Rocketdyne Division
Rockwell International Corporation
6633 Canoga Avenue
Canoga Park, California 91303

Telex: 698478
ROCKETDYN CNPK

Rockwell
International

June 1, 1992 In reply refer to 92RC-03980

Mr. R. R. LeChevalier
U. S. Department of Energy
San Francisco Field Office
ETEC Site Office
P O Box 1449
Canoga Park, California 91304

Subject: Final NESHAPS Report for 1991

Dear Mr. LeChevalier:

Enclosed with this letter is our final report showing compliance with the NESHAPS dose standard for airborne radioactivity released from DOE facilities. DOE/HQ comments on the draft NESHAPS report have been addressed in this final report.

This report is based on the EPA-approved computer program. AIRDOS-PC (Version 3.0), and shows that the estimated maximum dose to a nearby resident is less than 0.000003 mrem, 1991. This is far below the standard of 10 mrem established in 40CFR61.

Special information requested by DOE, beyond that required by EPA, is contained in Appendix D of the report.

If you have any questions regarding this report, please call me at (818) 586-6140.

Very truly yours,

Phil Rutherford

P. D. Rutherford, Manager
Radiation Protection and
Health Physics Services

Enclosure: Air Emissions Annual Report, including AIRDOS-PC report

cc: E. Ballard, DOE-SF/ESS

U. S. Department of Energy
Air Emissions Annual Report
(Under Subpart H, 40 CFR 61.94)
Calendar Year 1991

Site Name: Santa Susana Field Laboratory

Operations Office Information

Office: San Francisco Field Office
Address: 1333 Broadway
Oakland, CA 94612
Contact: E. Ballard Phone: 415/273-7967
FTS/536-7967

Site Information

Operator: Rocketdyne Division, Rockwell International Corp.
Address: 6633 Canoga Ave.
Canoga Park, CA 91303
Contact: P. D. Rutherford Phone: 818/586-6140

U. S. Department of Energy
Air Emissions Annual Report
(40 CFR 61, Subpart H)
DOE Operations
at
Santa Susana Field Laboratory
Calendar Year 1991

Section 1: Site Description

This report covers DOE operations at the Santa Susana Field Laboratory, operated by the Rocketdyne Division of Rockwell International Corporation. The operations specifically assessed are the Radioactive Materials Disposal Facility (RMDF) and the removal of residual induced radioactivity at a former experimental nuclear reactor facility (Building T059). Evaluation of the air emissions from these operations was performed for calendar year 1991, using ventilation exhaust sampling and analysis data for radionuclide emissions and the computer program AIRDOS–PC, with site–specific meterological data, to estimate possible airborne doses to the public. This evaluation shows the operations were in compliance with the EPA standard limiting radioactive emissions to less than the amounts that could cause an effective dose equivalent of 10 mrem/year.

The Santa Susana Field Laboratory (SSFL) consists of 2668 acres situated along the crest of the Simi Hills in eastern Ventura County in southern California. A small portion (90 acres) of this site is dedicated to Department of Energy (DOE) operations. The majority of the site is utilized for testing rocket engines, lasers, and other research and development. Decommissioning of a hot cell facility adjacent to the DOE territory is being performed under the regulation of the U.S. NRC and the State of California, and is not subject to reporting under Subpart H.

During the past 36 years, many small experimental reactors were tested in the Area IV (western–most) portion of SSFL. Nuclear reactor fuel assemblies were fabricated and irradiated fuel was declad. Over time, all such operations have been terminated, and the final operations of decontamination and decommissioning the nuclear facilities are underway. This consists of manual and mechanical cleaning and removal of radioactively contaminated structures and soil, packaging these materials for disposal at authorized radioactive waste sites, and storage and shipment of the waste packages. It is estimated that approximately 26 curies of radioactivity remains at SSFL, in the form of system and structural contamination by old mixed fission products, radioactivity induced in shielding and structural material by neutron activation, localized soil contamination, and stored waste packages. The majority of this radioactivity consists of Fe–55, with Co–60, Sr–90, Cs–137, Eu–152, and minor amounts of uranium and plutonium.

SSFL is surrounded by undeveloped land, out to distances of a mile and more. Occasionally, cattle graze near the southern portion and there is some orchard farming at the eastern boundary, but no significant agricultural land use exists within 20 miles of the SSFL site. While the land immediately surrounding SSFL is undeveloped, at greater distances there are the normal suburban residential areas and some low–density residential developments. For example, 1.7 miles toward the northwest from Area IV is the closest residential portion of Simi Valley. The sparsely developed community of Santa Susana Knolls lies 3 miles to the northeast, and a small truck farm exists approximately 4 miles to the northeast. The low–density Bell Canyon area begins about 1.4 miles to the southeast, and the Brandeis–Bardin Institute is 1.8 miles to the north. An unused sand and gravel quarry lies approximately 1.5 miles to the west.

The populated areas are generally 400 to 1000 feet lower in elevation than SSFL. The site and immediately surrounding area, extending to the borders of the more densely populated areas in the neighboring valley plains, consists of generally turbulent terrain, with hills, canyons, cliffs, and massive rock outcroppings. The adjacent valley floors, in contrast, are generally flat and smooth.

The site is in a semiarid region whose climate is controlled primarily by the semi–permanent Pacific high–pressure cell that extends from Hawaii to the southern California coast. The seasonal changes in the position of this cell greatly influence the weather conditions in this area. During the summer months, the high–pressure cell is displaced to the north. This results in mostly clear skies with little precipitation. During the winter, the cell moves sufficiently southward to allow moderate precipitation with northerly and northwesterly winds. Annual precipitation at SSFL averages 17 in., but variations of ±50% are common. In the summer, a subsidence inversion develops in the adjacent valleys, that is typical of slight neutral to lapse conditions, and contributes to the region–wide problem with air pollution. Nocturnal cooling inversions, although present, are relatively shallow. During the summer, a subsidence inversion is present almost every day. The base and top of this inversion often lie below the elevation of the SSFL site, however, it may extend over the Simi Hills during the afternoons. Atmospheric releases would generally result in lofting diffusion above the inversion and considerable atmospheric dispersion prior to any diffusion through the inversion into the Simi or San Fernando Valleys, or could result in trapping under the inversion and more moderate diffusion toward the significantly lower valley floors. In the winter season, the Pacific high pressure cell shifts to the south and the subsidence inversion is usually absent. The surface airflow is then dominated by frontal activity moving easterly through the area, resulting in high–pressure systems in the Great Basin region. Frontal passages through the area during winter are generally accompanied by rainfall. Diffusion characteristics are highly variable, depending on the location of the front. Generally, a light to moderate southwesterly wind precedes these frontal passages, introducing a strong onshore flow of marine air and producing lapse rates that are slightly unstable. Wind speeds increase as the frontal systems approach, enhancing diffusion. The diffusion characteristics of the frontal passage are lapse conditions with light to moderate northerly winds. Locally, average wind speeds for the various stability categories range from 0 to 14.4 ft/s with the greatest frequency occurring for winds from the northwest and the southeast sectors.

Downslope flow of cooling air at night, from the site into the valleys, is not significant in estimating offsite airborne exposure, since airborne releases associated with the facility ventilation exhaust effluent occur only while work is in progress, during the day.

Dispersion of atmospheric releases from SSFL is considerably increased, compared to calculations based on Gaussian plume models assuming smooth, flat terrain, by the turbulent terrain on and around the site, and by the significant differences in elevation from the site to the public.

Section 2: Radioactive Materials

The following radioactive materials are present as facility contamination, activation of structural materials, or packaged waste:

Hydrogen–3 (tritium)	H–3
Argon–39	Ar–39
Calcium–41	Ca–41
Calcium–45	Ca–45
Manganese–54	Mn–54
Iron–55	Fe–55
Cobalt–60	Co–60
Nickel–63	Ni–63
Strontium–90	Sr–90
Cesium–137	Cs–137
Europium–152	Eu–152
Europium–154	Eu–154
Thorium	Th–232
Uranium (depleted, normal, and enriched)	U–234 U–235 U–238
Plutonium	Pu–239 Pu–240 Pu–241
Americium–241	Am–241

Section 3: Facility Operations and Source Terms

Radioactive atmospheric effluent sources from DOE facilities are limited to continuously operated exhaust systems at the Radioactive Materials Disposal Facility (RMDF) and at Building T059. Minor locations of soil contamination,(RMDF pond, RMDF north slope, T064 side yard) have been monitored for airborne radioactivity, and none has been detected. Therefore, these have not been included in the estimate of airborne exposure.

Release points at facilities with significant potential for the discharge of radioactive material are controlled, by the use of HEPA filter systems, to maintain public doses far below 0.1 mrem/year. Sampling is performed to permit measurement of the releases, and these measurements are used to estimate hypothetical offsite doses.

Operations at the RMDF that generate airborne radioactivity include decontamination of equipment, repackaging of radioactive waste, evaporation of radioactively contaminated water, and packaging of the resultant residue.

These operations are performed inside a building, with workplace air sampling, equipped with a ventilation system that exhausts to the atmosphere through a HEPA filter system. The filters are certified for efficiency prior to installation and the system is tested after filter replacement, or at least annually. The filter system efficiency is determined by use of a polydisperse DOS aerosol with a CMAD (Count Median Aerodynamic Diameter) expected to be 0.8 micrometer. The radioactive contaminants include Fe–55, with Co–60, Sr–90, Cs–137, Eu–152, minor amounts of uranium and plutonium, and insignificant amounts of tritium (H–3).

The RMDF releases are the most significant contributors to the calculated dose.

Some airborne radioactive effluent is produced at Building T059 which was used as a test facility for a small experimental reactor during the 1960s. Operation of this reactor resulted in production of some radioactivity by neutron activation of shielding and structural materials. While the reactor and associated equipment were removed in the early 1970s, removal of the balance of radioactivity in the facility, primarily in bulk shielding and activated steel, was delayed to reduce worker exposure and minimize the complexity of the task. This remaining contamination consists primarily of Fe–55, with Co–60 and Eu–152, and minor amounts of H–3 in the concrete.

AIRDOS–PC Input Data

The input parameters to the AIRDOS–PC computer model are:

		Value for Emission Source	
	Parameter	**RMDF**	**T059**
1.	Distance to Nearby Individuals – Determined by use of USGS topographic maps, Calabasas quadrangle and Santa Susana (Simi East) quadrangle and commercial road maps. Since the two sources are relatively close to each other (1200 feet) no distinction was made in distances to nearby individuals.	2334m at N 2816m at SE 2301m at SSE 3009m at NW	
2.	Annual Average Temperature – Based on long–term average of SSFL weather records.	17°C	
3.	Rainfall Rate – During calendar year 1991, rainfall was measured at RMDF as 20.28 inches, and independently at T100 (2100 ft sw of RMDF) as 19.80 inches. The average was used.	51 cm/yr	
4.	Lid Height – Recommended by member of 1991 DOE "Tiger Team" after consulting with South Coast Air Quality Management District staff.	366m	
5.	Wind Data – A joint frequency table generated for SSFL by NRC/ANL/RI in 1980 (Letter, U.S. NRC Advanced Fuel and Spent Fuel Licensing Branch to Rockwell International/ Atomics International Division, May 7, 1980) from wind speed/direction (8 compass points) records for 1976. This set included a synthetic stability–class table. Frequencies were interpolated between the 8 compass points and the 16 sectors for needed entry to the Stability Array (STAR) file.	SSFLNRC.WND	
6.	Stack Height – Determined from engineering drawings.	39.6m	5.18m
7.	Diameter – Measured. Diameter for T059 is based on a circular area equal to the rectangular stack cross–sectional area.	0.916m	0.306m
8.	Momentum – Measured by traversing stack during normal operations with a standard pitot tube. Average velocity is calculated with area weighting.	10.51m/sec	10.26 m/sec

9. Radionuclide Data

			Release Rates (Ci/y)	
Radionuclide	**Class**	**AMAD**	**RMDF**	**T059**
Sr–90	Y	1.	6.759E–08	0
Pu–239	Y	1.	5.673E–09	1.119E–09
Cs–137	D	1.	1.217E–06	0
Co–60	Y	1.	6.316E–07	8.069E–08
Th–230	Y	1.	1.979E–09	0
U–234	Y	1.	8.924E–09	0
U–235	Y	1.	2.800E–09	0
U–238	Y	1.	3.619E–09	0

a. Radionuclide Identification – Based on analysis of membrane and backup fiberglass filters by IT Analytical Services. Radionuclides that were clearly of natural origin (K–40, Po–210; U at T059) were not included in the dose evaluation. No water suspected of having added tritium was evaporated at the RMDF, and so H–3 release was considered to be zero.

b. Class – Based on the oxide form being most likely. Class D for Cs–137 is the only Class available for that radionuclide in AIRDOS–PC.

c. Activity Median Aerodynamic Diameter, µm (AMAD) – Default values in AIRDOS–PC.

d. Release Rates – Determined by radionuclide–specific analyses of membrane and backup filters, by IT Analytical Services. Activities on backup filters were prorated to adjust for their use only during the latter half of the year. Adjusted total filter activities were used to calculate exhaust release rate by the ratio of volume of air exhausted to the volume of air sampled. Negative results were treated as zero.

Activities that were less than the overall uncertainty were, in most cases, omitted from the dose evaluation.

	Release Rates (Ci/yr)	
Radionuclide	**RMDF**	**T059**
Am-241	*(2.269 ±4.982) E-10	*(4.474 ±9.894) E-11
Sr-90	(6.759 ±2.195) E-08	
Pu-238	*(1.015 ±1.811) E-10	*(1.155 ±32.84) E-12
Pu-239/240	(5.673 ±1.203) E-09	(1.119 ±0.380) E-09
Cs-137	(1.217 ±0.152) E-06	*(5.160 ±14.45) E-09
K-40	*(9.119 ±6.918) E-10	*(1.107 ±1.071) E-07
Co-60	(6.316 ±1.168) E-07	(8.069 ±1.827) E-07
Po-210	*(5.592 ±0.744) E-08	*(2.673 ±0.360) E-08
Th-238	*(8.851 ±9.210) E-10	*(2.491 ±6.209) E-10
Th-230	(1.979 ±1.154) E-09	*(3.040 ±20.19) E-11
Th-232	*(1.228 ±7.010) E-10	
U-234	(8.924 ±5.114) E-09	*(2.169 ±1.941) E-09
U-235	(2.800 ±2.573) E-09	
U-238	(3.619 ±3.705) E-09	*(2.384 ±1.826) E-09

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*Omitted from dose evaluation as below the detection limit or as a natural occurrence.

Note:
The activity reported for Pu-239/240 at T059 is not plausible, because of the absence of this material from the facility. The presence of Th-230 at RMDF, as indicated, is not expected in a facility not processing uranium ore or mill tailings.

The SSFLNRC.WND wind data file is shown below.

