

TABLE B-4: ESTIMATED RELEASES OF SPECIFIC RADIONUCLIDES OF CONCERN (μCi)

Where two values are given, they are lower and upper bounds of a calculated range.
 The ranges do not reflect any elements of the uncertainty associated with these emission estimates other than the fraction of plutonium alpha activity that Am-241 constitutes.

Year	Am-241		Pu-238		Pu-239		Pu-240		Pu-241		Pu-242	
1953	0.20	0.70	0.030	0.042	1.0	1.4	0.23	0.32	6.6	9.2	2.1e-05	2.9e-05
1954	6.5	23	0.98	1.4	34	47	7.6	11	210	300	6.8e-04	9.4e-04
1955	7.2	25	1.1	1.5	37	52	8.4	12	240	330	7.5e-04	1.0e-03
1956	23	81	3.5	4.8	120	160	27	37	760	1,100	2.4e-03	3.3e-03
1957	160	560	24	34	830	1,100	190	260	5,300	7,300	1.7e-02	2.3e-02
1958	310	1,100	47	65	1,600	2,200	360	500	10,000	14,000	3.2e-02	4.5e-02
1959	140	490	21	29	720	1,000	160	230	4,600	6,400	1.5e-02	2.0e-02
1960	130	450	20	27	670	930	150	210	4,300	5,900	1.4e-02	1.9e-02
1961	150	520	23	31	780	1,100	180	240	5,000	6,900	1.6e-02	2.2e-02
1962	300	1,000	45	63	1,600	2,100	350	490	9,900	14,000	3.1e-02	4.3e-02
1963	390	1,400	59	82	2,000	2,800	460	630	13,000	18,000	4.1e-02	5.7e-02
1964	280	980	42	59	1,400	2,000	330	450	9,300	13,000	2.9e-02	4.1e-02
1965	650	2,300	98	140	3,400	4,700	760	1,100	21,000	30,000	6.8e-02	9.4e-02
1966	32	110	4.8	6.7	170	230	38	52	1,100	1,500	3.3e-03	4.6e-03
1967	40	140	6.1	8.4	210	290	47	65	1,300	1,800	4.2e-03	5.8e-03
1968	49	170	7.4	10	250	350	57	80	1,600	2,200	5.1e-03	7.1e-03
1969	170	590	26	36	880	1,200	200	280	5,600	7,800	1.8e-02	2.5e-02
1970	38	130	5.8	8.0	200	270	45	62	1,300	1,700	4.0e-03	5.5e-03
1971	7.4	26	1.1	1.6	38	53	8.7	12	240	340	7.7e-04	1.1e-03
1972	6.1	21	0.92	1.3	32	44	7.2	9.9	200	280	6.4e-04	8.8e-04
1973	7.9	28	1.6		55		13		360		1.1e-03	
1974	98	340	23		780		180		5,100		1.6e-02	
1975	1.0	3.6	0.24		8.2		1.9		53		1.7e-04	
1976	0.41	1.4	0.096		3.3		0.76		21		6.8e-05	
1977	0.41	1.4	0.096		3.3		0.76		21		6.8e-05	
1978	0.31	1.1	0.072		2.4		0.57		16		5.1e-05	
1979	0.51	1.8	0.12		4.1		0.95		27		8.5e-05	
1980	1.2	4.3	0.29		9.8		2.3		64		2.0e-04	
1981	0.82	2.9	0.19		6.5		1.5		43		1.4e-04	
1982	2.0	7.2	0.48		16		3.8		110		3.4e-04	
1983	8.0	28	1.9		64		15		420		1.3e-03	
1984	1.3	4.7	0.31		11		2.5		69		2.2e-04	
1985	2.0		0.22		7.3		1.7		48		1.5e-04	
1986	5.0		0.90		11		2.6		75		2.4e-04	
1987	3.0		0.60		12		2.8		80		2.5e-04	
1988	2.0		0.40		12		2.8		80		2.5e-04	
1989	1.0		0.20		4.1		0.95		27		8.5e-05	

TABLE B-7

ESTIMATED RELEASES OF SPECIFIC URANIUM ISOTOPES (μCi)

