DOE/NV/11718--442

National Emission Standards for Hazardous Air Pollutants Calendar Year 1999

June 2000

U.S. Department of Energy
Nevada Operations Office
Las Vegas, Nevada

DISCLAIMER

DOE/NV/11718--442

National Emission Standards for Hazardous Air Pollutants Calendar Year 1999

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June 2000

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ARL/SORD	Air Resources Laboratory Special Operations and Research Division
ASL	Analytical Services Laboratory
BN	Bechtel Nevada
CAP88-PC	Clean Air Package 1988 (EPA software program for estimating doses)
CFR	Code of Federal Regulations
CY	Calendar Year
DAF	Device Assembly Facility
DOE/NV	U.S. Department of Energy/Nevada Operations Office
DRA	Desert Rock Meteorological Observatory
EDE	Effective Dose Equivalent
EPA	U.S. Environmental Protection Agency
FFACO	Federal Facilities Agreement and Consent Order
HTO	Tritiated Water
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
NOAA	National Oceanic and Atmospheric Administration
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
STAR	Stability Array - (grouping of meteorological data)
TRU	Transuranic - (nuclides with atomic numbers greater than uranium)
UCC	Yucca Flat Meteorological Observatory
WEF	Waste Evaluation Facility

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U.S. Department of Energy
Nevada Operations Office
Air Emissions Annual Report
(under Subpart H, Title 40 Code of Federal Regulations [CFR] 61.94)
Calendar Year (CY) 1999

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SECTION I
FACILITY INFORMATION

SITE DESCRIPTION

The Nevada Test Site (NTS) is operated by the U.S. Department of Energy's Nevada Operations Office (DOE/NV) as the site for nuclear weapons testing, now limited to readiness activities and experiments in support of the national Stockpile Stewardship Management Program. It is located in Nye County, Nevada, with the southeast corner about 105 km (65 mi) northwest of Las Vegas, Nevada. The NTS covers about 3,561 km^2 (1,375 mi^2), an area larger than Rhode Island. Its size is about 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 0.2 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 there is great depth to slow-moving groundwater.

SOURCE DESCRIPTION

The sources of radionuclides include current and previous activities conducted on the NTS. Figure 2.0 is a map of the NTS that shows the areas used for such activities. 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) earth-cratering experiments, and (3) open-air nuclear reactor and rocket engine testing. Since the mid -1960s, testing of nuclear explosive devices has occurred underground in drilled vertical holes or in mined tunnels (DOE 1996a). No such tests have been conducted since September 23, 1992 (DOE 1994a). Limited non-nuclear testing includes spills of hazardous materials at the Hazardous Materials Spill Center and aerospace and demilitarization 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 1999 were releases from (1) evaporation of tritiated water (HTO) from containment ponds that receive drainage water from E Tunnel in Area 12 and from wells used for site characterization studies, (2) onsite radioanalytical laboratories, (3) the Area 5 RWMS (RWMS-5) facility, and (4) diffuse sources of tritium and resuspension of plutonium. The following sections present a general description of the present sources on the NTS.

At the North Las Vegas Facility, operated for DOE/NV 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 (probably deemanation of building materials) at lower levels, 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.

Ground Seepage of Noble Gases

Ground seepage may be enhanced when changes in ambient pressure act like a pump to bring small amounts of noble gases up through the overburden and into the atmosphere from the cavity created by a nuclear test. This process, sometimes referred to as "atmospheric pumping," creates a diffuse source of radiological effluents. This has occurred on Pahute Mesa at the NTS. Since there have been no underground nuclear tests since 1992 and there have been no significant differences between the noble gas concentrations at sampling locations on Pahute Mesa and on Yucca Flat (background location), this monitoring was terminated in 1997.

Tunnel Operations

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

Containment Ponds

Water contaminated with radionuclides seeped from the tunnels in Area 12 and was collected in containment ponds where some evaporated and some seeped into the soil. A photograph of tunnel containment ponds is provided in Figure 3.0. The tunnels have been sealed, but water continues to seep from E Tunnel. 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 recompleted in the vicinity of certain underground tests and at other locations on the NTS, as determined by hydrologists. During these drilling operations, contaminated water may be pumped from the wells. This water is diverted to lined containment ponds if the tritium level exceeds 2×10^{5} pCi/L, as required by the state and explained in the Underground Test Area Program (DOE 1996a). Calculations for this activity are also described in Appendix B.

Drillbacks

Following underground nuclear tests, slant wells are drilled so core samples can be taken from the cavity formed by the nuclear detonation for analysis and diagnosis. As a result, radioactivity may be discharged to the atmosphere. No tests or drillback activities occurred during 1999.

Laboratories

Radiological analyses are conducted in laboratories located in Building 650, Mercury; Building CP-95A and the Device Assembly Facility in Area 6; and in Building 5-6 at the Waste Management Facility in Area 5. 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 through the hood ventilation system during sample processing, particularly of spiked samples, or from loss of radioactive standards. Figure 4.0 is a photograph of the Building 650 hood ventilation stacks seen from above. The source term for these laboratories is described in Appendix C. In general, evaporation and spills from samples containing HTO, radioiodines, or noble gases are conservatively estimated by assuming all such

materials are released. Radioactive standards are the principal sources for these releases. Non-volatile materials are controlled by keeping their inventory below the possession limits set forth in Appendix E to Title 40 CFR 61 (CFR 1989) as shown in Appendix C.

Radioactive Waste Management Sites

The RWMSs in Area 3 (RWMS-3) and RWMS-5 are used for the disposal of low-level radioactive waste (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 effluent detected by the various types of samplers surrounding the site is HTO in atmospheric moisture. The calculation of the HTO source term is explained in Appendix D. The RWMS-3 LLW site is in a location where surface soil has been contaminated by deposited plutonium, and resuspension of this soil by wind or vehicular activity results in above background levels of plutonium being detected in air samples collected nearby.

Surface Areas Contaminated with Plutonium or Tritium

Surface soils in certain areas on and off of the NTS were contaminated with plutonium and/or tritium from either nuclear device safety, atmospheric, or the cratering tests, using nuclear explosives. An investigation of these areas during the Nevada Applied Ecology Group studies, by the Desert Research Institute (DOE 1991), developed the inventories of plutonium shown in Table 1.0. These areas could become sources of plutonium exposure if the contaminated soils were to be resuspended, e.g., during surface cleanup, construction, vehicular travel, or similar activities. Figure 5.0 is a map showing the approximate locations of the nuclear device safety tests on or near the NTS. There are air samplers at or near most of these onsite areas. Plutonium analyses of the glass-fiber filters from these samplers indicate that the majority of the results are less than the minimum detectable concentration (MDC) and most of those are even less than the two standard deviation (2s) counting error. The results that are different are from air samplers in areas where operational activities can cause contaminated surface soil to become resuspended. These areas are considered diffuse sources of radioactive effluents, although plutonium is the only detectable one. The derivation of the source term for and reason for selection of plutonium from contaminated areas is explained in Appendix E.

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

Federal Facilities Agreement and Consent Order (FFACO)

Under the FFACO between DOE/NV and the state (FFACO 1996), contamination generated by historical NTS activities is being removed. Two surface areas on the NAFR have had partial source removal so far. These surface areas are DOUBLE TRACKS in 1996 and CLEAN SLATE I in 1997. This results in a decrease in offsite EDE. The monitoring plan for such activities envisages continued air sampling until the concentration in air returns to background levels. The clean up of DOUBLE TRACKS (DOE 1997a) and CLEAN SLATE I (DOE 1997b) areas resulted in removal of 5.12 Ci and 5.65 Ci of $^{239+240}$Pu, respectively. The amounts removed are within the 95 percent confidence interval of 1.7 to 6.0 Ci estimated for each of these two locations.