Sampling Systems

These two exhaust stacks are continuously monitored for airborne radioactivity. The sample filter for the RMDF stack is installed in a Continuous Air Monitor (CAM) sensitive to both alpha and beta radiation, with a strip-chart recorder and an alarm capability. These filters (membrane and fiberglass backup) and those at T059 are removed weekly and counted for gross alpha and gross beta activity, after allowing the short-lived radon daughters to decay. The results of these analyses are reported to the DOE Effluent Information System. This report must be made before the detailed radiochemical analytical results are received and so only gross alpha and beta information is reported for 1991. Copies of the reports are shown. Since it was known that the predominant radionuclide released from T059 was Co-60, the activity was identified as Co-60. The detailed analysis

SSFLNRC.WND Wind Data File

FREQUENCY OF ATMOSPHERIC STABILITY CLASSES FOR EACH DIRECTION

SECTOR	FRACTION OF TIME IN EACH STABILITY CLASS						
	A	B	C	D	E	F	G
N	0.0000	0.1889	0.2463	0.0115	0.0096	0.2719	0.2719
NNW	0.0000	0.2084	0.2596	0.0147	0.0121	0.2524	0.2528
NW	0.0000	0.2118	0.2619	0.0151	0.0125	0.2492	0.2495
WNW	0.0000	0.2005	0.2474	0.0148	0.0122	0.2624	0.2627
W	0.0000	0.1163	0.1406	0.0122	0.0097	0.3606	0.3606
WSW	0.1325	0.2175	0.3739	0.0122	0.0065	0.1329	0.1245
SW	0.1654	0.2442	0.4340	0.0122	0.0058	0.0686	0.0698
SSW	0.1329	0.2138	0.3810	0.0344	0.0170	0.1088	0.1121
S	0.0515	0.1371	0.2486	0.0887	0.0443	0.2134	0.2163
SSE	0.0104	0.1443	0.4355	0.0438	0.0217	0.1717	0.1726
SE	0.0000	0.1459	0.4823	0.0325	0.0161	0.1614	0.1618
ESE	0.0000	0.1443	0.4506	0.0319	0.0150	0.1789	0.1792
E	0.0000	0.1314	0.1900	0.0264	0.0059	0.3232	0.3232
ENE	0.0000	0.1794	0.2489	0.0156	0.0062	0.2740	0.2759
NE	0.0000	0.2119	0.2893	0.0079	0.0060	0.2405	0.2444
NNE	0.0000	0.2002	0.2675	0.0097	0.0078	0.2566	0.2582

FREQUENCIES OF WIND DIRECTIONS AND TRUE-AVERAGE WIND SPEEDS

WIND TOWARD	FREQUENCY	WIND SPEEDS FOR EACH STABILITY CLASS (METERS/SEC)						
		A	B	C	D	E	F	G
N	0.026	0.00	1.46	2.17	4.80	4.37	0.91	0.91
NNW	0.089	0.00	1.76	2.29	4.82	4.37	1.30	1.30
NW	0.151	0.00	1.81	2.30	4.82	4.37	1.38	1.38
WNW	0.086	0.00	1.76	2.27	4.78	4.37	1.30	1.30
W	0.021	0.00	1.19	1.74	4.37	4.37	0.93	0.93
WSW	0.054	6.84	5.29	5.41	5.46	4.37	1.38	0.97
SW	0.086	6.85	5.75	5.70	5.72	4.37	1.00	1.01
SSW	0.060	6.61	5.20	5.31	5.52	4.37	1.03	1.04
S	0.035	4.81	2.74	3.63	5.45	4.37	1.05	1.06
SSE	0.087	4.85	2.30	3.76	5.62	4.37	1.44	1.44
SE	0.139	0.00	2.19	3.78	5.73	4.37	1.57	1.57
ESE	0.078	0.00	2.07	3.70	5.82	4.37	1.43	1.43
E	0.017	0.00	0.97	2.22	6.66	4.37	0.85	0.85
ENE	0.021	0.00	1.48	2.38	6.17	4.37	0.90	0.91
NE	0.025	0.00	1.70	2.46	5.02	4.37	0.95	0.96
NNE	0.026	0.00	1.59	2.33	4.89	4.37	0.93	0.94

FREQUENCIES OF WIND DIRECTIONS AND RECIPROCAL-AVERAGED WIND SPEEDS

WIND TOWARD	FREQUENCY	WIND SPEEDS FOR EACH STABILITY CLASS (METERS/SEC)						
		A	B	C	D	E	F	G
N	0.026	0.00	1.06	1.30	4.66	4.37	0.82	0.82
NNW	0.089	0.00	1.25	1.46	4.68	4.37	0.97	0.97
NW	0.151	0.00	1.29	1.49	4.67	4.37	1.01	1.01
WNW	0.086	0.00	1.26	1.45	4.64	4.37	0.97	0.97
W	0.021	0.00	0.92	1.07	4.37	4.37	0.82	0.82
WSW	0.054	5.97	2.88	3.37	5.19	4.37	0.89	0.83
SW	0.086	6.00	3.80	4.05	5.43	4.37	0.85	0.85
SSW	0.060	5.68	2.94	3.43	5.24	4.37	0.86	0.86
S	0.035	4.10	1.47	2.06	5.18	4.37	0.87	0.87
SSE	0.087	4.12	1.67	2.85	5.32	4.37	1.04	1.04
SE	0.139	0.00	1.72	3.00	5.42	4.37	1.12	1.12
ESE	0.078	0.00	1.56	2.79	5.51	4.37	1.04	1.04
E	0.017	0.00	0.84	1.12	6.52	4.37	0.80	0.80
ENE	0.021	0.00	1.07	1.37	5.89	4.37	0.81	0.82
NE	0.025	0.00	1.21	1.51	4.82	4.37	0.83	0.83
NNE	0.026	0.00	1.13	1.41	4.72	4.37	0.82	0.82

Radioactive Effluent/Onsite Discharges/Unplanned Releases

U.S. DEPARTMENT OF ENERGY

DOE F-5821.1 (Rev. 11-80)
Replaces DOE Form EV-799T (3-79)

RADIOACTIVE EFFLUENT/ONSITE DISCHARGES/UNPLANNED RELEASES

Typewriter compatible

Section O

(A = Air Effl. B = Air Dischg. M = Liq. Dischg. L = Liq. Effl.)

Report Control Codes						Reference Location Ident.		
	Op. Ofc.	Area Ofc.	Contr.	Plant	Facility	Map No.	Effl. Dischg. Point Iden.	
	2	3	4	5	6	7-9	10-12	13
	B	G	N	R	S	001	022	A

Incident Report Date YY MM DD 14 19 Navy-Time Zone -HH MM Z 20 25

Report Period: From YY MM DD (14–19) 910101; To YY MM DD (20–25) 911231

Keypunch Instr. cc 2-19 (All Cards) cc 20-26 (For Section 2 ONLY)

26 / 20 Security Class/ Amended Data Designation

Prepared By: J. D. Moore
Date: 03/23/92 Area Code (818) Phone 586-6087

Approved By: Phil Rutherford
P. D. Rutherford
Date: 03/24/92 Area Code (818) Phone 586-6140

01	21	22	23 SECTION 1 NARRATIVE SUMMARY *(For New Release Points and Amended Data Only)* 80
1	0	1	Plant Title: Rocketdyne Division, Rockwell International
1	0	2	*Facility Title*: Santa Susana Field Laboratory Site
2	0	1	Effluent Release Point or Onsite Waste Discharge Point: DOE facility at Santa Susana - Building 022 (RMDF)
2	0	2	Operations Generating Pollutants: Processing radioactive wastes
2	0	3	Waste Treatment System: Exhaust air HEPA filtration systems
2	0	4	Monitoring System: Radioactive particulate air monitor at release point
2	0	5	*Monitoring System Continued*
2	0	6	No. of Samples *(Approximately)* 31 — Sample Information 29 Continuous
2	0	7	Name of Receiving Media or Storage/Disposal Facility Receiving Discharge — Storage/Disposal Facility Class. Code — Storage/Disposal Facility Name Code 77 79 80
			Include Other Information-Detailed comments on the following lines of Section 1
2	0	8	
2	0	9	
2	1	0	
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2	1	2	
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2	1	4	
2	1	5	
2	1	6	
2	1	7	
2	1	8	

DO NOT WRITE IN THIS SPACE

SECTION 2 NUCLIDE DATA

Storage/Disposal Facility Operational Status

01	Start-up Date YY MM DD 28–33	Termination Date YY MM DD 35–40	41	Discharge/Effl. Point Gross Volume 46 49	UNITS 50	Section "0" Report Control Codes 51–63	Section "0" Report Control Codes 64–76	DO NOT WRITE IN THIS SPACE
3			+	7.70 E +09	F			

F-Cubic Feet M Cubic Metres K-Gallons P-Pounds L-Litres

Associated release/discharge point(s) reported on other F-5821.1's as emanating from disposal facility listed in section 1 (Obtain data from other F-5821.1's)

C-Curies D-Dis/SEC/ml G Grams M-Microcuries/ml
S-Soluble RCG is applicable N-Insoluble RCG is applicable U-Solubility is unknown

01	Nuclide Description 27–40	Amount or Concentration 41–46	49	Units 50	51	Brief Comments 52–80
4	MFP	+2 • 63 E	-06	C	U	Un-Id B+G Un-Id Alpha
4		+ • E				
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DO NOT WRITE IN THIS SPACE

Radioactive Effluent/Onsite Discharges/Unplanned Releases

U.S. DEPARTMENT OF ENERGY

DOE F-5821.1 (Rev. 11-80)
Replaces DOE Form EV-788T (3-78)

RADIOACTIVE EFFLUENT/ONSITE DISCHARGES/UNPLANNED RELEASES

Typewriter compatible

Section O

(A = Air Effl. B = Air Dischg. M = Liq. Dischg. L = Liq. Effl.)

Report Control Codes					Reference Location Ident.			Incident Report		Report Period			Security Class/ Amended Data Designation
Op. Ofc.	Area Ofc.	Contr.	Plant	Facility	Map No.	Effl. Dischg. Point Iden.		Date YY MM DD	Navy Time Zone -HH MM Z	From YY MM DD	To YY MM DD		
2	3	4	5	6	7-9	10-12	13	14 19	20 25	14 19	20 25	26 / 20	
B	G	N	R	S	059	A				910101	911231		

Keypunch instr. cc 2-19 (All Cards) cc 20-26 (For Section 2 ONLY)

Prepared By J. D. Moore
Date 03/23/92 Area Code (818) Phone 586-6037

Approved By Phil Rutherford
P. D. Rutherford
Date 03/24/92 Area Code (818) Phone 586-6140

SECTION 1 NARRATIVE SUMMARY *(For New Release Points and Amended Data Only)*

01	21	22	23	80
1	0	1	Plant Title Rocketdyne Division, Rockwell International	
1	0	2	Facility Title Santa Susana Field Laboratory Site	
2	0	1	Effluent Release Point or Onsite Waste Discharge Point DOE facility at Santa Susana Site-Building 059	
2	0	2	Operations Generating Pollutants Decontamination and decommissioning of facility	
2	0	3	Waste Treatment System Exhaust air HEPA filtration system	
2	0	4	Monitoring System Continuous sampler at discharge point	
2	0	5	Monitoring System Continued	
2	0	6	No. of Samples *(Approximately)* 57 | Sample Information 29 Sampling during discharge with later analysis	
2	0	7	Name of Receiving Media or Storage/Disposal Facility Receiving Discharge Atmosphere Storage/Disposal Facility Class Code / Storage/Disposal Facility Name Code 77 79 80	
			Include Other Information-Detailed comments on the following lines of Section 1	
2	0	8		
2	0	9		
2	1	0		
2	1	1		
2	1	2		
2	1	3		
2	1	4		
2	1	5		
2	1	6		
2	1	7		
2	1	8		

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SECTION 2 NUCLIDE DATA

Storage/Disposal Facility Operational Status

F-Cubic Feet M-Cubic Metres K-Gallons P-Pounds L-Litres

Associated release/discharge point(s) reported on other F-5821.1's as emanating from disposal facility listed in section 1 (Obtain data from other F-5821.1's)

01	Start-up Date YY MM DD 28 33	Termination Date YY MM DD 35 40	41	Discharge/Effl. Point Gross Volume 46 49	UNITS 50	Section "0" Report Control Codes 51 63	Section "0" Report Control Codes 64 76	DO NOT WRITE IN THIS SPACE
3			+	1.07 E +09	F			

C Curies D-Ope/SEC/ml. G Grams M-Microcuries/ml
S-Soluble RCG is applicable N-Insoluble RCG is applicable U Solubility is unknown

01	27 Nuclide Description 40	41 Amount or Concentration 46 49	Units 50	51	52 Brief Comments 80
4	Co-60	+ 1 • 73 E -07	C	U	Activation product in structure
4		+ • E			
4		+ • E			
4		+ • E			
4		+ • E			
4		+ • E			
4		+ • E			
4		+ • E			
4		+ • E			
4		+ • E			
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4		+ • E			
4		+ • E			
4		+ • E			
4		+ • E			
4		+ • E			
5	Disper. Factor	+ 1 • 5 E +04			

DO NOT WRITE IN THIS SPACE

shows that roughly two–thirds of the activity reported as Co–60 was, instead, natural K–40.

A sensitivity study was performed for the RMDF, to determine the effects of reasonable variations in the computer model input parameters. This study is attached as Appendix A.

A DOE "Tiger Team" inspection of the DOE operations at SSFL, including effluent monitoring and interpretation, was conducted from March 18 through April 16, 1991. Team findings applicable to this report are attached as Appendix B.

The RMDF exhaust air is sampled by use of a single, centrally located nozzle, sized to provide nominally isokinetic sampling. The nozzle is located 5.4 stack diameters above the last flow disturbance in the stack, and the air sample is transported to the collection filter through about 37 feet of 1/2–inch stainless steel tubing. The Reynolds number in the stack is about 15,000, well above the transition from laminar to turbulent flow (around 3,000), thus assuring well–mixed air. Minor modifications were made in April, 1991. The sampling efficiency of this system was calculated by use of the computer program DEPOSITION. (DEPOSITION: Software to Calculate Particle Penetration Through Aerosol Transport Lines (draft) NUREG/GR–0006, N. K. Anand and A. R. McFarland, September, 1991.) The calculation showed a sampling efficiency of about 98% for both the initial sampling arrangement and the modified arrangement for the particle size distribution expected to pass through the HEPA filter.

During the modification, a section of the tubing was removed and, with its tubing connectors, was analyzed for radioactivity by gamma ray spectrometry. This analysis showed small amounts of Cs–137 and Co–60. Comparison of the activity still in the sampling tube with that estimated to be caught in filter samples over the 12 years (1979–1990 inclusive) of operation of this system suggests a deposition of 20.1%, or a sampling efficiency of 79.9%. This may be the result of larger particles being released during filter changes, small leaks in the filter media that are not significant in terms of the results of the DOP/DOS tests, or possible condensation of water vapor trapping radioactive particulates during operation of the radioactive water evaporator.

