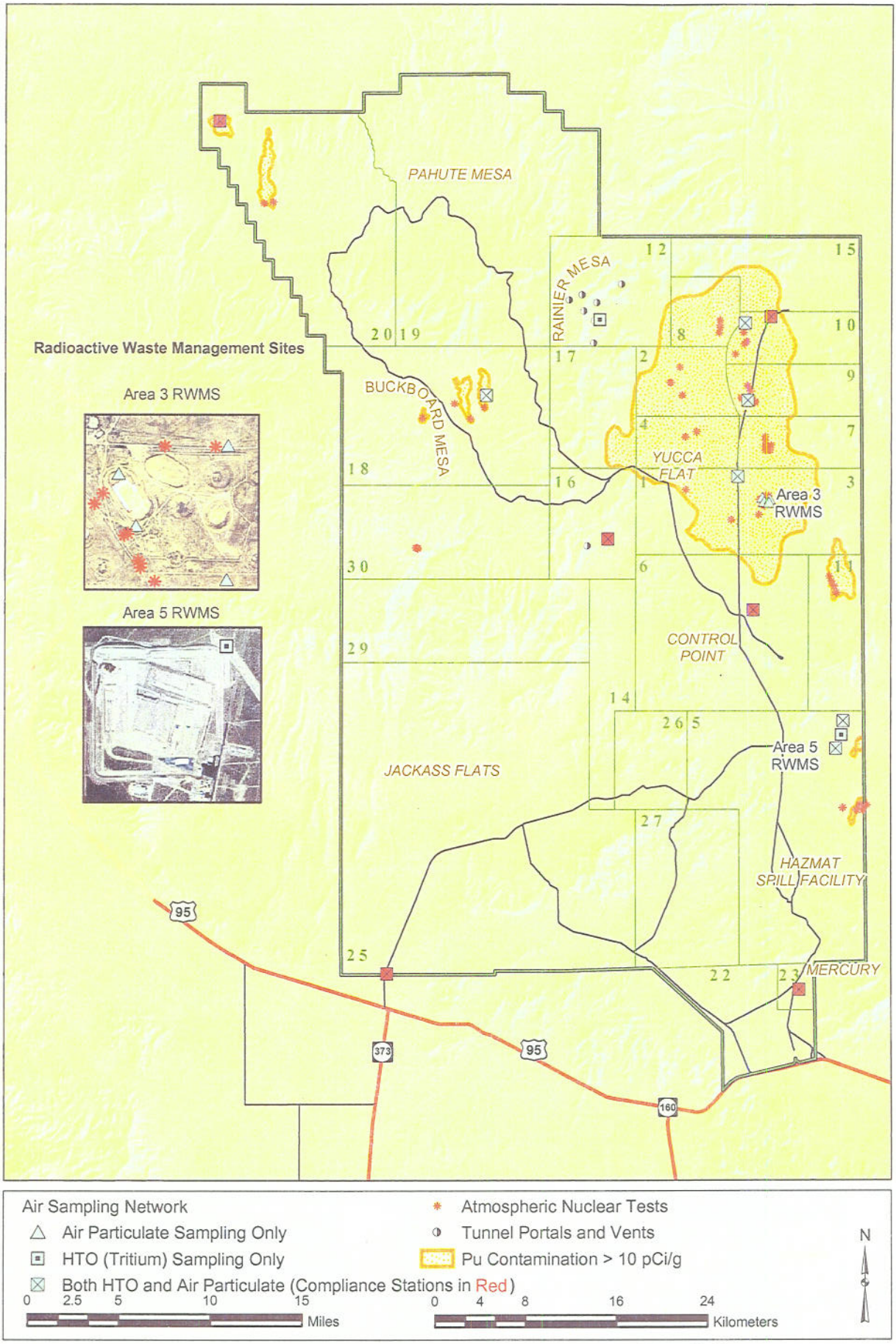

Figure 2.0 Air Sampling Network on the Nevada Test Site - 2002

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

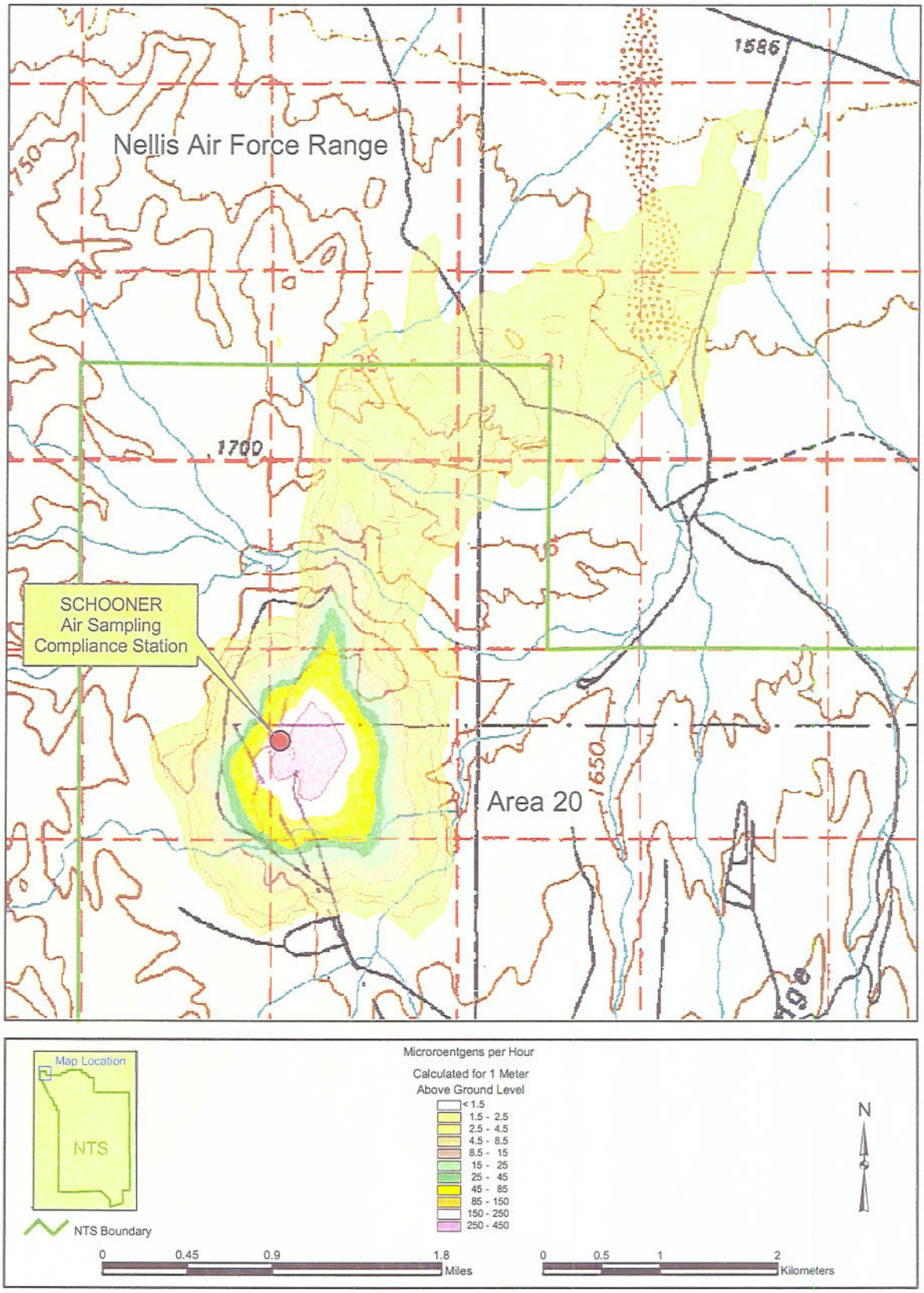

Figure 4.0 SCHOONER Air Sampling Compliance Station

APPENDICES

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APPENDIX A

PUBLIC DOSE CALCULATIONS FOR THE ATLAS TRITIUM INCIDENT

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 Operations area that emitted about 1 Ci of ^{3}H into a basement area used as a fixed radiation source range. Environmental surveillance began with notification on Friday, July 14, 1995, that the tritium leak had occurred. Environmental HTO samplers were installed at three locations outside the facility. Later, an HTO sampler was installed in the basement 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, only two-week samples were collected each quarter. The 1996, 1997, and 1998 results and offsite EDE to the MEI offsite (0.25 μrem, 0.53 μrem, and 0.08 μrem respectively) were reported in the annual NESHAPs reports.