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

Area	Area (mi^2)	^{241}Am(Ci)	^{238}Pu(Ci)	^{239}Pu(Ci)
Onsite Areas Studied [a]				
1	26.5	4.2	6.5	24
2	19.7	2.9	8.6	22
3	32.3	4.6	3.1	37
4	16.0	6.6	13	40
5	2.9	0.6	0.1	4.8
6	32.3	1.7	3.3	8.4[b]
7	19.3	2.2	0.6	16
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
16	14.3	0.7	1.5	3.7[b]
17	31.4	2.8	4.5	18
18	27.3	19	5.6	100
19	148.3	21	32	140[b]
20	6.2	23	30	41
25	0	0	0	0
26	0	0	0	0
30	0.3	3.2	4.5	14
Offsite Areas Studied [c]				
Area 13	1.55	N/A	N/A	46
CLEAN SLATE II	0.18	N/A	N/A	17
CLEAN SLATE III	0.67	N/A	N/A	37

N/A Not available.
(a) (DOE 1991).
(b) Used for resuspension calculations in this report and in past reports, however, re-evaluation of the above referenced report indicates levels were background; not NTS event-related.
(c) Safety/transport tests of nuclear devices (DOE 1992).

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, assuming that volatile radionuclides are released to the environment; (3) the measurement of tritiated water (as HTO or T_2O) concentration 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 resuspension calculations; or (5) using a combination of environmental measurements and Clean Air Package 1988 air dispersion model (CAP88-PC) (U.S. Environmental Protection Agency [EPA] 1992) to calculate emissions. Appendices A through E describe the methods used to determine the emissions from the sources listed in Section I. In accordance with Title 40 CFR 61.93.(b).(4), (CFR 1989) no credit was taken for pollution control equipment in determining air emissions.

The emissions for National Emission Standards for Hazardous Air Pollutants (NESHAPs), reporting are listed in Table 2.0. These emissions are very conservative (worst-case) and are used in Section Ill to calculate the EDE to the maximally exposed individual (MEI) offsite. Offsite environmental surveillance data, where available, are used to confirm that calculated emissions are, indeed, conservative.

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

Point Source [a]	Type of Control	Efficiency	Distance to Nearest Receptor	Nuclide	Quantity (Ci)
Bldg. CP-95A Lab	None	0%	42 km	^{3}H	5.1×10^{-4}
DAF Lab, Area 6	None	0%	40 km	^{3}H	5.74
Building A-1	None	0%	0.1 km	^{3}H	0.30
Building 5-6 Lab	None	0%	42 km	^{3}H	5.0×10^{-5}
Grouped Sources					
Building 650 Laboratory (12)[b]	None	0%	24 km	^{3}H	2.1×10^{-4}
				^{85}Kr	1.1×10^{-3}
				^{129}I	1.5×10^{-6}
Containment [c]					
Pond: Area 12	None	0%	56 km	^{3}H	15.3
Area 20	None	0%	36 km	^{3}H	9.43
Area 4	None	0%	56 km	^{3}H	2.8×10^{-2}
Non-Point Sources					
RWMS-5 [e]	None	0%	42 km	^{3}H	7.09
SEDAN[f]	None	0%	51 km	^{3}H	260
SCHOONER[f]	None	0%	36 km	^{3}H	65
Yucca Flat:					
Area 3	None	0%	55 km	$^{239+240}Pu$[d]	1.2×10^{-2}
Area 9	None	0%	53 km	$^{239+240}Pu$[d]	2.8×10^{-2}
Other Areas	None	0%	31 km (minimum)	$^{239+240}Pu$[d]	2.0×10^{-1}

(a) All locations at the NTS except Building A-1, which is at the Atlas Facility, North Las Vegas.
(b) (x) is number of vents or stacks.
(c) Evaporation of all tritiated water effluents is assumed.
(d) ^{241}Am is estimated to be present at a ^{241}Am to $^{239+240}Pu$ ratio of 1 to 6.2.
(e) Emissions based on environmental surveillance data and tritiated water pumped from Well RNM-2s.
(f) Emissions based on environmental surveillance data.

A summary of the NTS total CY 1999 emissions for NESHAP's reporting, by radionuclide, is provided in Table 3.0.

Table 3.0 Total Emissions for CY 1999 (Multiply Ci by 37 to obtain GBq)

Radionuclide	Half-Life (yr)	Annual Quantity (Ci)
^{3}H	12.35	357
^{85}Kr	10.72	1.1×10^{-3}
^{129}I	1.57×10^{7}	1.5×10^{-6}
$^{239+240}Pu$	24.065	2.4×10^{-1}
^{241}Am	432.2	3.9×10^{-2}

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 radionuclide releases listed in Section II above 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 resuspension. The latter include measurable particulate emissions of $^{239+240}$Pu originating in certain areas of the NTS and NAFR and HTO detected at the boundary of the RWMS.

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 source data listed in Table 2.0 are used with five stability array (STAR) data files as input to CAP88-PC. The five STARs for the NTS include the files with names NTSYUCCA, AREA05, MEDA20, DESERTRK, and T TUNNEL. NTSYUCCA is used for sources on Yucca Flat (Areas 1, 2, 3, 4, 6, 7, 8, 9, 10, and 18); AREA05 is used for sources in Area 5, which includes Frenchman Flat; DESERTRK is used for sources in Mercury; MEDA20 is used for sources in Areas 19 and 20; and T TUNNEL for the tunnel pond sources in Area 12. MEDA20, T TUNNEL, and AREA05 were developed by the Air Resources Laboratory, Special Operations and Research Division (ARL/SORD), using data obtained from the meteorological stations located near the boundary of Areas 19 and 20 on Pahute Mesa, near the tunnels in Area 12, and at Well 5B in Area 5. The other two files were provided by the National Climatic Data Center in North Carolina, based on data from meteorological stations in Yucca Flat and at Desert Rock Meteorological Observatory (DRA). The ARL/SORD assessment is attached as Appendix F. For each of these five STARs there may be a different location for the MEI; but when the contributions of all the NTS sources to a given location are considered, only one location would receive the maximum exposure. In this case, Springdale, Nevada, with a population of 20 persons, received the maximum exposure of 120 µrem. See Figure 1.0 for ranches and communities around the NTS.

The EDE, in mrem, to the MEI (a resident in Springdale, Nevada) was calculated using CAP88-PC for each of the listed sources in Section II. A summary of sources contributing to the EDE is shown in Table 4.0. Calculation of this EDE requires summing the contribution from all areas and facilities, as shown in Table 5.0. The portions of the EDE contributed by $^{239+240}$Pu were corrected to include the doses from ^{241}Am. A $^{239+240}$Pu to ^{241}Am ratio of 16:1 was used for resuspensions from Clean Slates II and III (DOE 1994b), and a ratio of 6.2:1 was used for all other sites based upon weapons grade source material aged 30 years (LLNL 1994). Appendices A through E contain the methods by which the releases of radionuclides were calculated.

Descriptions and estimations of the errors involved in each step of the process (measurement, monitoring, and calculation), estimations of potential releases, and worst-case scenarios are also included where possible. Evaporative and resuspension emissions are also compared to EPA suggested methods as a check on the relative values produced.

COMPLIANCE ASSESSMENT

Table 4.0 Summary of CY 1999 CAP88-PC Calculations of EDE to the MEI Offsite, Springdale, Nevada[a]

Source		Distance to Individual and Direction	EDE (mrem)[b]
Containment Ponds			
Area 4		56 km W	negligible
Area 12		53 km WSW	3.2×10^{-5} [c]
Area 20		37 km W	3.3×10^{-5}
Laboratories (Area 23)		78 km WNW	1.6×10^{-5}
Yucca Flat	(Area 3)	62 km W	5.5×10^{-3}
	(Area 9)	64 km W	1.2×10^{-2}
	(Area 10)	65 km WSW	3.4×10^{-2}
RWMS (Area 5)		74 km WNW	8.3×10^{-5}
Areas 19/20		42 km SW	3.0×10^{-2}
Other Areas	---		3.0×10^{-2}
TOTAL EDE			0.12 mrem

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

Beginning in July 1999, high volume air particulate samplers (68 m^3/h) were operated by Bechtel Nevada at Alamo, Amargosa Center, Beatty, Goldfield, Indian Springs, and Rachel for the purpose of validating the EDEs listed for these locations in Table 5.0, which were calculated by CAP88-PC. The weekly samples from these locations were composited monthly and analyzed for plutonium. Table 6.0 compares the EDEs calculated by CAP88-PC with the EDEs calculated from the analytical results for the air filters. As shown by this table, the EDEs calculated by CAP88-PC were consistently higher than the EDEs calculated from the air sampling results except for Rachel. The CAP88-PC EDE at Alamo was not much higher than the EDE calculated from air sampling results due to the fact that most of the sources on the NTS were beyond 80 km, which is the maximum distance for CAP88-PC calculations. At Rachel the majority of the EDE calculated from air sampling results is attributed to local resuspension, because Rachel has often been in the fallout pattern of past atmospheric tests and unplanned ventings from underground nuclear tests. The $^{239+240}Pu$ deposition levels of soil (120-132 nCi/m^2) measured by the EPA (DOE 1977) near Rachel suggest that resuspension of plutonium could increase the air sampler measurement (see Table 6.0).