At T059, the exhaust and sampling systems were significantly changed midway through the year. This resulted in a system closely complying with the recommendations in ANSI N13.1. The sampling configurations were analyzed using DEPOSITION. Before the change, the sampling system was somewhat subisokinetic (velocity ratio = 0.6) and so slightly oversampled (by about 25%) the larger particles passing through the HEPA filter. After the change, the calculated sampling efficiency exceeded 90% over a broad range of particle size distributions. The Reynolds number in the stack is about 7,500, assuring well mixed air at the sample nozzle location.

Dose Evaluation with No Air Pollution Control Equipment

These two release points (RMDF and T059) were evaluated, in the manner described in 40 CFR61.93 (b) (4) (ii), to determine the need to implement the emission measurement and quality assurance requirements described in 40CFR61 Appendix B, Method 114. This evaluation is done for normal operating conditions, but assuming that the pollution control equipment (HEPA filters) does not exist. Operations at RMDF during 1990 were taken as directly typical for this facility, while the operations at T059 during 1990, involving torch cutting of stainless steel, were taken as representing by far the greatest potential for airborne releases from this facility. The operations at RMDF in 1991 were similar to those in 1990. The operations at T059 in 1991 involved less torch cutting and, therefore, would result in lower releases than in 1990. If the expected maximum individual dose determined by this evaluation does not exceed 10% of the established standard, that is, 0.1 mrem/year, the release point is not subject to the emission measurement requirements. Instead, NESHAPs requires that periodic confirmatory measurement be made to verify the low emissions. The detailed evaluations are described in two Rocketdyne Internal Letters attached to this report (Attachments 1 and 2).

The hypothetical release from RMDF, assuming absence of the HEPA filters, was calculated by increasing the observed radionuclide releases for 1990 by the filter transmission calculated for a model particle–size distribution, a factor of 464. Potential off–site doses were calculated using the Burbank Airport meteorology (BUR1051.WND) provided in AIRDOS–PC, for a distance slightly less than the nearest neighbor (2065 meters), in any direction. The maximum dose calculated in this manner was 0.0005 mrem/year, well below the critical value of 0.1mrem/year. It was concluded that the emission measurement requirements were not applicable to this release point. The stack sampling system and analysis program will continue in operation, as required for routine effluent monitoring under DOE orders, and will provide the periodic confirmatory measurements required by NESHAPs.

The hypothetical release from T059 during the torch–cutting operations, assuming absence of the HEPA filters, was calculated by a detailed modeling of airborne particulate generation and filtration. The potential off–site doses were calculated in the same manner as for the RMDF evaluation, using BUR1051.WND in AIRDOS–PC, for a distance slightly less than the nearest neighbor (2226 meters), in any direction. The maximum dose calculated in this manner was 0.013 mrem/year, also below the critical value of 0.1 mrem/year. Therefore, the NESHAPs emission measurement requirements are not applicable to this release point. The stack sampling system and analysis program will continue in operation, as required for routine effluent monitoring under DOE orders, and will provide the periodic confirmatory measurements required by NESHAPs.

A review of airborne radioactivity monitoring, analysis, and interpretation in the DOE operations at SSFL was conducted by EPA Region 9 staff and a consultant to determine compliance with 40CFR61 Subpart H, on March 31–April 1. At the closeout meeting following this review, no items of noncompliance were proposed. A final inspection report is expected by the end of April 1992.

Section 4: Offsite Dose Calculations

The largest effective dose equivalent is calculated for the nearest residence located in the northwest sector, at a distance of 3009 meters from the sources. Closer locations in other sectors were also considered to assure that the maximum dose was identified. The results of this study showed:

Sector	Distance (m)	Dose (mrem/year)
NW	3009	0.00000269
SE	2816	0.00000180
SSE	2301	0.00000150
N	2334	0.00000064

Printouts from AIRDOS–PC for these calculations are shown in Appendix C. The summary of information is shown in Table 1.

The radionuclides contributing to the calculated airborne dose are shown below, ranked in order of importance, with the percentage of dose.

Cs–137	41.4%
Co–60	31.4%
Pu–239	15.4%
U–234	3.6%
Th–232	2.9%
Sr–90	1.5%
Th–230	1.5%
U–238	1.3%
U–235	1.1%
Am–241	0.6%

Table 1. Summary of Information – Air Pathway Dose Evaluation DOE Operations at SSFL

Parameter	Source	
	RMDF	T059
Release type	stack	stack
Height (m)	39.600	5.180
Diameter (m)	0.916	0.306
Momemtum (m/sec)	10.510	10.260
Wind Data	SSFLNRC.WND	SSFLNRC.WND
Food Source	Local	Local
Distance to individuals (m)	NW 3009	NW 3009
	SE 2816	SE 2816
	SSE 2301	SSE 2301
	N 2334	N 2334
Temperature (C)	17	17
Rainfall (cm/y)	51	51
Lid Height (m)	366	366
Radionuclides with potential for emission during 1991:	Co- 60	Fe- 55
	Sr- 90	Co- 60
	Cs-137	Eu-152
	Th-232	Eu-154
	U -234	
	U -235	
	U -238	
	Pu-239	
	Pu-240	
	Am-241	

For RMDF, Am-241 and Th-232 were not detected. Pu-240 was included implicitly in the analysis for Pu-239/240.
For T059, Fe-55 was not modeled since this nuclide is not included in the AIRDOS-PC library. Eu-152,-154 were not detected.

Release points:	Stack @ SW corner of Building T022	Stack @ NW corner of Building T059
Control devices:	HEPA filters	HEPA filters
Efficiencies:	99.9999% by DOS 6/19/91	99.999% by DOS 1/10/91
Monitoring:	Nominally isokinetic single nozzle. Membrane sample filter with fiber-glass backup in CAM with thin-window pancake GM, counted weekly, after delay, in thin-window gas-flow proportional alpha/beta counter. Later annual composite analysis by detailed radioanalytic techniques.	Nominally isokinetic single nozzle. Membrane sample filter with fiber-glass backup. Filters are counted weekly, after delay, in thin-window gas-flow proportional alpha/beta counter. Later annual composite analysis by detailed radioanalytic techniques.

Table 1. Summary of Information – Air Pathway Dose Evaluation DOE Operations at SSFL (Continued)

Input to AIRDOS-PC:

Radionuclide	Class	Amad	RMDF Ci/y	T059 Ci/y
Sr- 90	Y	1.0	6.8E-08	
Pu-239	Y	1.0	5.7E-09	1.1E-09
Cs-137	D	1.0	1.2E-06	
Co- 60	Y	1.0	6.3E-07	8.1E-08
Th-230	Y	1.0	2.0E-09	
U -234	Y	1.0	8.9E-09	
U -235	Y	1.0	2.8E-09	
U -238	Y	1.0	3.6E-09	

AIRDOS-PC Calculated Doses (mrem/year) EDE

Direction	Distance (m)	RMDF	T059	Combined
NW	3009	0.000002120	0.000000571	0.000002690
SE	2816	0.000001400	0.000000360	0.000001800
SSE	2301	0.000001100	0.000000330	0.000001500
N	2334	0.000000480	0.000000160	0.000000640

Section 5: Construction and Modifications

The only modifications to these facilities during Calendar Year 1991 were improvements to the exhaust and sampling systems. These modifications (described in Section 3) were exempt from the requirement for application for approval because emissions from both facilities are well below the amount that could cause a dose exceeding 1% (0.1 mrem/year) of the dose-related standard of 10 mrem/year.

Section 6: Certification of Accuracy

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 19 U.S.C. 1001.

5/1/92

D. C. Gibbs
General Manager
ETEC
Rockwell International

Date

5/5/92

R. R. LeChevalier
Site Office Manager
ETEC
Department of Energy

Date

D641-0028

Attachment 1
“Evaluation of Airborne Radioactive Effluent – T059”

Internal Letter **Rockwell International**

Date: . 3 March 1992 No: . 825il.rjt

TO: (Name, Organization, Internal Address)
. File
. 641, 055–T100

FROM: (Name, Organization, Internal Address, Phone)
. R. J. Tuttle
. 641, 055–T100
. 180–6135

Subject: . Evaluation of Airborne Radioactive Effluent — T059

Reference: 10CFR61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities"

Summary

The Reference, NESHAPs for radionuclides, establishes a limit on radionuclide emissions from DOE facilities, to not exceed an effective dose equivalent to a member of the public, of 10 mrem/yr. To determine compliance with this requirement, radionuclide emissions must be measured, in a manner described by the regulations in detail, for each release point that has a potential for exceeding 1% of the standard, 0.1 mrem/yr. Periodic confirmatory measurements must be made at potential release points that do not require the specified measuring. In evaluating the potential for radionuclide emissions, it must be assumed that any pollution control equipment (HEPA filters, in our case) do not exist, but operations are otherwise normal.

The only operation with significant potential for releasing airborne radioactivity from T059, was the torch (plasma–torch or arc–air) cutting of neutron–activated steel. This created airborne radioactivity at the work site, some of which was discharged to the atmosphere. Air from around the work–site was routinely exhausted through pre–filters and HEPA filters before being discharged to the atmosphere.

Subpart H became effective on December 15, 1989, the date of its publication in the Federal register, and required reporting for the calendar year of 1989, of the monitoring results and dose calculations performed using AIRDOS–PC or other approved methods. That copy of the Federal Register was received some time in 1990. DOE/SAN notified us formally on December 28, 1989, and EPA Region 9 advised us on August 7, 1990.

Some torch cutting of the vacuum duct was done in January of 1989, with an average filtered exhaust concentration measured to be about 1.2×10^{-11} µCi/cm^3 gross beta, during the release for 6 days. At that time the dispersion factor at the distance of the nearest residence was estimated to be 1.5×10^4. Therefore, the maximum annually averaged concentration at the nearest residence due to this operation would be less than $(1.2 \times 10^{-11})(6/365)/1.5 \times 10^4 = 1.3 \times 10^{-17}$ µCi/cm^3. This concentration would produce a hypothetical dose of 0.000016 mrem/year, based on comparison with the DOE Derived Concentration Guide for for Co–60 (8×10^{-11} µCi/cm^3), which is calculated to produce a dose of 100 mrem/year.

Torch cutting of the vacuum vessel was started in December of 1989, just before the year–end holiday. Because of the lack of a vacuum pump for the exhaust sampler and no perceived need to sample this exhaust, the exhaust sampler was not re–installed. The sampler was replaced late in December of 1990. Nearly all the torch cutting of significantly activated steel had been completed by the end of March 1990. Some NaK lines were cut in November 1990.

To estimate a probable value for the amount of radioactivity released in 1990, in the absence of exhaust concentration measurements, a detailed numerical analysis has been performed, using all the information that is known or can be reasonably approximated. This analysis has considered that all radioactivity that was discharged from the facility during the torch cutting of the core vessel (12/89 through 3/90) was released during calendar year 1990. This analysis shows that approximately 6.2 x 10^{-6} Ci (6.2 µCi) of Co–60 was released from the stack, resulting in a hypothetical maximum dose to the public of about 1.5 x 10^{-5} mrem/year (0.000015), which would still be far below the measurement requirement of 0.1 mrem year after adjusting for the absence of the HEPA filters, as is shown in the detailed analysis presented in the Appendix.

Analysis and Interpretation

Because of the little impact foreseen for the cutting operation, measurements were not made that would have permitted more direct estimation of the release. However, a reasonable estimate can be derived indirectly, as discussed below. The details of this derivation are presented in the Appendix.

Torch cutting the vacuum vessel produces molten spatter, vapor, and oxide particles, resulting in a broad distribution of particle sizes. Much of this initially airborne material falls out before travelling far from the point of production. At T059, in the Core Vessel Area where this cutting was done, the remaining airborne material became entrained in airflow to an exhaust duct, roughly 1 foot in diameter, which passed the exhaust through a pre–filter and HEPA filter, and discharged it to the atmosphere. (Airborne radioactivity was measured only in the general work area during this cutting.) Over an extended period of time, approximately 3 months, this material was exhausted to the atmosphere and dispersed downwind. This analysis uses what can be known or estimated about this process to derive a value for released radioactivity. This is done using the best estimates available, and is not done in a "worst–case" manner. The public dose is then calculated using AIRDOS–PC.

The steps in this estimation are described below and are shown in a flow–chart form in Figure 1:

1. Estimate of radioactive material released by torch cutting.

   The amount of steel cut by the torch is estimated to be a total lineal cut of 540 ft. with 90% at 3/8–inch thick with a 1/4–inch wide kerf, 6% at 2–inch with 1/2–inch kerf, and 4% at 4–inch by 5/8–inch. This amounts to 0.92 ft^3 (2.6 x 10^4 cm^3) of steel melted, burned, or vaporized. At a density of 8 g/cm^3, this amounts to 208 x 10^3g.

   The following calculated specific activities (µCi/g) were used to estimate the activity (µCi) released by the cutting.