Year	Depleted U-234	Depleted U-235	Depleted U-238	Enriched U-234	Enriched U-235	Enriched U-236	Enriched U-238
1953	130	17	1,200	35	1.1	0.14	0.011
1954	130	17	1,200	35	1.1	0.14	0.011
1955	190	26	1,800	70	2.3	0.28	0.022
1956	110	14	980	1,100	34	4.3	0.33
1957	85	11	780	220	7.1	0.90	0.069
1958	150	19	1,300	300	9.6	1.2	0.093
1959	28	3.7	260	520	17	2.1	0.16
1960	46	6.0	420	830	27	3.4	0.26
1961	48	6.4	440	460	15	1.9	0.14
1962	36	4.7	330	240	7.8	0.98	0.075
1963	33	4.4	300	270	8.7	1.1	0.084
1964	23	3.1	210	180	5.9	0.74	0.057
1965	27	3.6	250	180	5.9	0.74	0.057
1966	14	1.8	120	220	7.1	0.90	0.069
1967	14	1.8	120	110	3.4	0.43	0.033
1968	14	1.8	120	150	5.0	0.62	0.048
1969	16	2.2	150	49	1.6	0.20	0.015
1970	18	2.4	170	62	2.0	0.25	0.019
1971	5.6	0.74	52	40	1.3	0.16	0.012
1972	4.1	0.54	37	3.9	0.12	0.016	0.0012
1973	6.1	0.81	56	11	0.34	0.043	0.0033
1974	0.87	0.12	8.0	26	0.84	0.11	0.0081
1975	2.7	0.36	25	27	0.87	0.11	0.0084
1976	1.2	0.15	11	15	0.50	0.062	0.0048
1977	1.8	0.24	17	20	0.65	0.082	0.0063
1978	3.5	0.45	32	21	0.67	0.084	0.0063
1979	2.7	0.35	25	9.0	0.29	0.036	0.0027
1980	1.6	0.21	15	15	0.48	0.060	0.0045
1981	1.6	0.21	14	14	0.45	0.056	0.0042
1982	1.6	0.21	14	15	0.48	0.060	0.0045
1983	2.6	0.35	24	24	0.77	0.096	0.0072
1984	1.8	0.23	16	17	0.54	0.068	0.0051
1985	4.3	0.55	39	8.0	0.26	0.032	0.0024
1986	1.9	0.24	17	4.0	0.13	0.016	0.0012
1987	1.3	0.17	12	5.0	0.16	0.020	0.0015
1988	0.98	0.13	9.0	3.0	0.096	0.012	0.00090
1989	0.22	0.028	2.0	5.0	0.16	0.020	0.0015

TABLE B-8

TOTAL URANIUM ISOTOPE RELEASE ESTIMATES (μCi)

Year	U-234	U-235	U-236	U-238
1953	1.6e+02	1.8e+01	1.4e-01	1.2e+03
1954	1.6e+02	1.8e+01	1.4e-01	1.2e+03
1955	2.6e+02	2.8e+01	2.8e-01	1.8e+03
1956	1.2e+03	4.8e+01	4.3e+00	9.8e+02
1957	3.1e+02	1.8e+01	9.0e-01	7.8e+02
1958	4.4e+02	2.9e+01	1.2e+00	1.3e+03
1959	5.5e+02	2.0e+01	2.1e+00	2.6e+02
1960	8.8e+02	3.3e+01	3.4e+00	4.2e+02
1961	5.1e+02	2.1e+01	1.9e+00	4.5e+02
1962	2.8e+02	1.2e+01	9.8e-01	3.3e+02
1963	3.0e+02	1.3e+01	1.1e+00	3.0e+02
1964	2.1e+02	9.0e+00	7.4e-01	2.1e+02
1965	2.1e+02	9.5e+00	7.4e-01	2.5e+02
1966	2.4e+02	8.9e+00	9.0e-01	1.2e+02
1967	1.2e+02	5.2e+00	4.3e-01	1.2e+02
1968	1.7e+02	6.8e+00	6.2e-01	1.2e+02
1969	6.6e+01	3.8e+00	2.0e-01	1.5e+02
1970	8.0e+01	4.4e+00	2.5e-01	1.7e+02
1971	4.5e+01	2.0e+00	1.6e-01	5.2e+01
1972	7.9e+00	6.6e-01	1.6e-02	3.7e+01
1973	1.7e+01	1.1e+00	4.3e-02	5.6e+01
1974	2.7e+01	9.5e-01	1.1e-01	8.0e+00
1975	3.0e+01	1.2e+00	1.1e-01	2.5e+01
1976	1.7e+01	6.5e-01	6.2e-02	1.1e+01
1977	2.2e+01	8.9e-01	8.2e-02	1.7e+01
1978	2.4e+01	1.1e+00	8.4e-02	3.2e+01
1979	1.2e+01	6.4e-01	3.6e-02	2.5e+01
1980	1.7e+01	6.9e-01	6.0e-02	1.5e+01
1981	1.6e+01	6.6e-01	5.6e-02	1.4e+01
1982	1.7e+01	6.9e-01	6.0e-02	1.4e+01
1983	2.7e+01	1.1e+00	9.6e-02	2.4e+01
1984	1.9e+01	7.8e-01	6.8e-02	1.6e+01
1985	1.2e+01	8.0e-01	3.2e-02	3.9e+01
1986	5.9e+00	3.7e-01	1.6e-02	1.7e+01
1987	6.3e+00	3.3e-01	2.0e-02	1.2e+01
1988	4.0e+00	2.2e-01	1.2e-02	9.0e+00
1989	5.2e+00	1.9e-01	2.0e-02	2.0e+00