During 1999, 2000, and 2001, sampling for HTO in the basement was conducted intermittently. The results of the sampling and the basement ventilation rate were used to estimate the annual tritium emission, which was input to CAP88-PC software to calculate the EDE to the MEI (1.4 μrem, 1.8 μrem, and 0.96 μrem respectively). As the EDEs for the past six years were well below the annual limit of 10 mrem/yr (10,000 μrem/yr), sampling in the basement was terminated in January 2001. Since the tritium continues to emanate at a relatively consistent rate into the basement which is vented outside of the building, the emission (200 mCi/yr) and EDE (0.96 μrem/yr) from the previous year was used in this year's report.

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APPENDIX B

EMISSIONS FROM CONTAINMENT PONDS

E TUNNEL PONDS

Effluent water from the Area 12 E Tunnel was sampled quarterly. During 2002, these water samples were analyzed for tritium (as HTO). The flow rate of water discharged from the tunnels was measured monthly. 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 using 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 the effluents which could be released. During 2002, it was estimated that 13 curies of HTO were discharged into the ponds.

From the estimated tritium discharged from E Tunnel, the EDE to the MEI was calculated with CAP88-PC software. The MEI for the Area 12 emission was found to reside at Medlin Ranch and Rachel, 62 km east-northeast and 64 km northeast, respectively, of the tunnel ponds, where individuals would have received a calculated EDE of 0.031 μrem/yr.

EVAPORATION OF WATER - EPA's RECOMMENDATION

A calculation was performed in the 1995 NESHAPs report (DOE 1996b) to estimate tritium emission from the E Tunnel pond during 1994, using the 1992 EPA methods for estimating diffuse emissions. It was concluded that the EPA's methods seriously underestimated the effluent source term; therefore, the calculation was not repeated. For reference, the equation used for that calculation is repeated below.

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

where E = evaporation rate, g/s
A = surface area of pond, m^2
U = wind speed, m/s
P_s = equilibrium water vapor pressure at ambient temperature, mm Hg
T = $^{O}K = {}^{O}C + 273.2$

Use of the equation resulted in a source term of 2.4 Ci for 1995 when total evaporation would yield 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, Building 650, all the standards, check sources, and tracer solutions were stored in a basement room until all items can be properly disposed of. The activity contained in these sources was orders of magnitude above that contained in samples (based on data collected in previous years).

From an inventory of these materials, only three of them are volatile and could become a source of air emissions. These are ^{3}H (as HTO), ^{129}I, and ^{85}Kr and are in the following quantities:

^{3}H	3.0×10^{-4} Ci
^{85}Kr	8.7×10^{-2} Ci
^{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. Since no portion of these sources were released or consumed during the year, no emission was estimated.

Los Alamos National Laboratory

In previous years, this laboratory maintained standards of radioactivity containing ^{133}Xe, ^{131}I, and ^{3}H. Due to the test moratorium that began in 1992, the need for standards was reduced. Since the use of the standards during the year did not result in any release to the atmosphere, no emission was calculated.

Area 6 CP-50 Laboratory

About 40 μCi of tritium gas from a pressurized tank located at the CP-50 Laboratory was consumed during the calibration of analytical equipment. The quantity consumed was used as the source term for a CAP88-PC calculation of the hypothetical EDEs that could have been received by offsite residents within 80 km of the laboratory. From the calculation, the EDE to the MEI was13 femto-rem/yr (1.3×10^{-8} μrem/yr) at American Concrete and Aggregate Company, which is 35 km south-southeast of the laboratory.

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APPENDIX D

ATMOSPHERIC TRITIUM EMISSIONS FROM DIFFUSE SOURCES

BACKGROUND INFORMATION

Environmental monitoring for tritium in atmospheric moisture was conducted at 10 locations on the NTS until July 2001, when the number of locations was increased to 14 and realigned to conform to a change in strategy for demonstrating compliance with NESHAPs (see Compliance Assessment in Section III). There were four air samplers around the perimeter of RWMS-5 because many curies of ^{3}H are buried at that facility; however, all but one sampler at the northeast corner were terminated and samplers identified as DOD and Sugar Bunker North were added north and south of the compound within the prevailing downwind sectors of the facility. Other air samplers, operated at locations with levels of tritium greater than the MDC, were operated at the E Tunnel pond area, near the SEDAN crater, and near the SCHOONER crater.