	(µCi/g)	(µCi)
Fe–55	0.62	0.129x10^6
Ni–59	0.0056	0.001x10^6
Co–60	1.4	0.291x10^6
Ni–63	1.2	0.250x10^6

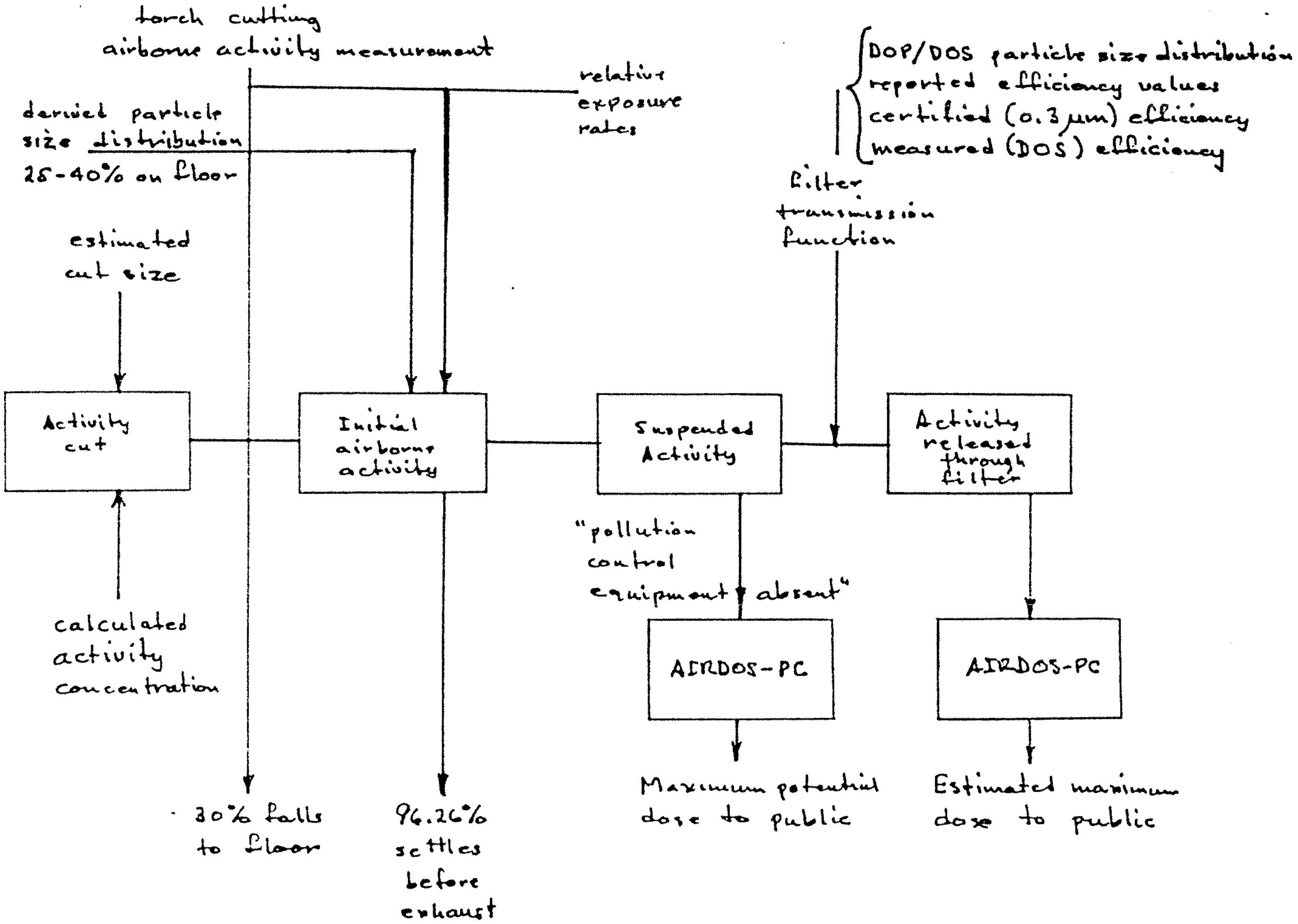


Figure 1. Flow-Chart for Estimation of Radioactive Releases from T059 and Consequent Dose to Public

Only the Co–60 is significant: the others decay by electron capture or emission of a very low energy beta particle, without accompanying gamma radiation, and so are not readily detected, nor are they significant in terms of dose.

2. Airborne radioactivity initially suspended by torch cutting.

   Based on visual observations, about 25 to 40% of the material cut by the torch fell out as spatter and slag. A fraction of 70% has been assumed to remain airborne. That is, 30% falls to the floor. This leaves 0.204 x 10^6 μCi suspended.

3. Concentration of airborne radioactivity.

   During the torch cutting of the vacuum duct about a year earlier, the airborne concentration was measured about 1 meter away from the torch tip. This was 1.7 x 10^{-9} μCi/cm^3 beta activity (essentially only Co–60).

   The vacuum vessel was more intensely activated than the vacuum duct, and so the airborne concentration measured during the vacuum duct cutting must be adjusted. The radiation exposure rate near the vacuum duct was 1.6 R/hr, while that near the core vessel was 7 R/hr. The ratio of these two values was used to adjust the measured concentration from 1.7 x 10–9 μCi/cm^3 to 7.4 x 10–9 μCi/cm^3.

4. Activity exhausted from the cutting area.

   The sustained airborne activity, that was exhausted from the cutting area, can be estimated from the concentration (7.4 x 10–9 μCi/cm^2), flow rate (2160 ft^3/min), and time (281 hours). This results in an estimate of 7.63 x 10^3 μCi. This corresponds to a mass concentration of 5.29 mg/m^3, which is relatively dense.

5. Settling fraction.

   Moderate–sized particles that initially remain airborne may settle before travelling very far from the point of production. This settling is estimated from the ratio of the sustained airborne activity (Step 4) to the initial airborne activity (Step 2). Thus,

$$\text{Settling fraction} = 1- \frac{7.63 \times 10^3}{204 \times 10^3} = 0.9626$$

   (That is, only 0.0374 of the original activity released by the cutting remains airborne.) This results in a mass concentration of 0.20 mg/m^3, which is quite reasonable.

   This parameter is used to adjust the airborne particle size distribution.

6. Filter transmission at 0.3 μm.

   HEPA filters are tested before delivery by use of a monodisperse aerosol (nearly all particles are essentially the same size) with a particle diameter of 0.3 μm using DOP (di–octylphthalate). Filters are certified to have an efficiency of at least 99.97%.

   This value is used as one point in defining the shape and magnitude of the filter transmission curve.

7. Filtration efficiency for 0.8 μm distribution.

   The filter bank is tested for efficiency by use of a polydisperse aerosol (the particles have a broad size distribution) using a CMAD (Count Median Aerodynamic Diameter) of 0.8 μm, generated with DOS (di–octylsebacate). The T059 Unit–1 filter was tested on 11/7/89 and showed an efficiency of 99.997% for this test aerosol.

   This value is used to further define the filter transmission curve.

8. Observed filtration efficiency. The filtration efficiency for HEPA filters has been measured as a function of particle size and is shown in the "Nuclear Air Cleaning Handbook" (ERDA 76–21).

   These values were used to determine the shape and magnitude of the filter transmission curve over the range of these measurements.

9. Determine activity released.

   With the particle size distribution determined by Step 5, the radioactivity concentration defined by Step 3, and the filter transmission curve determined by Steps 6, 7, and 8, the radioactivity that passes through the filter and is discharged to the atmosphere can be estimated.

   This is 6.2 μCi of Co–60: the others do not contribute to dose and are neglected.

10. Determine activity that would be released if the pre–filters and HEPA filters ("pollution control equipment," 40CFR61–93(b)(4)(ii)) were absent.

    This is the activity exhausted from the cutting area that reaches the filter, determined to be 5.27 x 10^3 μCi.

11. Calculate maximum public dose for actual release.

    The AIRDOS–PC computer program was used to calculate offsite doses, with variations of the input parameters. Two different wind–sets were used: the Burbank Airport (BUR1051.WND) set accepted by EPA, and a local set (SSFL.WND) developed by NRC, ANL, and RI, but using a synthetic, rather than measured, stability frequency table. For the Burbank wind, the maximum dose in any direction at the distance of the nearest neighbor (2226 m to the SE) is shown. For the SSFL wind, the maximum of the doses at the nearest neighbor in each sector is shown. To further document the sensitivity of this calculation to user's choice parameters, two extreme values for the lid height were used for both wind sets. The maximum doses, as discussed above, are shown below:

Effective Dose Equivalent (mrem/year)

Lid Height	300m	9000m
BUR1051.WND	0.0000150	0.0000150
SSFL.WND	0.0000060	0.0000032

These values should be compared with the 10 mrem/year standard of 40CFR61.

12. Calculate maximum public dose for release if the pre–filters and HEPA filters were absent.

The same calculations as in Step 11 were performed using the unfiltered discharge estimated in Step10. The results are shown below:

Lid Height	300m	9000m
BUR1051.WND	0.0130	0.0130
SSFL.WND	0.0051	0.0027

Effective Dose Equivalent (mrem/year)

These values should be compared with the 1% limit, 0.1 mrem/year, that requires detailed effluent measurements.

While these estimates may seem to be too tenuous, each step has been a reasonable approximation to a relatively bounded process. The success of this approach may be judged by consideration of one direct comparison based on a measured value. On 15 February 1991, several activated NaK pipes were torch–cut in a tent enclosure in the reactor pit, during a 50–min operation. At that time the air in the enclosure was sampled and showed 2.29 x 10^{-9} μCi/cm^3 beta activity. (This is comparable to the value of 7.4 x 10^{-9} μCi/cm^3 estimated in Step 3.) The exhaust effluent was also sampled, and showed an average concentration of 1.4 x 10^{-14} μCi/cm^3 beta activity for 164 hours. The expected time–averaged concentration from the 50–min cutting operation without filtration is 1.16x10^{-11} μCi/cm^3. The ratio of the observed filtered concentration to the expected unfiltered concentration, which gives us the filter transmission for this aerosol, is 0.00120. The filter transmission calculated for the suspended aerosol in this case shows excellent agreement: 0.00117.

R. J. Tuttle
Radiation Protection and
Health Physics Services

D641–0015/tab

Attachment

cc:	P. D. Rutherford PDR	T100
	R. D. Meyer	T038
	P. H. Horton	T020
	G. G. Gaylord	T038
	RP&HPS	T100

ESTIMATE OF AIRBORNE RADIOACTIVITY RELEASED FROM T059 IN 1990

The particle size distribution of aerosols is typified as a log–normal distribution. In this, the logarithm of the aerodynamic diameter is distributed according to the Gaussian probability distribution. This distribution is specified by a parameter generally representing the particle size (often the Count Median Aerodynamic Diameter; half the particles have aerodynamic diameters greater than this value) and the spread or variability of the particle sizes (the geometric standard deviation (g); roughly 68% of the particle sizes are between (1/g)x the mean and (g)x the mean).

The formula for the log–normal distribution function is:

$$f(d) = \frac{1}{\sqrt{2\pi}\ \ln g}\ e^{-0.5\left(\frac{\ln d - \ln CMAD}{\ln g}\right)^2}$$

where:

f	is the frequency, normalized to produce an integral of 1.0
d	is the aerodynamic diameter
CMAD	is the Count Median Aerodynamic Diameter
g	is the geometric standard deviation

Two examples of log–normal aerosol distributions, with explanatory notes, are shown in Figure 1.

These distributions are also shown in Figures 2 and 3 as calculated by the spreadsheet used for this analysis, both with a linear scale for comparison with the published figures, and in a semi–log plot to show the symmetrical "bell–shaped" curve usually associated with the Gaussian distribution .

The particle size distribution is adjusted to an activity distribution simply by scaling the frequency by multiplying by the cube of the diameter (representing the volume or mass). This shows how the larger particles are responsible for carrying most of the activity. This is shown in Figure 4 for the same distributions with CMAD = 1.0 μm and g = 2.0 and with CMAD = 0.41 μm and g = 1.88.

These calculations are based on the unit–density aerodynamic sphere model, in which actual particles are represented by spheres of unit density with the diameter determined to have the same settling velocity as the actual material. The settling velocity is calculated by Stoke's Law:

$$V = \frac{2gd^2\ (\rho_1 - \rho_2)}{9\ \eta}$$

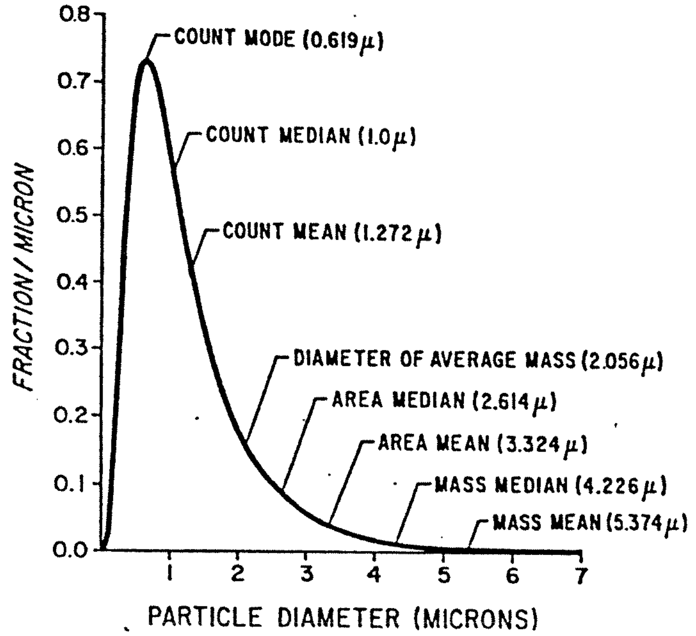


FIG. 10. This representative log-normal distribution shows the position of several parametric functions of interest to aerosol investigations. The values within parentheses are based on an assumed count median diameter of 1.0 μ and geometric standard deviation of 2.0 (kindly furnished by O. RAABE).

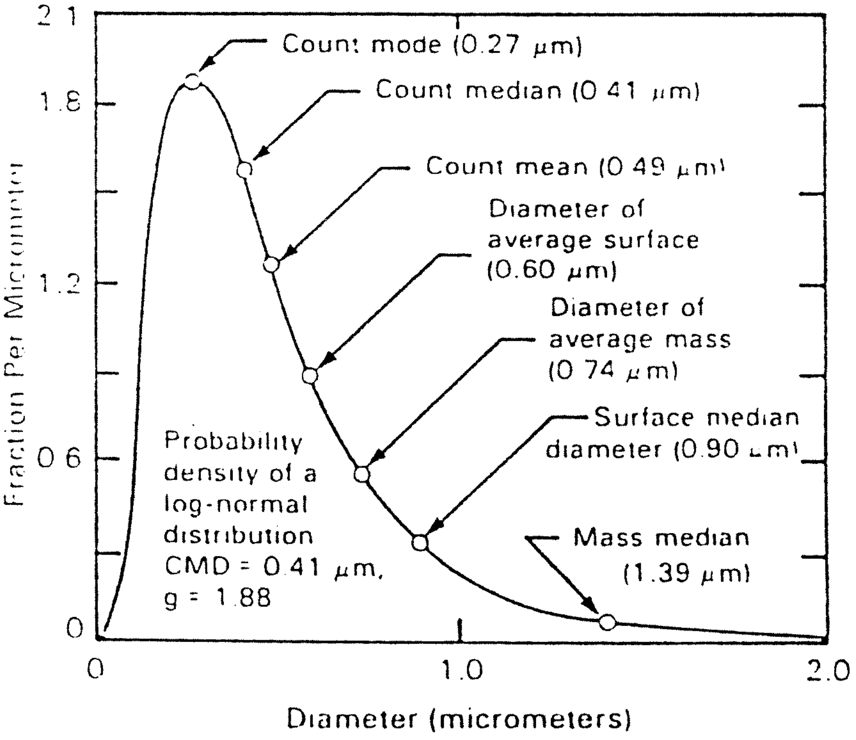


Figure 12–6. Data on the same aerosol as in Figure 12–5 plotted to show the probability density of a log—normal distribution. See Raabe (1970).