TABLE E-2

**ROCKY FLATS PLANT BUILDING 707
CARBON TETRACHLORIDE EMISSION ESTIMATES**

Resource	Estimate Basis	Estimate Year	Carbon Tetrachloride Emission Estimate (tons/yr)
EG&G, 1990a (APEN)	Use	1989	32.3
Rockwell, 1988a	Use	1988	66
Hamilton and Moser, 1990	Monitoring	1989	53
Fruehauf and Richter, 1974	Use	1973	80
Hobbs, 1982	Monitoring	1974-75	46 Average
	Monitoring	1974-75	120 Maximum
	Material balance	1981	20
Rockwell, 1989	Use	1988-89	48 Average
	Use	1988-89	76 Maximum
Ferrera, 1989	Use	1988	50 Average
	Use	1988	80 Maximum
	Use	1987-88	93

TABLE E-3

**ROCKY FLATS PLANT BUILDING 776/777
CARBON TETRACHLORIDE EMISSION ESTIMATES**

Resource	Estimate Basis	Estimate Year	Carbon Tetrachloride Emission Estimate (tons/yr)
EG&G, 1990b (APEN)	Use	1989	8.10
Dow Chemical, 1974	Monitoring	1973	10 Average
	Monitoring	1973	34 Maximum
Hamilton and Moser, 1990	Monitoring	1989	33
U.S. Dept. of Energy, 1989	Use	1989	44
Hobbs, 1982	Material balance	1974-75	15

TABLE E-4

**ROCKY FLATS PLANT — TOTAL
CARBON TETRACHLORIDE EMISSION ESTIMATES**

Resource	Estimate Basis	Estimate Year	Carbon Tetrachloride Emission Estimate (tons/yr)
EG&G APENs	Use	1989	40
U.S. Dept. of Energy, 1980	Use	1977	36
	Monitoring	1975	66
Fruehauf and Richter, 1974	Use	1973	81
Hamilton and Moser, 1990	Monitoring	1989	89
U.S. Dept. of Energy, 1989	Use	1988	93
EG&G, circa 1990	Use	1988	65
	Use	1989	24
Hobbs, 1982	Monitoring	1974-75	56 Average
	Monitoring	1974-75	153 Maximum
	Material Balance	1974-75	34
	Material Balance	1974-75	106
Ferrera, 1989	Use	1988-89	48

TABLE E-10

ROCKY FLATS PLANT — TOTAL 1,1,1-TRICHLOROETHANE EMISSION ESTIMATES

Resources	Estimate Basis	Estimate Year	Trichloroethane Emission Estimate (tons/year)
EG&G APENs	Use/Analogy	1989	20.8*
U.S. Department of Energy, 1980	Use	1977	26
Hamilton and Moser, 1990	Monitoring	1989	46
U.S. Department of Energy, 1989	Use	1988	24
Weis, 1988	Use	1988	20
Ferrera, 1988	Use	1987-89	44
Church, 1989	Use	1988-89	17
EG&G, circa 1990	Use	1988	24
	Use	1989	23

* Adjusted to include a higher emission estimate for Building 707 Production Control Operations — Module D — TCA dip tanks.