SOURCE TERM ESTIMATES

The method for estimating the tritium emissions as HTO from air sampling data requires a CAP88-PC estimate, of the air concentration at the location of each air sampler. This estimate is from a 1 Ci release from the center of the source for each source location, which was the center of the compound for Area 5 RWMS and the center of the craters for SEDAN and SCHOONER. The total annual emission was estimated by dividing the annual average concentration of HTO measured at each sampling location by the CAP88-PC concentration for a 1 Ci release. The monitoring results from the airborne-tritium sampling stations and estimated emissions are provided in Table D.1. The emission for E Tunnel in this table 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 EDEs for all populated offsite locations within 80 km of each of the sources of emission (see Table 5.0).

Table D.1 Airborne Tritium Sampling Results During CY - 2002

Sampler Location	Coordinates[a]		Mean		Emission (Ci)
			pCi/m^3 [b]	Bq/m^3	
DOD (for Area 5 RWMS)	NE	1589 m	0.69	0.026	5.3[c]
SEDAN Crater	N	838 m	14	0.52	40[c]
E Tunnel Ponds	-	-	7.1	0.26	13[d]
SCHOONER	WNW	269 m	430	16	230[c]

(a) Sampler direction and distance from center of suspected source.
(b) Median MDC is 0.9 pCi/m^3.
(c) Estimated number of curies emitted from the source that would give the sampler result.
(d) Estimated from total water discharged and tritium concentration measurements.

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 ^{241}Am and $^{239+240}Pu$ are routinely detected, but only in concentrations slightly above the 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 NTS. In NUREG/CR-3332 (NRC 1983), page 5-30, an equation for calculating a suspension rate (fraction resuspended per second) is given as follows:

$$S = K \times V_g$$

where: S = suspension rate (sec^{-1}) - fraction of the deposit resuspended/sec
K = re-suspension factor (m^{-1})
V_g = deposition velocity (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 will be used as conservative estimates. If 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 Ci) from Table 1.0 and re-suspension rate, as follows:

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

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

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

This method was used for calculating the ^{241}Am and $^{239+240}Pu$ emissions from all other areas. The results are shown at the end of 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 ^{137}Cs and ^{238}Pu. The cesium isotope is neglected because it migrates readily, and in eight to ten years after assessment in the soil, only a fraction will remain in the surface layer. Since the ^{238}Pu concentration in air is usually below the MDC, this isotope has also 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

Using the equation in EPA's Methods for Estimating Diffuse Emissions (unpublished), a wind erosion calculation for Area 9 for comparison with the NTS NESHAPs report calculation can be done. To illustrate this calculation, the equation on page 18 of the EPA report is used:

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

where:
- E' = soil particles lost (tons/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 - $C = 0.345\ (mph^3/PE^2)$ where $PE = 0.83$
- L' = unsheltered field width factor
- V' = vegetative cover factor
- A = site area (m^2) - use high density of 75.6 Ci on 7.5 mi^2
- c = conversion factor tons/acre to kg/m = 0.224

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

- k = 0.5 (fraction of resuspended soil that is 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 X 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 cm^2/m^2 x 5 cm deep x 1.5 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 nCi/kg

and the source-term becomes:

23 x 10^{-9} Ci/kg x 1.9 x 10^8 kg/yr = 4.4 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.

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

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APPENDIX F

IDENTIFICATION AND JUSTIFICATION FOR THE DEVELOPMENT OF METEOROLOGICAL DATA USED AS INPUT TO CAP88-PC

SITE CHARACTERISTICS

The NTS is located in southern Nevada, approximately 105 km (65 mi) northwest of Las Vegas, Nevada and encompasses an approximate rectangular area of approximately 1,375 mi^2 (see Figure F.1). Topography is complex with generally north-south oriented ridges and valleys typical of Nevada. Terrain elevations range from almost 2,700 ft in the extreme southwest corner of the NTS (Area 25) to almost 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 NNSA/NSO by the 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 4.5 in/yr at Station No. 25, to 6.8 in/yr at Yucca Flat (Station No. 6), to 7.6 in/yr at Desert Rock, to 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). This network 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.

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 hr/day, 365 days/yr at the Desert Rock Meteorological Observatory (DRA; elevation 3,304 ft) located three miles southwest of Mercury, Nevada (Station No. 23). Upper-air observations (radiosondes) are taken twice daily from DRA. DRA has been in operation since May 1978. DRA was built to replace a similar observatory that was located at the Yucca Flat Meteorological Observatory (UCC; elevation 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.