Figure 1

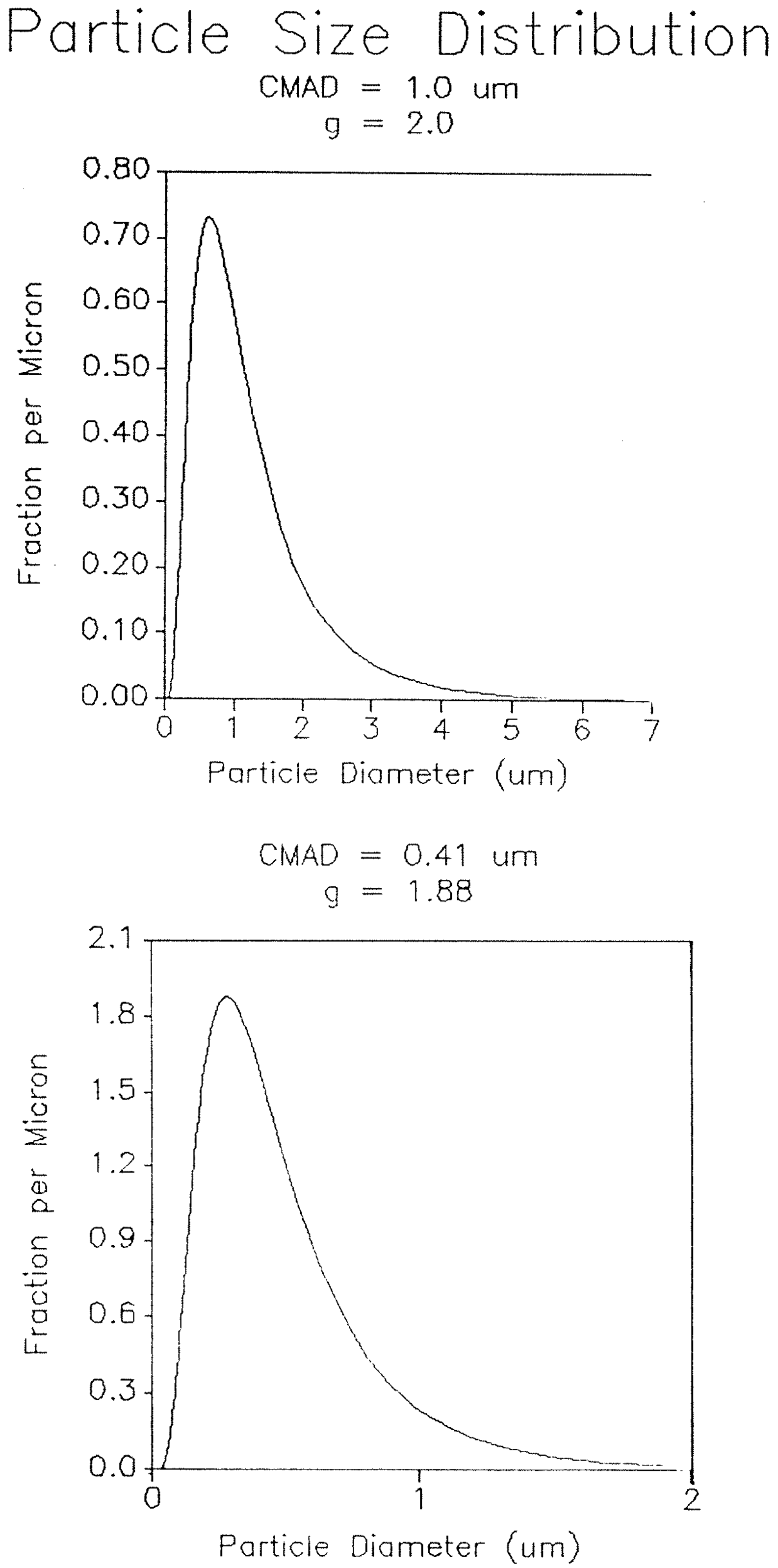

Particle Size Distribution
CMAD = 1.0 um
g = 2.0
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Fraction per Micron
0
1
2
3
4
5
6
7
Particle Diameter (um)
CMAD = 0.41 um
g = 1.88
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0.0
Fraction per Micron
0
1
2
Particle Diameter (um)

Figure 2

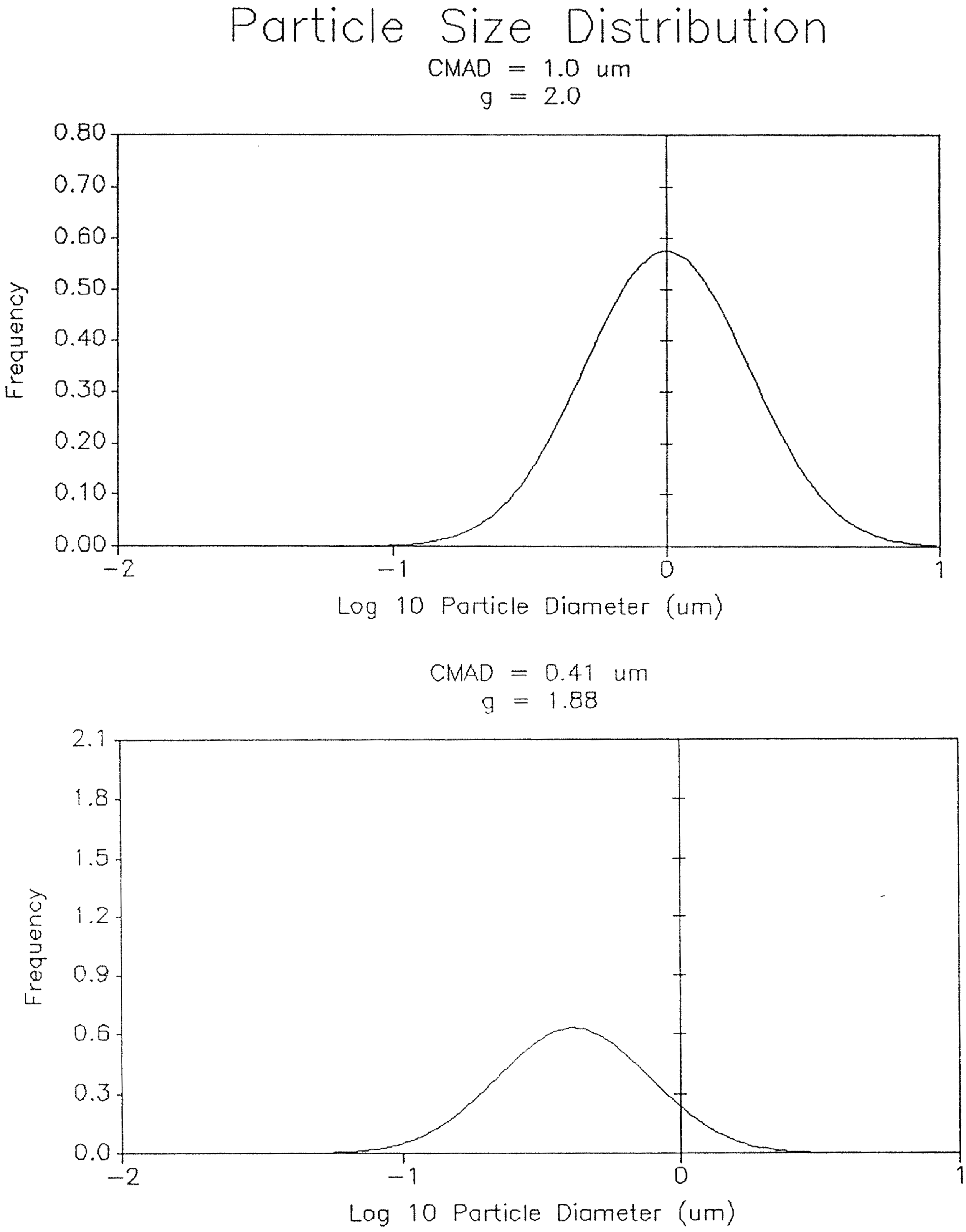
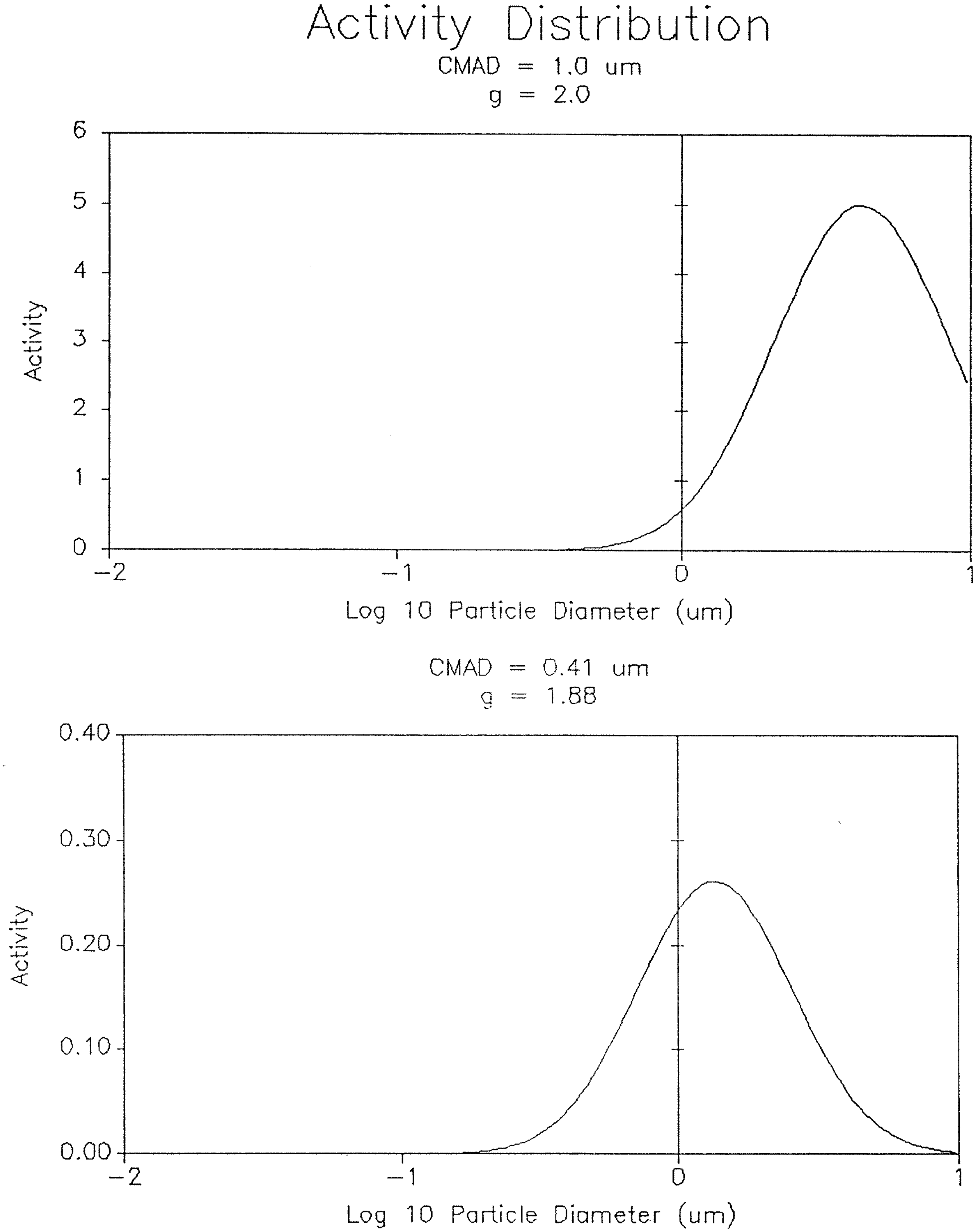

Particle Size Distribution
CMAD = 1.0 um
g = 2.0
Frequency
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
−2
−1
0
1
Log 10 Particle Diameter (um)
CMAD = 0.41 um
g = 1.88
Frequency
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0.0
−2
−1
0
1
Log 10 Particle Diameter (um)

Figure 3



Activity Distribution

CMAD = 1.0 um
g = 2.0

CMAD = 0.41 um
g = 1.88

Figure 4

where:

g	is the acceleration due to gravity (980 cm/sec^2)
d	is the diameter (in cm)
ρ_1	is the density of the particle, or unit density (g/cm^3)
ρ_2	is the density of air ((0.001213 g/cm^3)
η	is the coefficient of viscosity of air (at 18°C, 182.7 x 10^{-6} poise)

For particles with density other than 1.0, the aerodynamic diameter is related to that of the unit density model by

$$d_a^2 = \frac{d_\rho^2}{(\rho_1 - \rho_2)}$$

or

$$d_a = \frac{d_\rho}{\sqrt{(\rho_1 - \rho_2)}}$$

Thus, for iron oxide (FeO) with a density of 5.7 g/cm^3, the diameter scale is reduced by a factor of 0.419.

The filter transmission function is less well defined but it is known to decrease (fewer particles pass) for larger size particles, and also to decrease for smaller particles, even atoms/molecules of particulate elements/compounds. Particles are trapped in the filter by adhesion following contact with the surface of a fiber as the result of impaction, interception, or diffusion.

Large particles are trapped by impingement, direct collision with a filter fiber. Due to inertial forces, the particle cannot follow the airstream around the filter fiber, collides with it and sticks. For medium particles which follow the airstream, interception by grazing collisions is effective in removal. Small particles are subject to random Brownian motion and are trapped by adhesion upon colliding with a fiber as a result of this motion. These effects are shown for a different type of filter (a gas cleaning filter) in Figure 5. The "capture by interception" curve refers to the sieve–like action of a filter in catching larger particles, while the "capture by diffusion" curve refers to the effect of adhesion, whereby small particles deposit on the surfaces of the filter media fibers. The combination of these two effects defines a "most penetrating particle size," which is 0.04 μm at 50 cm/sec for the gas cleaning filter, but in the present analysis of HEPA filters, has been found to be 0.07 μm based on the best fit of a theoretical filter transmission curve.