Table 5.0 EDE Tabulation by Location (Multiply μrem or mrem by 10^{-2} for Equivalent μSv and mSv Units, Respectively) - 1999

Location	EDE (μrem/yr) due to releases from:								
	Lab. Sources	RWMS-5[a] Tritium	Area 10[a] Tritium	Area 12[a] Tritium	Area 20[b] Tritium	All Areas $^{239+240}Pu$ ^{241}Am[b]	Total EDE[c] μrem	Pop.[d]	Collective EDE person-mrem
Alamo			0.29			9.88	10.2	1000	10.2
Amargosa Center	0.018	0.085	0.35	0.033	0.021	67.5	68.0	1100	74.8
Ash Meadows	0.018	0.082				8.88	8.88	10	0.090
Ash Springs						2.00	2.00	70	0.140
Beatty	0.017	0.086	0.38	0.034	0.323	93.3	94.1	1620	152
Cactus Springs	0.015	0.092	0.35	0.072		17.1	17.7	10	0.177
Clark Station						5.61	5.61	2	0.0112
Corn Creek Sta	0.0023	0.080					0.082	4	3.3×10^{-4}
Crystal	0.020	0.088	0.33	0.053		48.8	49.2	45	2.22
Death Valley Jct	2.4×10^{-5}	0.081					0.081	7	5.7×10^{-4}
Goldfield					0.29	19.9	20.2	580	11.7
Hiko						1.88	1.88	103	0.193
Indian Springs	0.015	0.090	0.35			26.9	27.3	3140	85.8
Lathrop Wells	0.020	0.091	0.37	0.061	0.313	90.0	90.9	30	2.73
Lida Junction					0.32	12.4	12.7	8	0.102
Medlin's Ranch	0.015	0.008	0.30	0.037	0.018	41.5	41.9	2	0.084

(a) Emissions calculated from surveillance data.
(b) Emissions calculated from engineering data.
(c) For portion of EDEs contributed by emissions from individual areas, see Table E.2.
(d) Population at that location for 1999.

Note: Blank spaces represent locations farther than 80 km from the source for the column.

Table 5.0 (EDE Tabulation by Location [Multiply µrem or mrem by 10^{-2} for Equivalent µSv and mSv Units, Respectively] - 1999, cont.)

Location	EDE (µrem/yr) due to releases from:								Collective EDE person-rem
	Lab. Sources	RWMS-5[a] Tritium	Area 10[a] Tritium	Area 12[a] Tritium	Area 20[b] Tritium	All Areas $^{239+240}Pu^{241}Am$[b]	Total EDE[c] µrem	Pop.[d]	
Mt. Charleston	2.3×10^{-5}	0.079					0.079	960	0.075
Pahrump	2.3×10^{-5}	0.081					0.081	22,430	1.81
Penoyer Farm			0.30	0.036	0.31	53.8	54.5	16	0.872
Rachel			0.30	0.035	0.31	48.6	49.3	105	5.17
Sarcobatus Flats			0.34	0.050	0.29	84.8	85.5	40	3.42
Scotty's Junction				0.045	0.29	31.3	31.7	10	0.317
S NV Corr. Ctr	0.015	0.084				2.88	2.97	2000	5.95
Springdale	0.016	0.083	0.39	0.032	0.332	118	118.9	20	2.38
Stateline and Area	2.4×10^{-5}	0.082				3.63	3.71	70	0.259
Stone Cabin Rn						4.29	4.29	6	0.026
Tolicha Peak	0.014		0.36	0.060	0.342	74.8	75.6	10	0.756
Tonopah						3.74	3.74	3080	11.5
Twin Springs Rn						5.50	5.50	6	0.033
U.S. Ecology	0.019	0.088	0.35	0.033	0.32	83.6	84.4	35	2.96

Total Population: 36,517 MEI: 0.12 mrem Location of MEI: Springdale, NV	Maximum Individual Dose Calculated from Following Sources - mrem					Total Person-rem:
	Area 5 Tritium	Area 10 Tritium	Area 12 Tritium	Areas 20 Tritium	All Areas $^{239+240}Pu/^{241}Am$	
	0.000099	0.00039	0.000072	0.00034	0.118	0.38

(a) Emissions calculated from surveillance data.
(b) Emissions calculated from engineering data.
(c) For portion of EDEs contributed by emissions from individual areas, see Table E.2.
(d) Population at that location for 1999.
Note: Blank spaces represent locations farther than 80 km from the source for the column.

Table 6.0 Comparison of EDEs Calculated by CAP88-PC with EDEs Calculated from Measured $^{239+240}Pu$ Concentrations in Air

Location	No. of Samples	Conc. from Air Sampling, Average x 10^{-6} pCi/m^3		EDE[(a)] from CAP88	EDE[(a)] from Air Sampling
		^{238}Pu	$^{239+240}Pu$	(µrem)	(µrem)
Alamo	6	0.396	2.46	9.88[(b)]	8.55
Amargosa Center	6	0.0214	1.28	67.5	4.45
Beatty	6	0.0440	2.66	93.3	9.25
Goldfield	6	0.0785	0.960	20.8	3.34
Indian Springs	6	0.0287	2.28	26.9[(b)]	7.93
Rachel	6	0.409	27.6[(c)]	48.6	96.0
Median MDC		0.924	0.924		

(a) Corrected to include dose from ^{241}Am, assuming $^{239+240}Pu/^{241}Am$ ratio of 6:2, an annual breathing rate of 8400 m^3/yr, and the respective dose factors of 330 rem/µCi and 520 rem/µCi. Although the concentration averages were determined over 6 months, they were assumed to be representative for all 12 months of the year.

(b) Estimate low due to most of NTS sources being beyond 80 km, which is the maximum range for CAP88-PC calculations.

(c) The $^{239-240}Pu$ deposition levels of 120-132 nCi/m^2 near Rachel is higher than the general offsite area, so resuspension would increase the air sampler measurement.

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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: K. A. Carlson, Manager, DOE Nevada Operations Office

Signature: K A Carlson Date: 6/28/00

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SECTION IV
ADDITIONAL INFORMATION

NEW CONSTRUCTION/MODIFICATION ACTIVITIES AT THE NTS

There were no new construction or modification activities at the NTS involving radioactivity.

UNPLANNED RELEASES DURING CALENDAR YEAR (CY) 1999

No unplanned release occurred on the NTS during CY 1999. There was a 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).

SOURCES OF DIFFUSE OR FUGITIVE EMISSIONS

These sources included evaporation from containment ponds that receive liquid effluents from E Tunnel in Area 12 and from groundwater characterization wells in Areas 4 and 20; $^{239+240}Pu$ resuspension from soil deposits on the NTS in Areas 3, 8, and 9 and other atmospheric test and safety test areas; and seepage of tritium from the SEDAN and SCHOONER craters and from packages buried at the RWMS-5.

The EDE to the MEI was principally due to the diffuse sources. The EDE from point sources was negligible. The methods used to determine the emissions from these diffuse sources are described in the appendices.