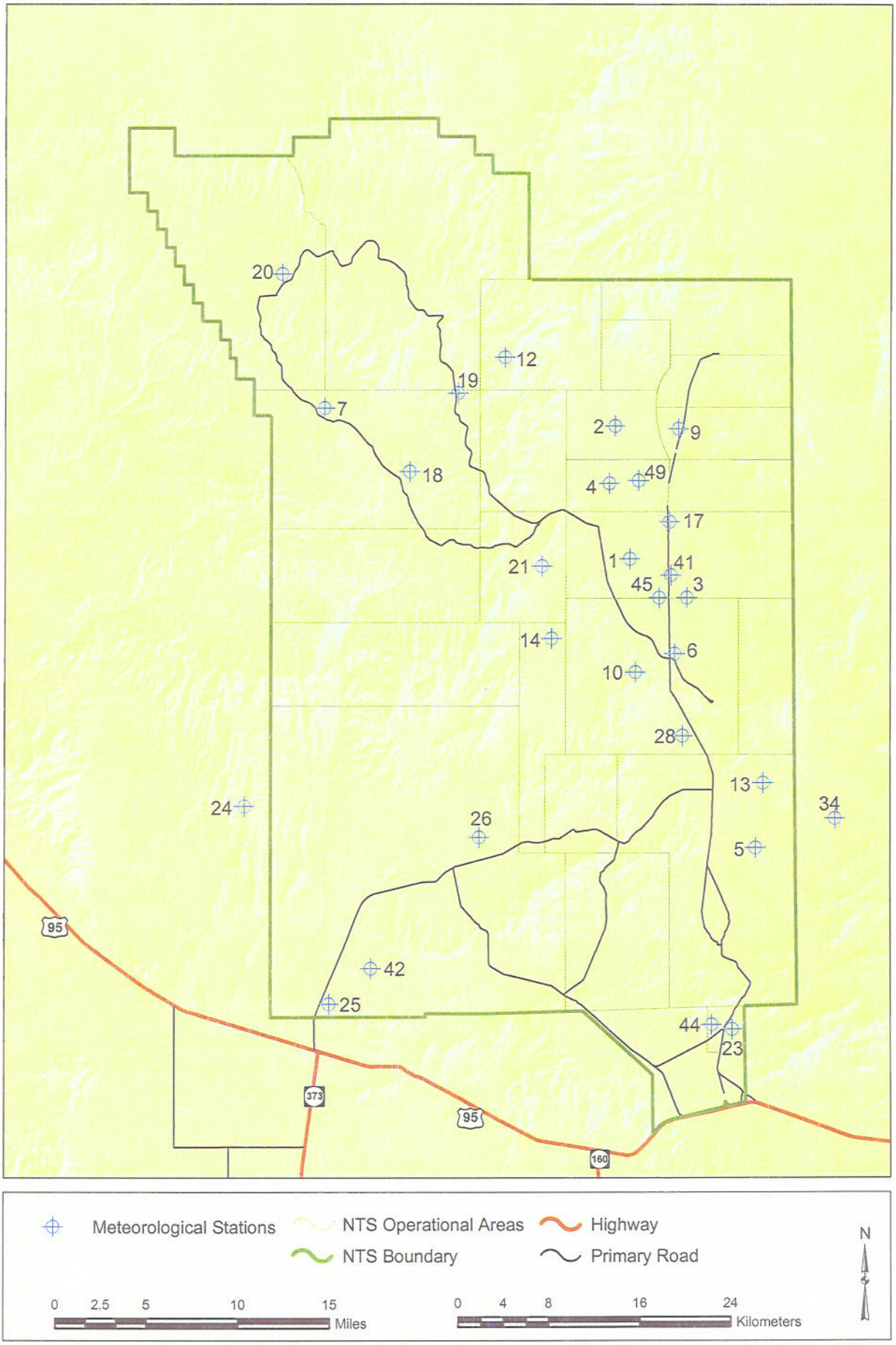

Figure F.1 Locations of Meterological Data Acquistion System (MEDA) Stations on the NTS - 2002

A key component of the MIDNET system is the MEDA. The MEDA consists of an enclosed trailer, a portable 10-m 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 (see 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 the 3-m level. A total of 27 MEDA stations are located on or around the NTS (see 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°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, display, 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 3 miles; from UCC to Frenchman Flat, 12 miles; and from DRA to Pahute Mesa, 40 miles.