A theoretical expression for the filter transmission function, per fiber in the line–of–sight, has been developed by R. G. Dorman (Chapter VIII, "Filtration" in Aerosol Science, edited by C. N. Davies, Academic Press 1966). Unfortunately, the function behaves properly only over a limited range of particle size, from about 0.002 to 0.2 μm, and was difficult to adjust to achieve reasonable transmission values for the DOP and DOS

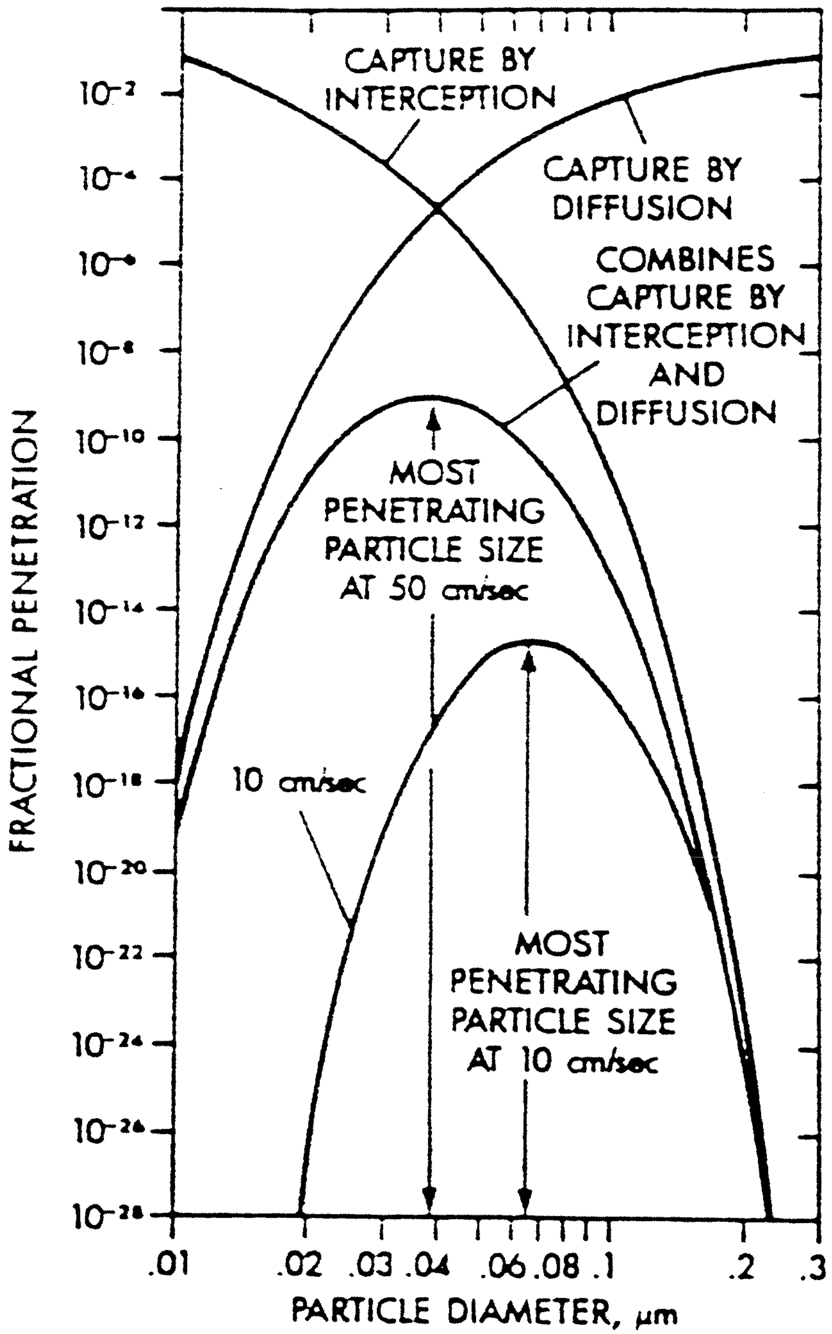

CAPTURE BY INTERCEPTION
CAPTURE BY DIFFUSION
COMBINES CAPTURE BY INTERCEPTION AND DIFFUSION
MOST PENETRATING PARTICLE SIZE AT 50 cm/sec
10 cm/sec
MOST PENETRATING PARTICLE SIZE AT 10 cm/sec
FRACTIONAL PENETRATION
10⁻²
10⁻⁴
10⁻⁶
10⁻⁸
10⁻¹⁰
10⁻¹²
10⁻¹⁴
10⁻¹⁶
10⁻¹⁸
10⁻²⁰
10⁻²²
10⁻²⁴
10⁻²⁶
10⁻²⁸
.01
.02
.03
.04
.06
.08
.1
.2
.3
PARTICLE DIAMETER, µm

Figure 5

test aerosols. For these reasons, an empirical function was used to represent the filter transmission in this study.

The theoretical and empirical functions are shown in Figure 6, with observed values reported in the Nuclear Air Cleaning Handbook. (These values are barely discernible in the upper plot.) To more clearly show the similarity and differences between these functions, the lower plot uses an expanded scale. The observed values are indicated as the points of the straight line segments between log diameters of –1 and 0.

The empirical function is compared with the observed values in Figure 7, using linear scales to more clearly show the good agreement obtained by adjusting the empirical parameters. Integral filter efficiency values are shown for a polydisperse DOS aerosol (99.9887%) and a monodisperse DOP aerosol (99.9509%).

The polydisperse (pneumatically generated DOS or DOP) aerosol particle size distribution was derived from data reported by Flanders Filters, Inc. The cumulative percentage values reported were fit by a linearized Gaussian distribution and the parameters obtained (CMAD = 0.64 μm and g = 1.703) were then used to calculate a log–normal distribution, shown in the upper plot of Figure 8. The cumulative fraction from the derived distribution and the observed values are shown in the lower plot.

Unlike the well defined DOP/DOS aerosol, the aerosol generated by the torch–cutting consists of a mixture of smoke, fumes, spatter, and slag. The larger particles (greater than about 40 μm in actual diameter) fall out quickly, leaving a dense aerosol with many large particles.

The airborne particulates from the torch–cutting probably constitute a trimodal (oxide smoke, vapor condensate, molten spatter) distribution, as shown for atmospheric aerosols by Whitby and Cantrell in Figure 9 (this example plots surface area of the particles, and so the magnitudes are weighted according to the square of the particle diameter), with smoke particles (small), condensed vapor (larger), and molten spatter (largest). The precise shape of this distribution is not important. Fundamentally, the exhausted aerosol consists of those particles that did not settle farther than 1 m in 120 seconds. Entrainment in the directed air flow of the exhaust and turbulence along the convoluted wall of the elephant–trunk exhaust duct assures continued suspension until the filter plenum is reached.

The settling velocity, calculated by Stoke's law as described previously, is shown in Figure 10 as a function of actual particle size for a density of 5.7 g/cm^{3}.

The settling velocity, which applies to individual particles and should not be confused with the deposition rate considered in aerosol transport studies (which applies to the distribution as a whole) was then used in conjunction with the ratio of suspended airborne activity (as determined by workplace air sampling) to the released airborne activity (estimated from the amount of steel cut, adjusted for fallout), to determine the particle size distribution.

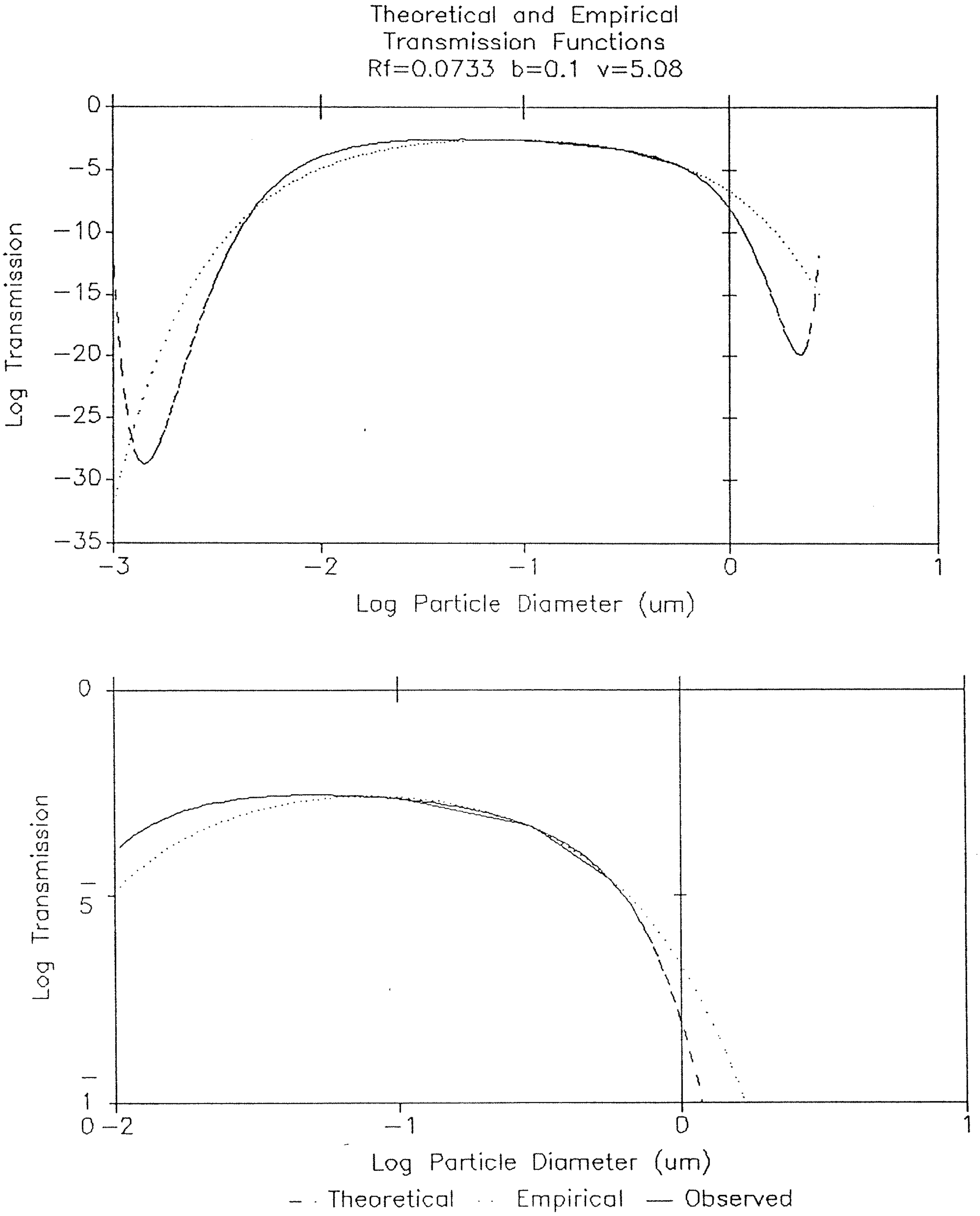

Theoretical and Empirical
Transmission Functions
Rf=0.0733 b=0.1 v=5.08
0
−5
−10
−15
−20
−25
−30
−35
Log Transmission
−3
−2
−1
0
1
Log Particle Diameter (um)
0
5
1
0
Log Transmission
−2
−1
0
1
Log Particle Diameter (um)
- · Theoretical
· · Empirical
— Observed

Figure 6

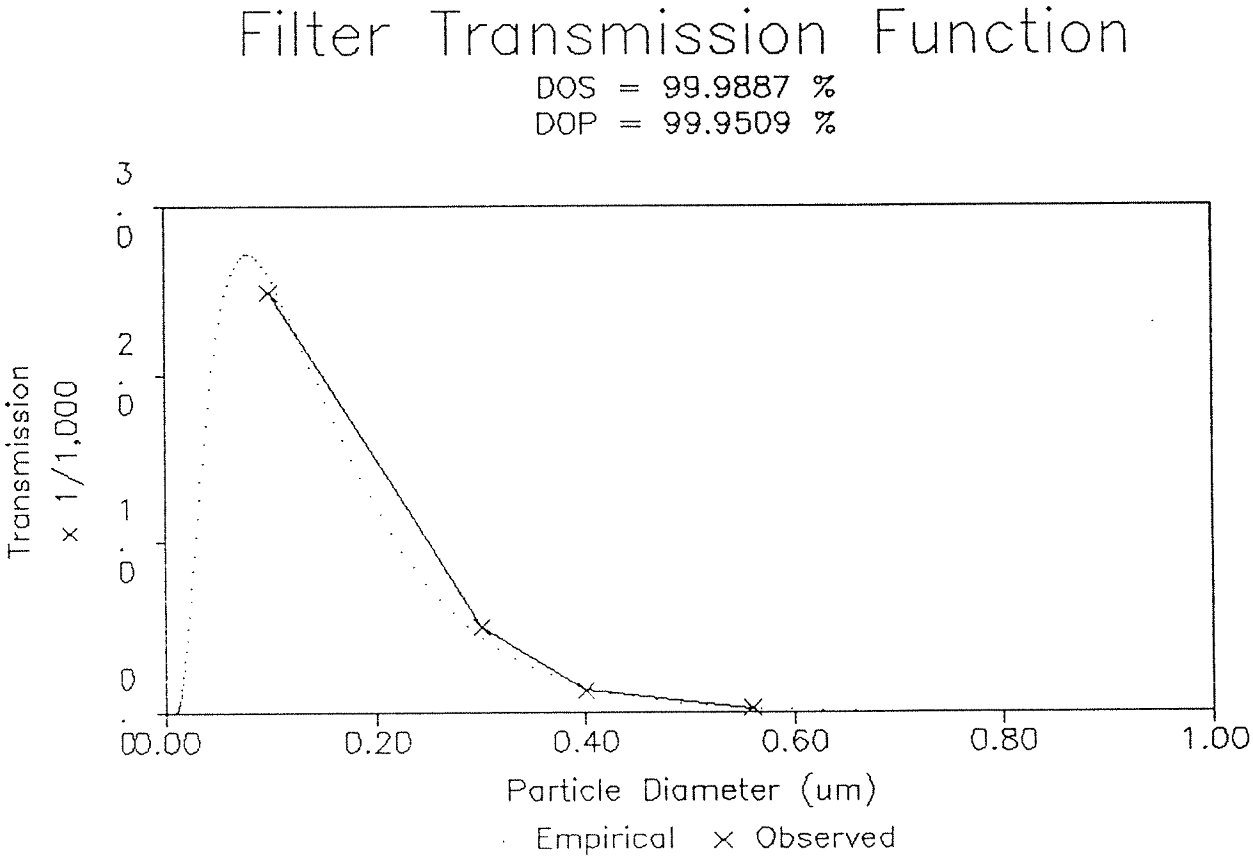

Filter Transmission Function
DOS = 99.9887 %
DOP = 99.9509 %
Transmission
x 1/1,000
3.0
2.0
1.0
0
00.00
0.20
0.40
0.60
0.80
1.00
Particle Diameter (um)
· Empirical
× Observed