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FIGURES

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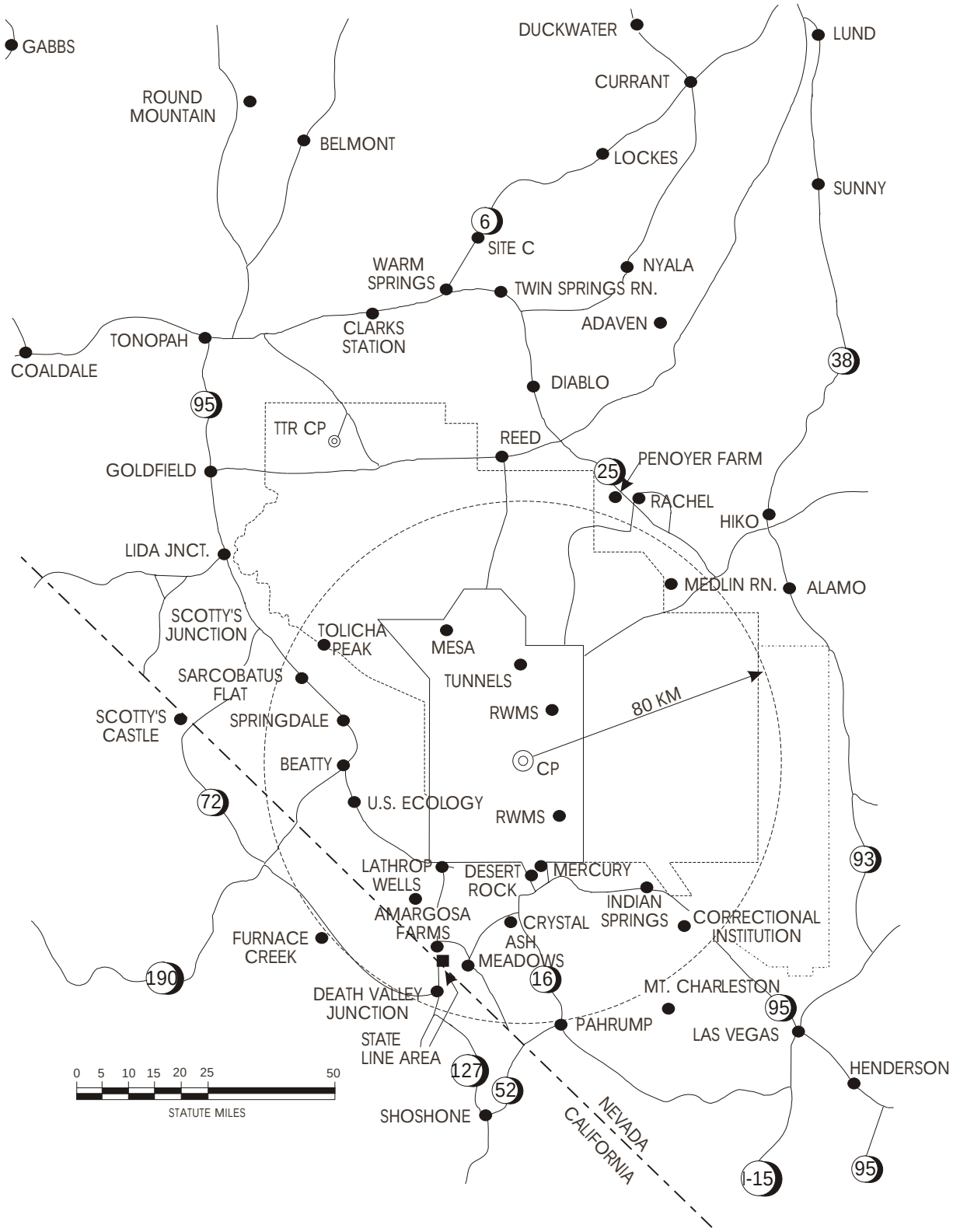

Figure 1.0 Map of the NTS and Surrounding Areas

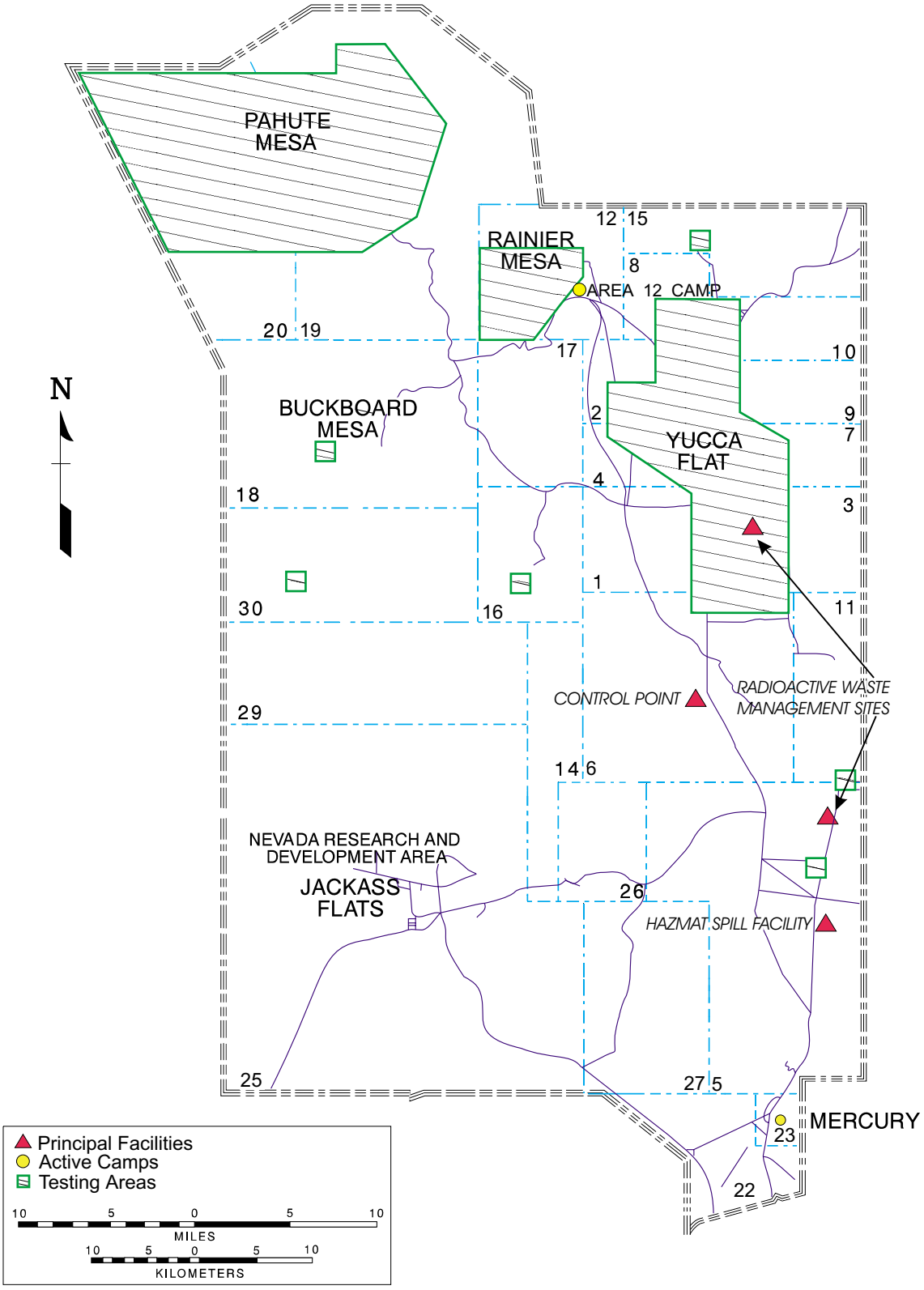

Figure 2.0 Nuclear Testing Areas on the NTS

Figure 3.0 Photograph of Tunnel Containment Ponds (Photo Date Not Available)