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, in tenths, from sunrise to sunset for both stations is 3.9 tenths daily. The total number of cloudy days for UCC is 81 days and 88 days for DRA, annually. Therefore, the cloud cover observations from DRA and UCC can be considered as representative for most of the NTS.

In a study of precipitation on the NTS, Quiring (1983) found that the northwest part of the NTS, including Pahute Mesa, is clearly an area of diminished precipitation for the given elevation (6,500 ft). Furthermore, the total annual precipitation for Pahute Mesa (7.9 inches) is more compatible with that from DRA (7.6 inches) than from UCC (6.8 inches). Consequently, assuming that cloud cover is directly related to precipitation, it logically follows that the cloud cover for Pahute Mesa is better represented climatologically by the cloud observations from DRA.

APPLICATION TO CAP88-PC INPUT

Based on the above considerations and on the limitations of 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 three miles from Mercury.

The STAR file is a matrix that includes 7 Pasquill stability categories (A through G), 6 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 year 2002 were used in creating the STAR files for the CAP88-PC calculations.

The STAR files were prepared only from observations for the current report year. 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
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	7
meda18.str	18, 30
meda19.str	17
meda20.str	20
meda21.str	16
meda23.str	23
meda34.str	5
meda41.str	3

APPENDIX G

SUPPLEMENTAL INFORMATION

COMPARISON WITH PREVIOUS YEARS' DATA

Maximum Potential Individual EDE:
2002 - 1.1 x 10^{-1} mrem (1.1 μSv)
2001 - 1.7 x 10^{-1} mrem (1.7 μSv)
2000 - 1.7 x 10^{-1} mrem (1.7 μSv)
1999 - 1.2 x 10^{-1} mrem (1.2 μSv)
1998 - 9.2 x 10^{-2} mrem (0.9 μSv)
1997 - 9.0 x 10^{-2} mrem (0.9 μSv)
1996 - 1.1 x 10^{-1} mrem (1.1 μSv)
1995 - 1.8 x 10^{-1} mrem (1.8 μSv)
1994 - 1.5 x 10^{-1} mrem (1.5 μSv)
1993 - 3.8 x 10^{-3} mrem (38.0 nSv)
1992 - 1.2 x 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 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 ^{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 EDE is the sum of the EDEs from each emission source for each location multiplied by the population. The collective EDE for CY 2002 was 0.42 person-rem/yr for the 35,556 people who lived within 80 km of the NTS emission sources. The collective EDE for each populated location is shown in Table 5.0. The collective offsite EDE by Area in which the emission sources were located is shown in Table G.1.

Table G.1 Contribution to Offsite Collective EDE by NTS Areas

Area	Person-mrem/yr	Area	Person-mrem/yr
1	27.3	11	22.1
2	6.9	12	4.7
3	28.4	15	2.3
4	14.7	16	3.4
5	9.4	17	5.8
6	6.8	18	110.0
7	14.6	19	9.6
8	33.2	20	14.8
9	39.7	30	15.7
10	53.2		
Total = 422 person-mrem/yr or 0.42 person-rem/yr			

The population information was based on the 2000 Census and State projections (Nevada State Demographer 2001) for cities and unincorporated towns, where available. The population sum (35,566) was less this year because Tonopah was not within 80 km of the emission sources.

Since the state projections did not include many smaller population groups or combined them together for a given county, the cumulative population dose within 80 km of the emission sources was estimated with GIS Arc-Map software and a global population data base (Bright 2002), which is based upon the 2000 Census. This data base, called LandScan, provides population estimates at a 30-arc-second by 30-arc-second resolution and uses satellite imagery to re-distribute the populations from the census cells based upon location of road proximity, night-time lights, land slope, land use, and land cover. This graphical population distribution was then joined with polygons created by over-lapping the CAP88-PC radial grids from each of the emission sources. Each radial grid consisted of 16 radial sectors intersected by five circles at 16-km increments. For each polygon an EDE was determined from the sum of the individual EDEs associated with the radial sectors which over-lapped. The total EDE was then multiplied by the population in that area. The resulting population sum within 80 km was determined as 32,601, and the cumulative population dose was estimated to be 0.50 person-rem. The higher population dose by this method with lower population sum as compared with Table 5.0 is probably due to the method by which the LandScan data base distributed the Census 2000 population information.