Figure 7

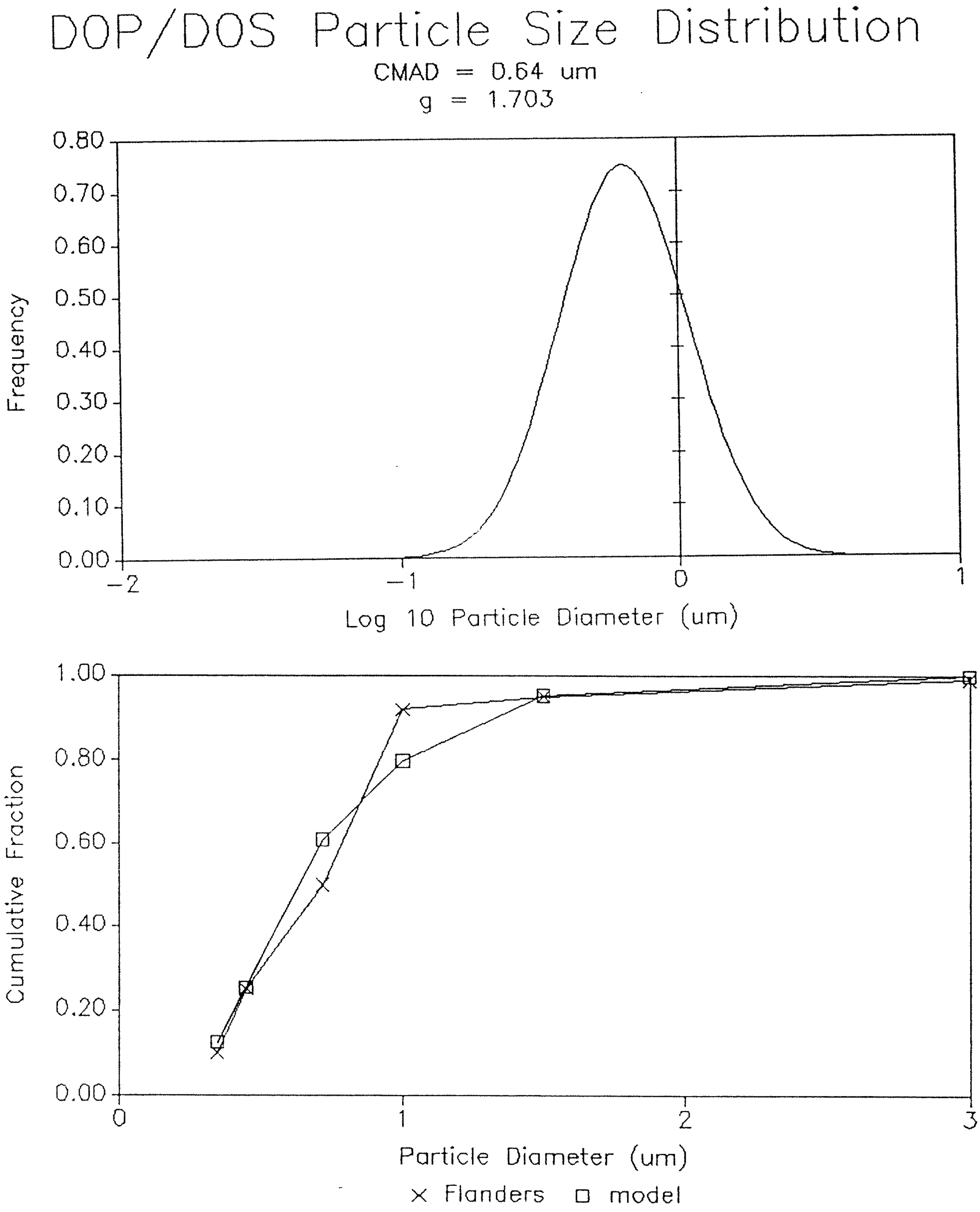
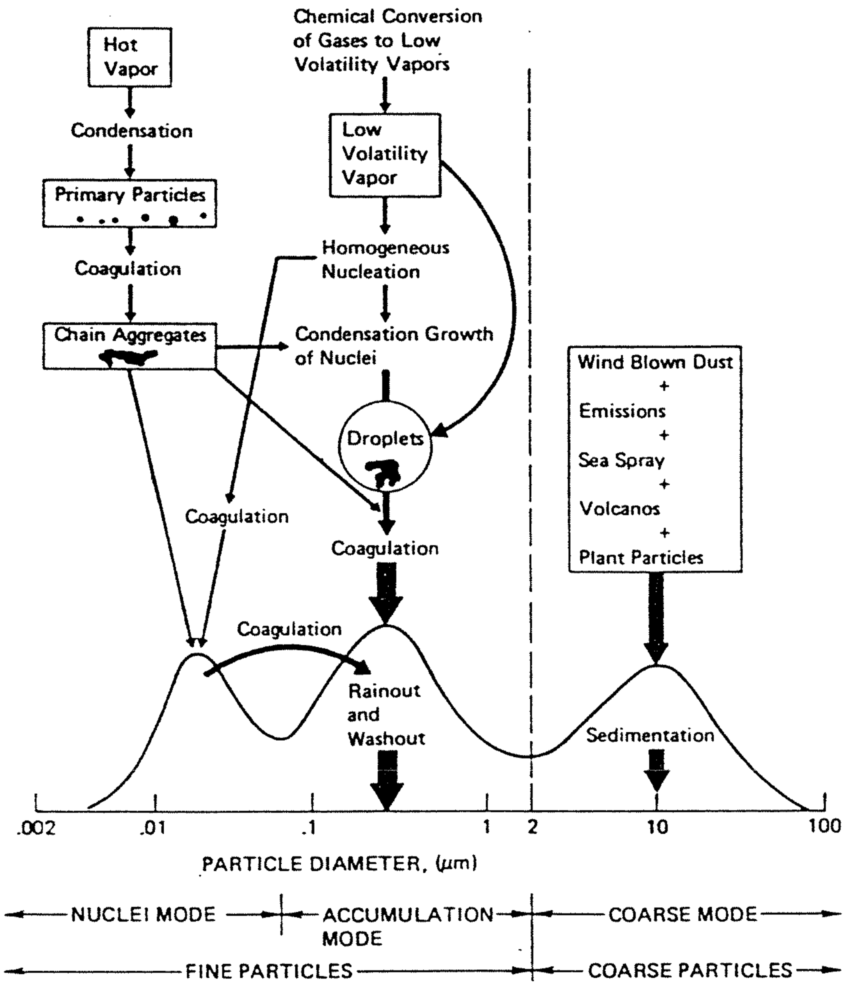

DOP/DOS Particle Size Distribution
CMAD = 0.64 um
g = 1.703
Frequency
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
−2
−1
0
1
Log 10 Particle Diameter (um)
Cumulative Fraction
1.00
0.80
0.60
0.40
0.20
0.00
0
1
2
3
Particle Diameter (um)
× Flanders □ model

Figure 8



SOURCE: Whitby and Cantrell (1976) Fine particles. *In* International Conference on Environmental Sensing and Assessment. September 14-19, 1975, Las Vegas, Nevada. Institute of Electrical and Electronic Engineers.

FIGURE 1.2 Idealized schematic of the distribution of particle surface area of an atmospheric aerosol. (The principal modes, sources of mass, and formation and removal processes are indicated.)

Figure 9

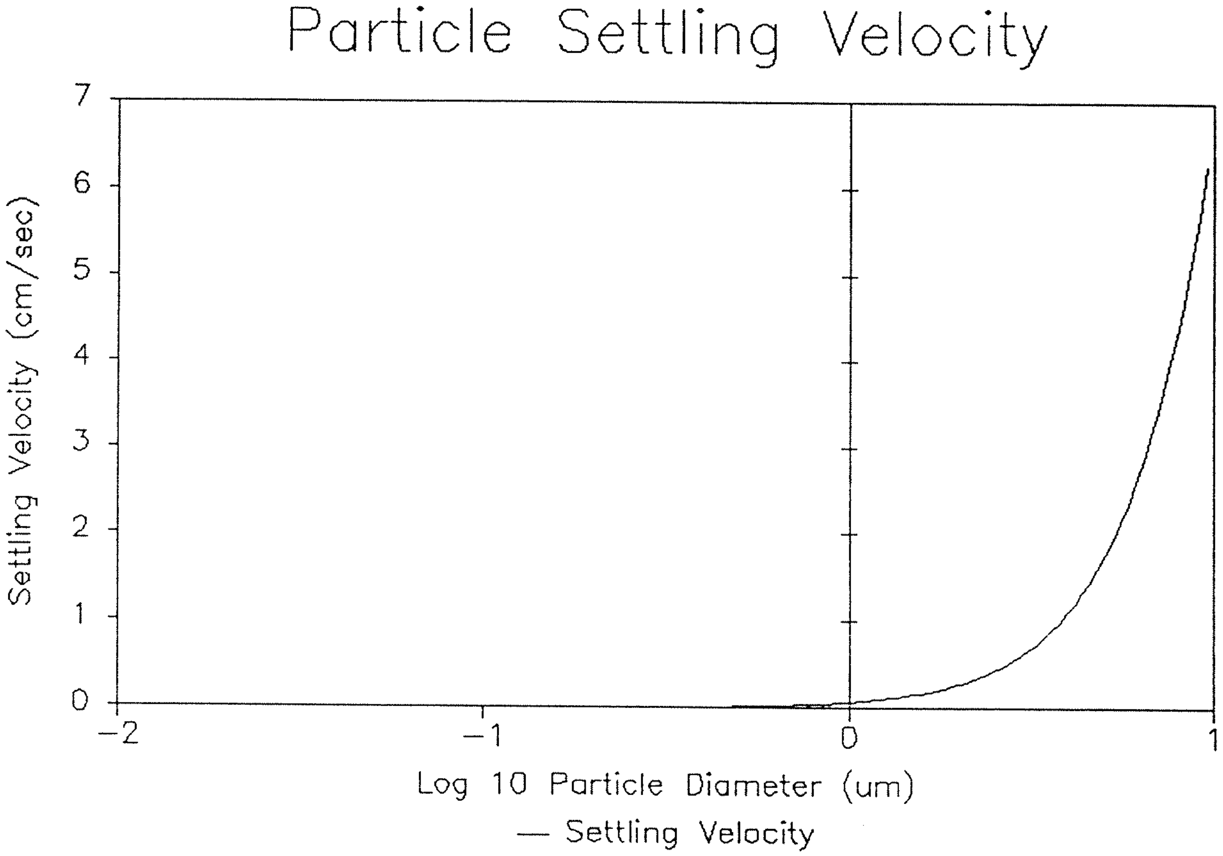

Particle Settling Velocity
Settling Velocity (cm/sec)
7
6
5
4
3
2
1
0
−2
−1
0
1
Log 10 Particle Diameter (um)
— Settling Velocity

Figure 10

The particle size distribution (frequency) and the activity distribution for the oxide smoke, condensed vapor, and molten spatter are shown in Figure 11. (These are shown in log–log plots because of the large range required to show the distributions.)

The ratio of the suspended activity to the released activity is 0.0374. Allowing a settling time of 120 seconds before the remaining aerosol is entrained in the exhaust flow, a trimodel distribution with CMADs of 0.2, 4.6, and 100 μm and g = 2.423, and with relative magnitude of 1.0, 2.1×10^{-6} and 9.33×10^{-11} gives a suspended airborne activity ratio of 0.03735 This remaining distribution was then used to represent the aerosol as it passed through the filter.

The combined frequency and activity distributions of this aerosol are shown in the upper plot of Figure 12. The lower plot compares the initial (released) distribution, the distribution after settling (exhausted), and the distribution discharged from the filter.

The fraction of the activity that passes through the filter gives the total release. Based on the estimated radioactivity in the material cut during torching, the release is calculated to be 6.2 μCi.

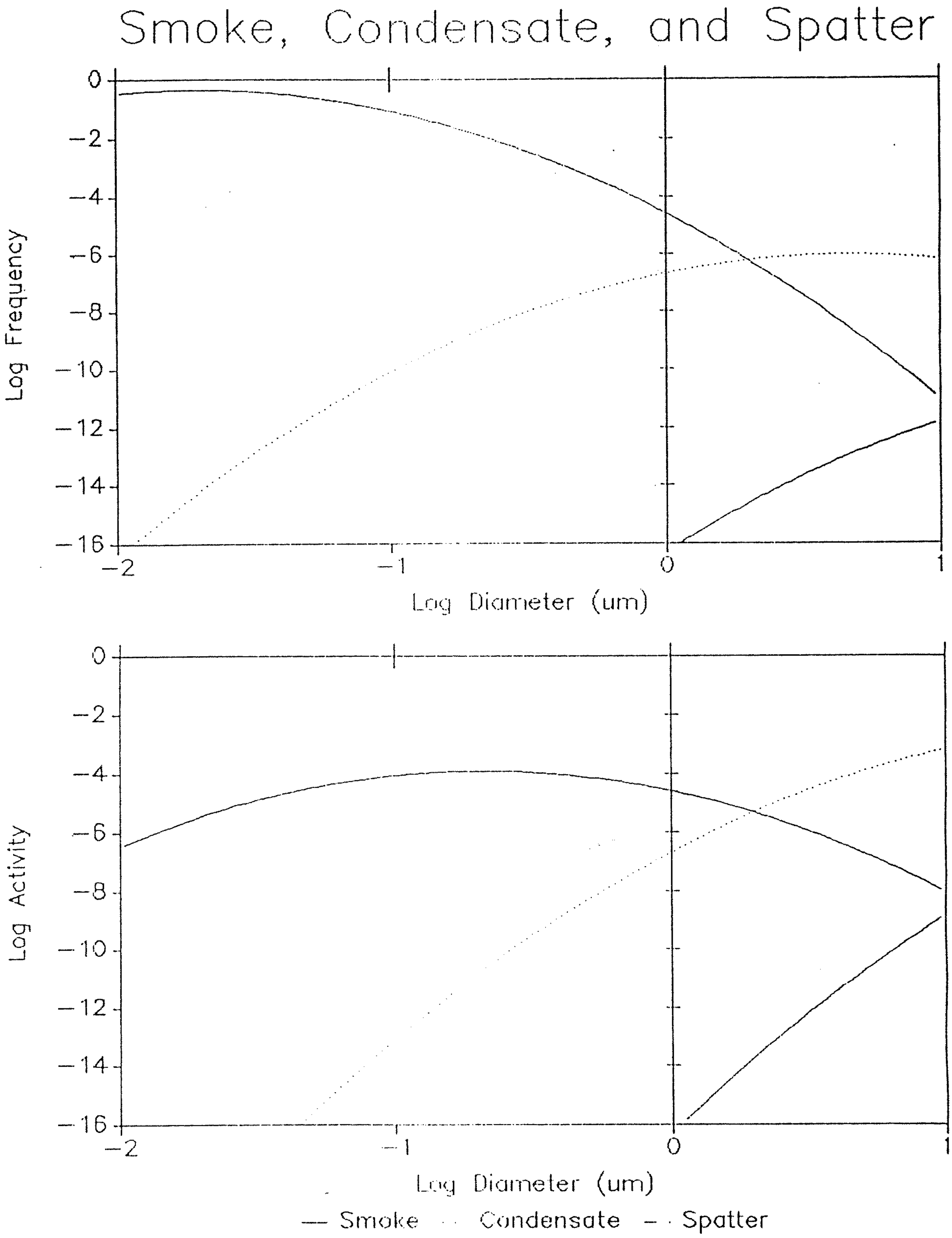

Smoke, Condensate, and Spatter
Log Frequency
0
−2
−4
−6
−8
−10
−12
−14
−16
−2
−1
0
1
Log Diameter (um)
Log Activity
0
−2
−4
−6
−8
−10
−12
−14
−16
−2
−1
0
1
Log Diameter (um)
— Smoke
·· Condensate
– · Spatter