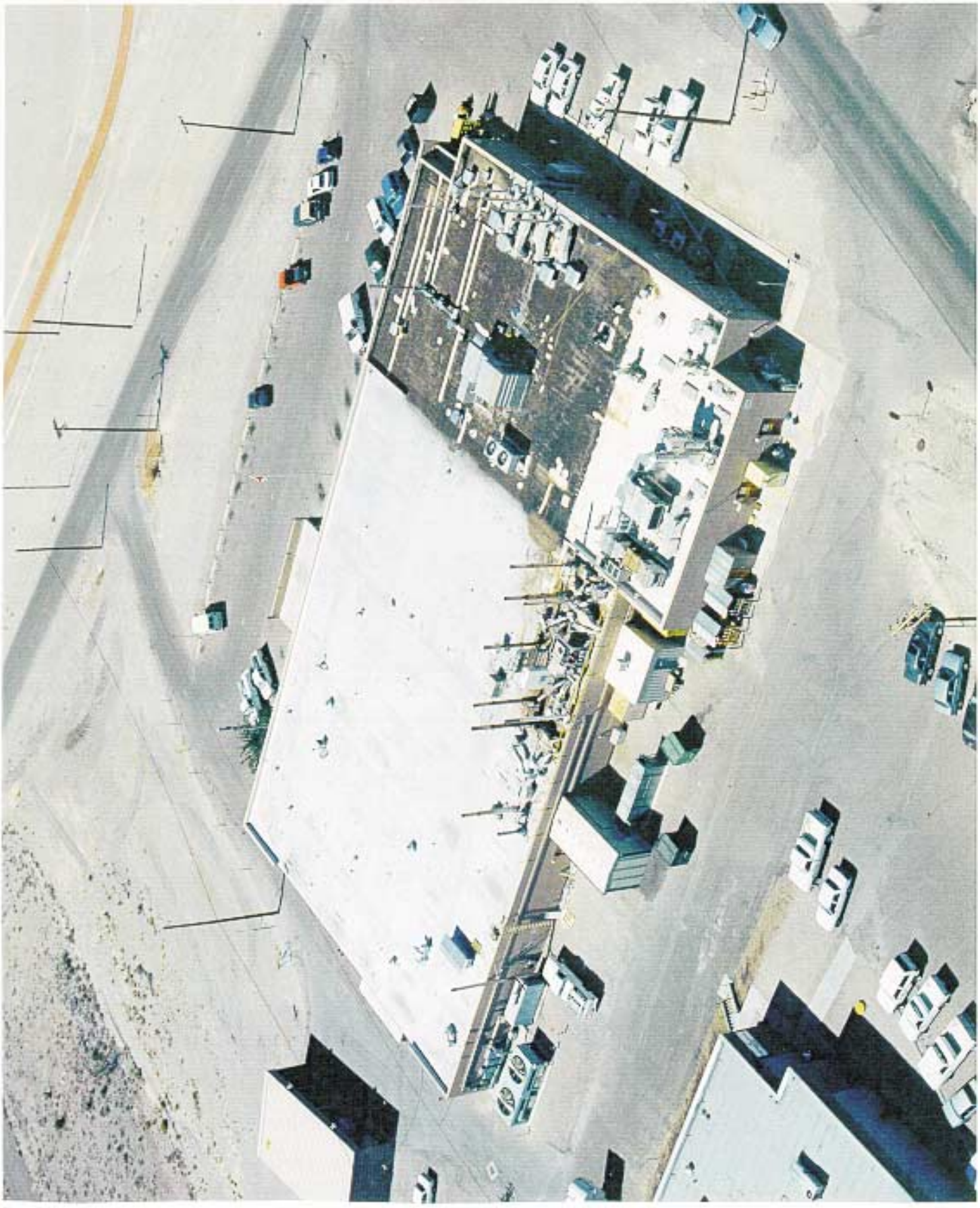

Figure 4.0 Photograph of the Building 650 Hood Ventilation Stacks Seen from Above (Photo Date Not Available)

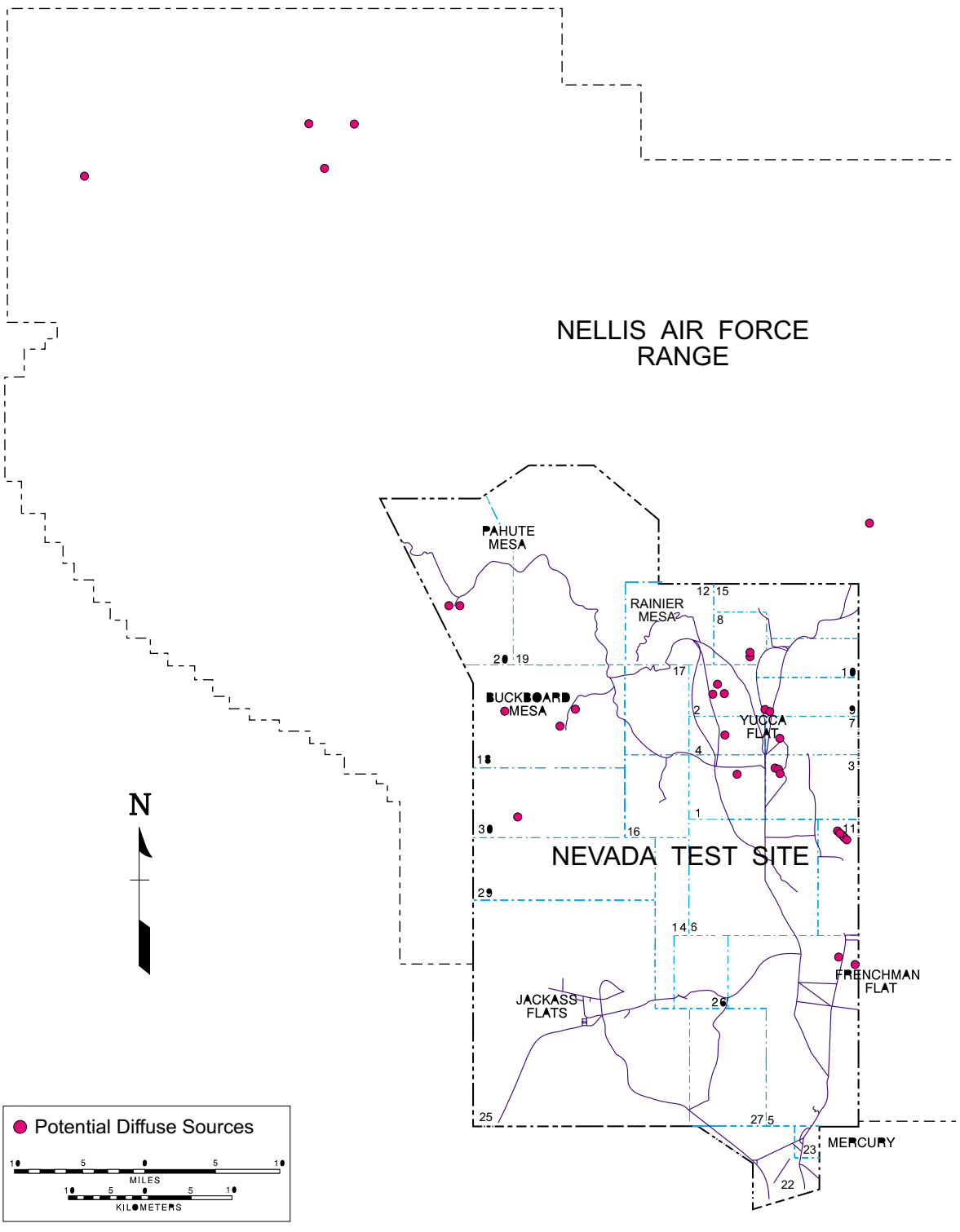

Figure 5.0 Locations of Potential Diffuse Sources of Plutonium on and Near the NTS

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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 a 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 EDEs were reported in the respective annual NESHAPs reports.

One-week samples were collected in the Building A-1 basement from November 21, 1999, through January 5, 2000. Sampling results are listed in Table A-1. From the average tritium concentration for room 4862, the EDE for a hypothetical MEI (100 m northwest of the exhaust vent as determined from the 1995 NESHAPS evaluation) was calculated by the following method:

- The volume rate of air discharged to the atmosphere from the Building A-1 basement (673 cfm) during 1999 was calculated from information obtained from an industrial hygiene ventilation survey conducted on October 22, 1998.

- The total tritium discharged was calculated by multiplying the average tritium concentration from Table A.1 by the air volume discharge rate and the number of minutes per year (30,000 pCi/m^3 x 673 ft^3/min x 0.02832 m^3/ft^3 x 5.26 x 10^5 min/yr x 10^{-9} mCi/pCi) to get 301 mCi/yr.