TABLE E-11

INFORMATION CONCERNING USE OF TRICHLOROETHYLENE DURING 1973

Building	User	Annual Use (gallons)
444	Chem Tech R&D	55
447/881	Metallurgical Operations	495
551	Stores	55
705	Ceramic R&D	55
771	Plutonium Fab R&D	55
771/707	Assembly Operations	5,720
774	Waste Treatment	165
777	Special Assembly	55
865	General Fab R&D	550
881	Assembly Operations	1,815
881	Fabrication	440
883	Metallurgical Operations	55
Site Wide	Chem Tech R&D Activities	55
Site Wide	Waste Management Activities	55
Miscellaneous	Unknown	165
TOTAL		9,790

TABLE E-12

ROCKY FLATS PLANT — TOTAL TRICHLOROETHYLENE EMISSION ESTIMATES

Resource	Estimate Basis	Estimate Year	Trichloroethylene Emission Estimate (tons/yr)
EG&G APENs	Use	1986, 1987, 1988, 1989	1.5×10^{-3}
Dow Chemical (1972-1974)	Use	1973	60
Musgrave (circa 1973)	Use	1973	62
U.S. Department of Energy (1980)	Use	1977	2

TABLE A-1: SUMMARY OF ROCKY FLATS AIRBORNE PARTICLE SIZE STUDY DATA

Study	Sampling Point	Count Median Diameter	Mass Median Diameter	Aerodynamic Equivalent Diameter	Comments
Hayden <i>et al.</i> , 1972 (used 3 μm membrane filters, fission track sizing method)	Building 776 exhaust (in general)	0.07 - 0.12 μm			Tandem filters were not used.
Hayden <i>et al.</i> , 1972 (used 3 μm membrane filters, fission track sizing method)	Building 776 exhaust (in a malfunctioning exhaust system)	0.12 - 0.15 μm			Similar distributions on the two filters. Significant breakthrough to backup filters.
Hayden, 1972 (used 3 and 0.8 μm membrane filters, fission track sizing)	Building 776 effluent		0.09 μm GSD = 1.6	0.3 μm (if PuO_2) 0.4 μm (if metal)	Particle sizes were consistent with theory of HEPA filter operation.
Hayden, 1974 (used membrane filters, fission track sizing method)	Building 771 effluent	0.09 - 0.19 μm			Leaking HEPAs caused non-lognormal distribution, indicating multiple sources.
Hayden <i>et al.</i> , 1976 (continuous air monitor filters; fission track, alpha track, and microscopy sizing techniques)	Inside Building 707 after a plutonium oxide spill	most were < 0.2 μm			Lognormally distributed.
Moss <i>et al.</i> , 1961 (used membrane filters, optical and alpha track sizing)	Unfiltered plutonium aerosols from plutonium processing		0.14 to 0.65 μm (SD 1.3 to 1.9)		Size distributions varied little between operations.
Hayden, 1978 (Pu salts, alpha track sizing)	Between HEPA stages, Building 771	0.075 μm		0.25 μm (if PuO_2)	Collected between 5th and 6th stages of HEPA filters.
Elder <i>et al.</i> , 1974 (cascade impactor, alpha counting)	Building 707 exhaust prior to final filters.			over 50% 1-5 μm^* (3.3 to 4.7 μm^* dominates)	Fabrication operations produced largest particle sizes.
Elder <i>et al.</i> , 1974 (cascade impactor, alpha counting)	Building 771 exhaust prior to final filters.			over 70% <1.0 μm^*	Recovery operations produced highest activity and smallest aerosol sizes.
Nininger and Osborne, 1992 (laser particle analyzer)	Building 559/561 exhaust			<<2 percent >5 μm	Strong bias toward particles smaller than 0.3 μm . All radionuclides unquantifiable.

SD = standard deviation; GSD = geometric standard deviation; *Activity median aerodynamic diameters (AMAD)