ESTIMATING TRITIUM EMISSIONS FROM SCHOONER

The tritium emissions from SCHOONER for CY 2001 were calculated assuming that the area of the source (approximately 100,000 m^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 m from the crater rim during 2002, the area of the source term appears to have been under-estimated. For CY 2002 the source-term area was estimated as 492,000 m^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 west-northwest) within the source term area (radius of 396 m), the CAP88-PC concentration estimate at the sampler location for a 1 Ci/yr release has high uncertainty (see Figure G.1). 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. The ratio for 2002 was 0.34. To correct this situation another air sampler will be positioned at a distance where the area source is treated by CAP88-PC as a point source. Also, other methods will be used to determine the area of the source and to estimate the source term from measurements of tritium transpiration from the soil and vegetation.

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, BN 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 $pCi/m^2/s$ required by Subpart Q in the event that by-product material as defined by section 11.e(2) of the Atomic Energy Act of 1954 (as amended) is disposed of in these areas in the future. The results of the most recent study (DOE 2001) 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 RWMS-5 to the public projected that the in-growth of ^{222}Rn from the decay of ^{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 EMISSION

None of these sources exist on the NTS.

QUALITY ASSURANCE PROGRAM NESHAP

The quality assurance program for samples collected and analyzed for NESHAP is documented in an environmental monitoring plan (DOE 1998). The applicable requirements of CFR 61, Appendix B, Method 114, "Test Methods for Measuring Radionuclide Emissions from Stationary Sources" (EPA 2001) and the requirements of DOE Order 414.1A, "Quality Assurance" (DOE 2001) have been implemented in this plan.

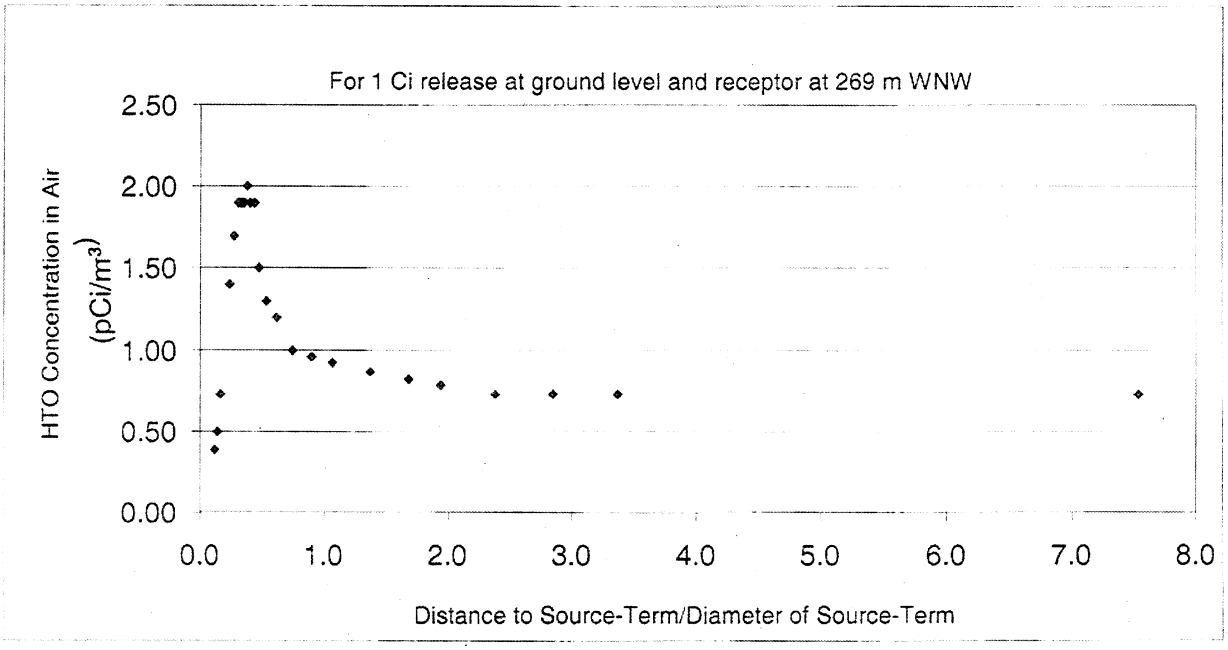

Figure G.1 CAP88 Predicted Air Concentration versus Area of Source

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APPENDIX H

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