- The EDE for the MEI was calculated by multiplying the estimated total annual discharge of tritium by the CAP88-PC dose factor for that location. The resulting EDE is (301 mCi/yr) (4.8 x 10^{-6} mrem/mCi/yr)(1000 µrem/mrem) or 1.4 µrem.

For comparison, the NESHAPs specifies a limit of 10 mrem to the MEI, which is much greater than the calculated EDE.

Table A.1 HTO in Air at the Atlas Facility

Collection Period	Building A-1 Basement Room 4860 (µCi/mL)	Building A-1 Basement Room 4862 (µCi/mL)	Building A-1 Basement Room 4860 (pCi/m^3)	Building A-1 Basement Room 4862 (pCi/m^3)
11/17 to 11/24 1999		3.59×10^{-8}		35,900
11/24 to 12/01 1999		1.60×10^{-8}		16,000
12/01 to 12/08 1999	1.26×10^{-9}	2.85×10^{-8}	1,260	28,500
12/08 to 12/15 1999	1.22×10^{-9}	3.07×10^{-8}	1,220	30,700
12/15 to 12/22 1999	1.24×10^{-9}	3.20×10^{-8}	1,240	32,000
12/22 to 12/29 1999	1.34×10^{-9}	3.38×10^{-8}	1,340	33,800
12/29 to 01/05 2000	1.21×10^{-9}	3.33×10^{-8}	1,210	33,300
Average				30,000

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APPENDIX B

EMISSIONS FROM CONTAINMENT PONDS

EMISSION FROM TUNNELS, PONDS, ETC.

Effluent water from the Area 12 E Tunnel and any containment ponds receiving that water were sampled quarterly. During 1999, 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 radionuclides in the water and the total volume of water discharged during the year, based on the monthly flow-rate measurements. This is a conservative estimate, as no allowance for infiltration into the soil column was made.

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. Despite efforts to seal it, E Tunnel is still a source of HTO to the tunnel ponds. The curies of HTO discharged are shown in Table B-1.

In 1999, only two wells were pumped: one on Pahute Mesa (Area 20) and the other on Yucca Flats (Area 4). The HTO that was pumped from them was discharged to lined containment ponds. The volume and tritium concentration were measured with the results as shown in Table B-1.

Table B-1 Tritium Water Effluents in 1999

Location	Total ^{3}H Discharged (Ci)
Area 4, Well U-4u PS #2A	0.028
Area12, E Tunnel Pond	15.3
Area 20, Well U-20n PS #1DD-H	9.4
Total Effluent	24.7

The MEI for the Area 4 emission resides at Medlin Ranch, Nevada and would receive an EDE of 2.8×10^{-5} mrem (2.8×10^{-7} mSv).

The MEI for the Area 12 emission resides in Cactus Springs, Nevada and would receive an EDE of 7.2×10^{-5} mrem (7.2×10^{-7} mSv).

The MEI for the Area 20 emission resides in Tolicha Peak, Nevada and would receive an EDE of 3.4×10^{-4} mrem (3.4×10^{-6} mSv).

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.

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

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

RADIONUCLIDE INVENTORY OF RADIOANALYTICAL LABORATORIES

Analytical Services Laboratory (ASL)

The inventory of radionuclides in the ASL of BN, located in Building 650 at the NTS, was estimated by inventorying the standards, check sources, and tracer solutions. The activity contained in these sources was orders of magnitude above that contained in samples (based on data collected in previous years) and are listed in Table C.1.

From the inventory, only three of the items are volatile and may become a source of air emissions. These are ^{3}H (as HTO), ^{129}I, and ^{85}Kr and are listed in Table 2.0. All of the standards and solutions are compared to the possession limits set forth in Title 40 CFR 61 Appendix E, and all are less than 25 percent of those limits as shown in the last column of Table C.1.

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 and the only standard of significance for airborne emission maintained in 1999 was 510 µCi of tritium (5.1×10^{-4} Ci). This quantity is assumed to evaporate over the course of the year.

Device Assembly Facility (DAF) Laboratory

The DAF laboratory is located in Building 301, Room 103. It contains about 5.74 Ci of ^{3}H in liquid form as HTO and an insignificant amount in gaseous form.

Radioactive Waste Management Site (RWMS) Laboratory

This laboratory is located in Building 5-6, Area 5. It presently contains 50 µCi of ^{3}H.

Source Term

The source term for these laboratories is calculated by assuming that all of the volatile substances are completely released over the course of the year to become an airborne source of exposure.

Table C.1 Building 650 ASL Inventory Compared to NESHAPs Limits

Radionuclide	Annual Inventory (µCi/Yr)	Possession Limit[a] (Ci/Yr Liquid Form)	Ratio %
H-3	164.000	15000.000	1.1×10^{-6}
C-14	7.500	290.000	2.6×10^{-6}
Fe-55	1.600	140.000	1.1×10^{-6}
Cr-51	0.000	63.000	--
Co-57	0.030	1.600	1.9×10^{-6}
Co-60	9.000	0.016	5.6×10^{-3}
Ni-63	6.490	140.000	4.6×10^{-6}
Kr-85	1084.000	840.000	1.3×10^{-4}
Sr-85	0.000	1.900	--
Sr-89	0.000	21.000	--
Sr-90	0.880	0.520	1.7×10^{-4}
Y-88	0.018	0.250	7.2×10^{-6}
Tc-99	6.940	9.000	7.7×10^{-5}
Cd-109	1.600	5.000	3.2×10^{-5}
Sn-113	0.053	1.900	2.8×10^{-6}
I-129	1.510	0.260	5.8×10^{-4}
I-131	0.000	6.700	--
Te-123	0.000	1.200	--
Cs-137	2000.000	0.023	8.7
Eu-152	15.000	0.016	0.094
Eu-154	15.000	0.020	0.075
Pb-210	0.500	0.055	9.1×10^{-4}
Ra-226	10.300	0.0055	0.19
Ra-228	0.015	0.013	1.2×10^{-4}
Th-229	0.014	0.00049	2.9×10^{-3}
Th-230	0.008	0.0013	6.2×10^{-4}
Th-Nat	12.800	--	--
U-232	0.013	0.0013	1.0×10^{-3}
U-233	0.45	0.0076	5.9×10^{-3}
U-238	0.45	0.0086	5.2×10^{-3}
U-Nat	0.135	0.0086	1.6×10^{-3}
Np-237	0.013	0.002	7.2×10^{-4}
Pu-238	0.022	0.0027	8.1×10^{-4}
Pu-239	1.700	0.0025	0.068
Pu-241	0.030	0.130	2.3×10^{-5}
Pu-242	0.013	0.0025	5.2×10^{-4}
Am-241	14.000	0.0023	6.1×10^{-2}
Am-243	0.010	0.0023	4.3×10^{-4}
Cm-244	1000.000	0.0042	24
Gamma Emitters [b]	5.9	0.016	3.7×10^{-2}

(a) Title 40 CFR 61 Appendix E, Table 1.
(b) Gamma emitters include the sum of mixed gamma sources, mostly ^{237}Cs and ^{60}Co; the possession limit is for ^{60}Co.

APPENDIX D

DIFFUSE SOURCE ATMOSPHERIC TRITIUM EMISSIONS

BACKGROUND INFORMATION

Environmental monitoring for tritium in atmospheric moisture was conducted at 14 locations on the NTS during 1999. There were four air samplers around the perimeter of RWMS-5 because many curies of ^{3}H are buried at that facility. One was also operated next to the Area 6 Decontamination Pad for six weeks at the beginning of the year due to the temporary storage of some tritium waste that was disposed of during the fourth quarter 1998. Some of these samplers collect HTO at concentrations that are higher than background levels.

In 1999, the air samplers at the tunnel pond area, near the SEDAN crater, and at SCHOONER measured levels of HTO at slightly higher than the minimum detectable concentration. The sampler at the Area 15 Farm was not operated this year; the one north of the SEDAN crater was considered to be adequate coverage for both areas. The monitoring results from the airborne-tritium sampling stations are provided in Table D.1.

The other CY 1999 monitoring data indicate that gross beta and $^{239+240}Pu$ concentrations in air at RWMS-5 are not statistically different from sitewide NTS levels, excluding the results for Bunker 9-300, which again this year had levels significantly higher than all other locations with air particulate samplers.

SOURCE TERM

It is estimated that 0.71 Ci (26 Gbq) of ^{3}H were emitted from RWMS-5 during 1999. This source term is calculated to give an EDE of 8.8×10^{-6} mrem (12×10^{-8} mSv) to an individual residing in Cactus Springs, Nevada. This is the location of the MEI for a source in Area 5. The method used to calculate this quantity is described below.

Only environmental monitoring data were available, and there was no information on the volume of air discharged from the RWMS. Considering that the RWMS processes only packaged waste, it is not likely that an air volume or discharge can be determined. However, a source term can be calculated using a method similar to that described for Yucca Flat in Appendix E.

The mean annual airborne HTO concentrations from the tritium samplers surrounding the RWMS were used along with the DOE/EH-0071 dose conversion factors to calculate a dose at each sampler location. For example, an individual breathing 4.3 pCi/mL of HTO (at RWMS No. 4) for one year receives 3.5×10^{-3} mrem EDE when skin absorption is included[1]. Doses are calculated similarly for the other sampler locations. The result of a CAP88-PC run, assuming a 1 Ci release of ^{3}H at the center of the RWMS, is that an individual 430 m to the northeast (at HTO sampler RWMS No. 4) would receive an EDE of 4.9×10^{-3} mrem per year. Therefore, 3.5 measured at

---

(1) The following equation was used to calculate an EDE at each sampler location.

EDE = $pCi/m^3 \times 8{,}400\ m^3/yr$ (inhaled) x 1.5 (skin abs.) x 6.4×10^{-8} mrem/pCi
where pCi/m^3 is the annual average HTO concentration.

that sampler divided by 4.9/Ci (from CAP88PC) equals an estimated annual release of 0.71 Ci. This calculation was performed for all sampler locations. As shown in Table D.1, a release of 0.71 Ci (71 GBq) was the maximum from RWMS-5.

The other samplers with elevated mean concentration of HTO in air are at the Area 10 SEDAN crater, Area 20 SCHOONER, and the E Tunnel Pond. The E Tunnel Pond emission is calculated in Appendix B. The emission from the SEDAN crater (calculated from air sampler data as above) is shown in the table, assuming SEDAN is the source. It appears unlikely that as much as 260 Ci of HTO are being emitted from the SEDAN crater. However, there is no other likely source for the tritium measured in atmospheric moisture in that area. Therefore, the E Tunnel Pond, RWMS-5, SEDAN crater, and SCHOONER are considered to be sources for emission of HTO on the NTS. After tritium waste was removed from the Decon Pad in October 1998, the tritium concentrations decreased to levels near the MDC; therefore, sampling was terminated in February 1999, and no tritium emission was calculated for this location.

Table D.1 Airborne Tritium Sampling Results During CY - 1999

Sampler Number	Coordinates[a]		Mean µCi/mL[b]	Bq/m^3	Emission[c] (Ci)	Comment
BJY			3.0×10^{-12}	0.11		Historical samples
RWMS No. 4	NE	430 m	4.3×10^{-12}	0.16	0.71	
RWMS No. 7	W	295 m	1.7×10^{-12}	0.063	0.16	
RWMS No. 9	S	313 m	1.6×10^{-12}	0.059	0.20	
WEF NE	SE	424 m	3.2×10^{-12}	0.12	0.54	
Well 5B			0.12×10^{-12}	0.004	---	Background
Decon Pad			3.4×10^{-12}	0.13	---	Sampler removed
SEDAN Crater	N	1290 m	15.0×10^{-12}	0.56	260.	
E Tunnel Pond			20.0×10^{-12}	0.74	15.	Use evaporation
Stake T-18			0.28×10^{-12}	0.010	---	Background
Area 15 Farm			11.0×10^{-12}	0.41	---	SEDAN effluent
SCHOONER	WNW	269 m	200.0×10^{-12}	7.4	65.	

(a) Sampler direction and distance from center of suspected source.
(b) Median MDC is 2.2×10^{-12} µCi/mL.
(c) Estimated number of curies emitted from the source that would give the sampler result.

APPENDIX E

RESUSPENDED PLUTONIUM FROM YUCCA FLAT AND OTHER AREAS

BACKGROUND INFORMATION

Areas 3, 8, 9, 10, 11, 18, and 20 on the NTS, Area 13 on the NAFR, and the CLEAN SLATE sites on the NAFR at the Tonopah Test Range contain diffuse sources of radionuclide effluents. Due to occasional high winds, some contaminated soil becomes airborne. Results from the air samplers, in these areas, indicate that $^{239+240}$Pu is routinely detected, but only in concentrations slightly above the MDC. Only a few of the 25 air sampler locations on the NTS had concentrations exceeding the background level by four standard deviations (the criterion used for a high result).

SOURCE TERM FROM RESUSPENSION CALCULATIONS

A conservative estimate of plutonium emissions from diffuse sources is obtained by the use of a resuspension 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 = resuspension 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 resuspension is between 2×10^{-12} and 1×10^{-11}/s. To be conservative, the higher resuspension 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 resuspension 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:

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

As this emission rate is more conservative (a factor of ten greater than that calculated above from air sampling measurements), this method was used for calculating the $^{239+240}$Pu emissions from all other areas. The results are shown at the end of Table E.1. The EDEs for each of the areas were then determined from CAP88-PC calculations using the individual area emission rates, corrected to include the contribution to the dose from ^{241}Am, and are listed in Table E.1.

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 minimum detectable concentration, this isotope has also not been included in evaluations for NESHAP compliance.

Table E.1 Offsite EDE Calculated from Resuspension of Plutonium and Americium for Areas Sited - 1999 (10^{-3} mrem)

Location	Area 3	Area 9	Areas 8 and 10	Area 11	Area 13	Area 18	Area 20	CLEAN SLATE	SUM mrem
Deposit[(a)] ☞	37 Ci	89 Ci	220 Ci	29 Ci	46 Ci	100 Ci	181 Ci	54 Ci	
Alamo			8.3		1.6				0.0099
Amargosa Center	4.8	12	28	3.6		9.6	10		0.0675
Ash Meadows	4.9			4.0					0.0088
Ash Springs					2.0				0.0020
Beatty	5.5	12	29	3.5		21	23		0.0933
Cactus Springs	3.9	6.5		4.3		2.5			0.0171
Clarks Station								5.6	0.0056
Crystal	6.9	9.3	21	6.5		4.9			0.0488
Goldfield							14	6.2	0.0199
Hiko					1.9				0.0019
Indian Springs	3.1	6.1	14	3.9					0.0269
Lathrop Wells	7.9	15	35	5.9		13	14		0.0900
Lida Junction							6.3	6.2	0.0124
Medlin's Ranch	2.9	7.9	16	2.1	5.8	2.9	3.8		0.0415
Penoyer Farm	2.4	6.4	20	1.4	6.1	4.8	9.8	3.1	0.0538

(a) Values for $^{239+240}$Pu deposition are from Table 1 (DOE 1991).

Table E.1 (Offsite EDE Calculated from Resuspension of Plutonium and Americium for Areas Sited - 1999 [10^{-3} mrem], cont.)

Location	Area 3	Area 9	Areas 8 and 10	Area 11	Area 13	Area 18	Area 20	CLEAN SLATES	SUM mrem
Deposit[(a)] ☞	37 Ci	89 Ci	220 Ci	29 Ci	46 Ci	100 Ci	181 Ci	54 Ci	
Rachel	2.3	6.1	19	1.6	6.8	4.4	8.8		0.0486
Sarcobatus Flat		9.4	25			8.9	38	4.1	0.0848
Scotty's Junction						4.0	23	4.8	0.0288
S NV Corr Inst	1.5			1.4					0.0031
Springdale	5.5	12	34	3.6		30	30	2.8	0.118
Stateline				3.6					0.0036
Stone Cabin								4.3	0.0043
Tolicha Peak	2.3	11	31	1.4	5.0	4.0	14	6.2	0.0748
Tonopah								3.7	0.0037
Twin Springs Ranch								5.5	0.0055
US Ecology	5.6	12	25	3.5		20	18		0.0836
Calculated Emission - mCi	12	28	69	9	14	32	57	17	238

(a) Values for $^{239+240}$Pu deposition are from Table 1 (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-yr

Area 9 (from McArthur in “DOE/NV/10485--02"):

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 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 resuspension equation calculation for Area 9 (0.028 Ci/yr) 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

INTRODUCTION

The NTS is located in southern Nevada, approximately 105 km (65 mi) northwest of Las Vegas, Nevada and encompasses an approximate rectangular area of 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 (Station No. 25) to almost 7,700 ft on Rainier Mesa in the northern part of the NTS (Station No. 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 Department of Energy, Nevada Operations Office (DOE/NV) by the ARL/SORD. The ARL/SORD is a National Oceanic and Atmospheric Administration (NOAA) office and supports DOE/NV programs under the authority of an Interagency Agreement between NOAA and DOE/NV.

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 DOE/NV authorized activities on the NTS. This vital program consists of many meteorological monitoring systems that have been brought together under the acronym MIDNET, or Meteorological Data Network. This network has been operated on the NTS for over 30 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, 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.

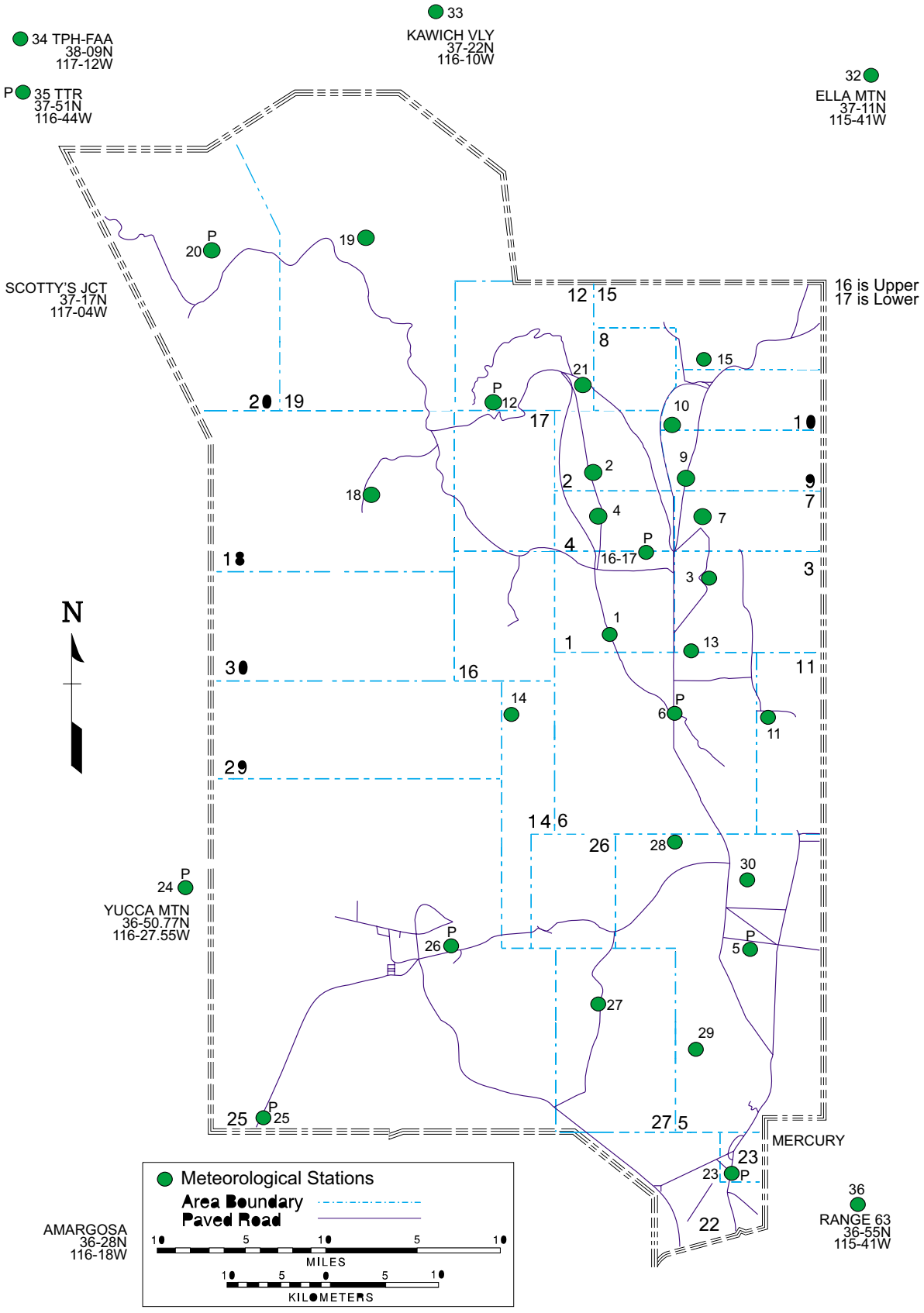

Figure F.1 Location of MEDA Stations on the NTS

A key component of the MIDNET system is the Meteorological Data Acquisition System (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 specially 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 30-40 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.

CONCLUSIONS

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 3 miles from Mercury.

The STAR file is a matrix that includes 6 Pasquill stability categories (A through F), 6 wind speed categories, and 16 wind sectors from wind roses calculated for each specified MEDA station on the NTS.

APPENDIX G

SUPPLEMENTAL INFORMATION

COMPARISON WITH PREVIOUS YEARS' DATA

Maximum Potential Individual EDE:

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, resuspension of plutonium from surface deposits was calculated. Area 20 emissions increased this year (krypton seepage and HTO from characterization wells). The 1996 decrease is due to decreased emissions and cleanup of areas. The 1997 decrease was due to decreased emissions, cleanup of areas, and a slight population decrease. 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.

COLLECTIVE EFFECTIVE DOSE EQUIVALENT

The maximum potential collective EDE to the 36,517 people who live within 80 km of the NTS emission sources was 0.37 person-mrem in 1998, due mostly to calculated resuspended plutonium and americium exposure. Tritium exposure was more in 1997 because of the increase in effluent from wells and craters. The collective EDE data are based on distance and direction from each of the sources of emission on the NTS to nearby areas. These data are displayed in the last column of Table 5.0. The collective EDE is the sum of the EDEs to the community from each emission source multiplied by the population of the community.

Maximum Potential Collective EDE (person-mrem) by NTS Source:

Areas 3, 9	82.50
Area 5	2.59
Area 8,10	137.93
Area 12	0.11
Areas 19/20	60.84
Other Areas	97.11
	376 person-mrem
	(0.38 person-rem)

The higher potential population doses from plutonium areas are due to the conservative assumptions about resuspension of plutonium from deposited material in those areas. The extent of overestimation is shown by the calculation displayed in Table 6.0. The resuspension calculation indicates that an EDE of 68.7 µrem should be measured at Amargosa Center, whereas only 4.45 µrem was actually measured at that location. The calculated value for resuspension is higher by a factor of 15-16. The Amargosa Center was chosen for this comparison because it was within 80 km of most of the emissions, and, at Rachel, local resuspension of soil was suspected to have caused the higher-than-expected radioactivity concentrations at that location.

COMPLIANCE WITH NESHAPs

DOE/NV was in compliance with Title 40 CFR 61, Subpart H, during CY 1999. Periodic confirmatory measurements and analyses of the NTS environs are provided in Appendices A through E. These measurements and analyses are the methods of determining NTS effluents presented in the April 24, 1991, meeting between Region 9 and DOE/NV and documented in the 1990 through 1998 annual NESHAPs reports of DOE/NV.

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 in these areas were below the standard of 20 $pCi/m^2/s$ required by Subpart Q. The results of the study (DOE 2000) 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 ^{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

In the past, material from Mound Applied Technologies containing these sources was stored in cargo containers at the RWMS in Area 5. However, since the shipment of these containers offsite in 1997, none of these sources are present at the NTS.

NON-DISPOSAL/NON-STORAGE SOURCES OF RADON EMISSION

None of these sources exist on the NTS.

QUALITY ASSURANCE PROGRAM NESHAP

Provisions in Method 114 described in Appendix B of Title 40 CFR 61 are related to continuous monitoring of major sources. The NTS has only minor sources.

APPENDIX H

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