Figure 11

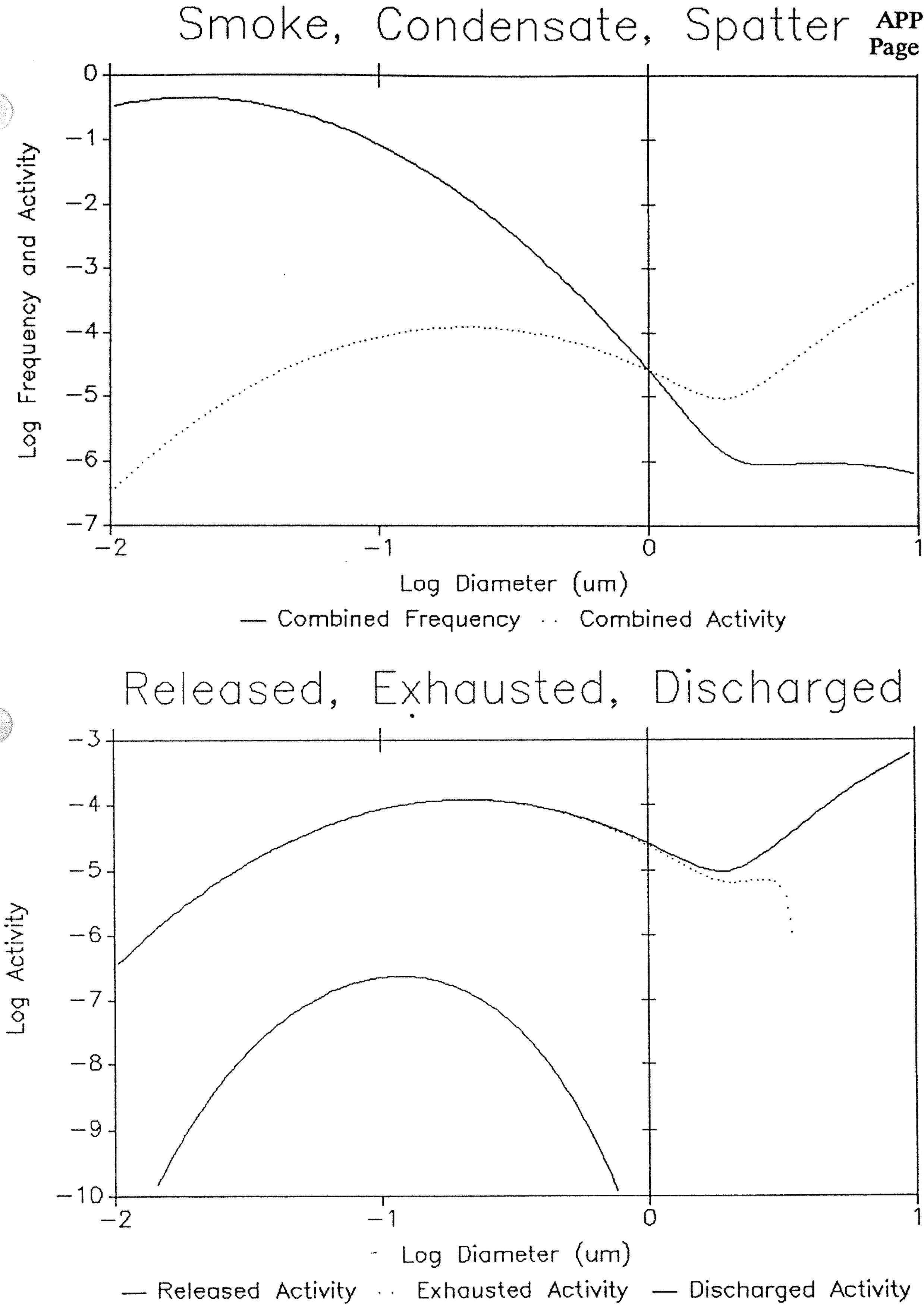

Smoke, Condensate, Spatter
Log Frequency and Activity
0
−1
−2
−3
−4
−5
−6
−7
−2
−1
0
1
Log Diameter (um)
— Combined Frequency
· · Combined Activity
Released, Exhausted, Discharged
Log Activity
−3
−4
−5
−6
−7
−8
−9
−10
−2
−1
0
1
Log Diameter (um)
— Released Activity
· · Exhausted Activity
— Discharged Activity

Figure 12

Attachment 2
"Evaluation of Airborne Radioactive Effluent - RMDF"

Internal Letter **Rockwell International**

Date: 25 March 1992
No:

TO: (Name, Organization, Internal Address)
File
641, 055-T100

FROM: (Name, Organization, Internal Address, Phone)
R. J. Tuttle
641, 055-T100

180-6135

Subject: Evaluation of Airborne Radioactive Effluent — RMDF

Ref: (1) 10CFR61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities"

(2) "DEPOSITION: Software to Calculate Particle Penetration Through Aerosol Transport Lines," NUREG/GR-0006 (draft), N. K. Anand and A. R. McFarland, September 1991

(3) IL, R. J. Tuttle to File, "Evaluation of Airborne Radioactive Effluent — T059," dated 3 March 1992

Summary

Reference (1), NESHAPs for radionuclides, establishes a limit on radionuclide emissions from DOE facilities, to not exceed an effective dose equivalent to a member of the public, of 10 mrem/yr. To determine compliance with this requirement, radionuclide emissions must be measured, in a manner described by the regulations in detail, for each release point that has a potential for exceeding 1% of the standard, 0.1 mrem/yr. Periodic confirmatory measurements must be made at potential release points that do not require the specified measuring. In evaluating the potential for radionuclide emissions, it must be assumed that any pollution control equipment (HEPA filters, in our case) do not exist, but operations are otherwise normal.

Operations at the RMDF which might produce airborne radioactivity that could be discharged from the exhaust stack include decontamination of equipment and material, evaporation of radioactive liquid (water) waste, packaging of evaporator sludge, and size reduction of contaminated equipment. These operations take place in the Decon and Packaging Rooms of Building T021. The hi-bay and vaults of Building T022 are also ventilated by the same exhaust system but only minor amounts of surface contamination are present to produce airborne radioactivity. These areas are rarely disturbed, thus there is little potential for airborne activity.

Room air is collected by ceiling exhaust registers and ducted to banks of pre- and HEPA filters. The HEPA filters are pre-certified at a DOE filter-testing laboratory, and the system is tested by use of a polydisperse DOS aerosol after filter installation. The air is then exhausted by way of 130-ft exhaust stack. Exhaust air is sampled in the stack by a single nominally isokinetic nozzle and transported to a continuous air monitor, where particulate material is trapped by a membrane filter. The efficiency of this sampling system for the model particle distribution was calculated by use of the NRC computer program DEPOSITION [Reference (2)]. Minor losses were found to be distributed throughout the system, and the overall efficiency was calculated to be 98.31%.

Activity on the sample filter is measured for gross alpha and gross beta in a thin–window gas–flow proportional counter, weekly, after a few days delay to permit decay of short–lived natural radioactivity. The annual collection of sample filters is sent, as a composite, to an outside laboratory for detailed analysis. The results of this analysis are used to estimate offsite doses, by use of AIRDOS–PC.

The activity discharged by the exhaust stack is calculated from the sample results by multiplying by the ratio of air volume exhausted to air volume sampled. These values, for 1990, (results for 1991 are not yet available) are shown below:

Co–60	0.49 µCi
Sr–90	0.029 µCi
Cs–137	0.33 µCi
(Po–210	0.04 µCi daughter of natural Pb–210)
U–234	0.0000159 µCi
Pu–238	0.0000114 µCi
Pu–239/240	0.00251 µCi
Am–241	0.000000000105 µCi

In the dose evaluation, Pu–238 (and –240) were combined with Pu–239, and the Am–241 was omitted. The EPA dose–assessment program, AIRDOS–PC, was used to calculate the hypothetical dose due to this release at the distance of the nearest residence. The compliance report from this calculation is shown as Attachment 1. [Since a representative wind–set (BUR1051.WND) has been used, the maximum dose at this distance, irrespective of direction, has been used. The dose calculated with this wind–set for the actual residence location (direction and distance) is roughly a factor of 3 lower.] This dose is 0.00000118 mrem/year, for comparison with the NESHAP standard of 10 mrem/year.

In Reference (3), a detailed modeling of HEPA filtration efficiency and particle size distributions was described, as applied to airborne releases during torch–cutting stainless steel at T059. The same techniques were used in this study. A particle size distribution was developed that was sufficiently fine–grained that little loss of particles by settling occurred. This was chosen because the work is done in rooms with relatively still air and the exhaust registers are mostly a considerable distance away in the ceiling. This particle distribution was then passed through the filter, mathematically, to calculate the filter efficiency for this airborne activity. This was found to be 99.7845%. (See the supplement for a discussion of "filter efficiency.")

This efficiency (or rather the transmission, = 0.2155%) was used to calculate, from the analysis of the composite stack samples, what would have been released if the HEPA filters were not present, as required by 10 CFR 61.93(b)(4)(ii). This is:

Co–60	230	µCi
Sr–90	14	µCi
Cs–137	150	µCi
U–234	0.0074	µCi
Pu–239	1.2	µCi.

The unfiltered release was calculated (by use of AIRDOS–PC with identical parameters as for the filtered release) to produce a dose of 0.0005 mrem/year at the distance of the nearest residence. This should be compared with the 1% limit requiring prescribed monitoring methods, of 0.1 mrem/year. The compliance report for this calculation is shown as Attachment 2.

The releases required to produce a calculated dose of 0.1 mrem/year at the distance of the nearest residence were also calculated. (The compliance report for this calculation is shown as Attachment 3.) These were found to be:

Co–60	41,000	µCi
Sr–90	2,500	µCi
Cs–137	28,000	µCi
U–234	1.3	µCi
Pu–239	210	µCi.

Doses calculated for each radionuclide by AIRDOS–PC at 300 meters (the nearest distance accommodated by AIRDOS–PC) were used to estimate the concentration in the area immediately surrounding the RMDF. Dose conversion factors for inhalation were taken from DOE/EH–0071 to convert doses to activity inhaled. The standard man breathing rate from ICRP23 was used to derive concentrations. These were incorrectly estimated for the radionuclides with significant gamma and long–range beta doses because of the ground dose contribution, and so a derived χ/Q was used to calculate concentration from releases. The equivalent gross alpha and gross beta annual–average concentrations were calculated for comparison with results from ambient air samples. The calculated concentrations of a gross alpha and gross beta activity associated with a nearest neighbor dose of 0.1 mrem/year that would exist at 300 meters are:

Gross alpha	1.7×10^{-15} µCi/ml
Gross beta	5.9×10^{-13} µCi/ml.

The average concentrations measured by the SSFL ambient air samplers for 1990 are:

Gross alpha	2.8×10^{-15} µCi/ml
Gross beta	0.3×10^{-13} µCi/ml.

These values are considered to represent naturally occurring airborne radioactivity since similar values are found for all sampler locations. While the gross alpha result is well above the value for a dose of 0.1 mrem/year, and this would mask large releases from RMDF, the beta value is far below this value, and would clearly indicate any releases above this level. The locations of the ambient air samples at SSFL are shown on the map, Attachment 5. Plots of daily values of the weekly average exhaust and ambient air concentrations (gross alpha and gross beta) for 1990 are shown as Attachment 6. (On the scale used, 10^{-3} corresponds to 10^{-15} µCi/ml, and the top of the graph 10^{-1} corresponds to 10^{-13} µCi/ml.) There is clearly no excursion of ambient air beta activity above the level that would lead to an annual average exceeding even 1% of the dose standard.

Annual average ambient and exhaust concentrations presented in Attachment 7 show that the exhaust concentration has been far below the levels associated with a dose of 0.1 mrem/year throughout the stack monitoring record. Thus, it is concluded that normal operation of the RMDF does not lead to releases of airborne radioactivity that would require the level of monitoring specified by 10 CFR 61.93(b)(4)(ii).

RJ Tuttle

R. J. Tuttle
Radiation Protection and
Health Physics Services

D641-0025/sls

Attachments as noted

cc:	P. D. Rutherford PDR	T100
	R. D. Meyer	T038
	P. H. Horton	T020
	G. G. Gaylord	T038
	I. Bassat	T034
	RP&HPS	T100

Attachment 1

```
                     CLEAN AIR ACT COMPLIANCE REPORT      5/29/92  4:53 PM


Facility: RMDF
 Address: SSFL                             City: Simi Hills           State: CA
Comments: for demonstrating doses below 1% requirement.
    Year: 1990
                          Dose Equivalent Rates to Nearby
                       ________Individuals (mrem/year)________
        Effective     ¦¦                                      ¦¦
     Dose Equivalent  ¦¦              1.18E-06                ¦¦
                      ¦¦______________________________________¦¦
      Highest Organ   ¦¦                                      ¦¦
        Dose is to    ¦¦              2.74E-06                ¦¦
      ENDOSTEUM       ¦¦______________________________________¦¦

  -----------------------EMISSION INFORMATION-----------------------

:--------:-----:----:--------:
¦ Radio- ¦     ¦    ¦  Stack ¦
¦ nuclide¦Class¦Amad¦  RMDF  ¦
¦        ¦     ¦    ¦ (Ci/y) ¦
¦--------¦-----¦----¦--------¦
¦ CO-60  ¦  Y  ¦ 1.0¦ 4.9E-07¦
¦ SR-90  ¦  D  ¦ 1.0¦ 2.9E-08¦
¦ CS-137 ¦  D  ¦ 1.0¦ 3.3E-07¦
¦ U-234  ¦  Y  ¦ 1.0¦ 1.6E-11¦
¦ PU-239 ¦  Y  ¦ 1.0¦ 2.5E-09¦
¦BA-137M ¦  D  ¦ 1.0¦ 3.3E-07¦
¦BA-137M ¦  D  ¦ 1.0¦ 0.0E-01¦
¦________¦_____¦____¦________¦
   Stack Height (m) ¦   39.60¦
 Stack Diameter (m) ¦    0.91¦
     Momentum (m/s) ¦    13.6¦
                    ¦________¦

  -------------------------SITE INFORMATION-------------------------

                     :-----------------:                  :---------------:
       Wind Data     ¦   BUR1051.WND   ¦  Temperature (C) ¦      17       ¦
     Food Source     ¦      LOCAL      ¦  Rainfall (cm/y) ¦      44       ¦
     Distance to     ¦      2065       ¦   Lid Height (m) ¦     366       ¦
  Individuals (m)    :_________________:                  :_______________:


    *NOTE:  The results of this computer model are dose estimates.
            They are only to be used for the purpose of determining
            compliance and reporting per 40 CFR 61.93 and 40 CFR 61.94.
```

Attachment 2

```
                    CLEAN AIR ACT COMPLIANCE REPORT      5/29/92  4:51 PM


Facility: RMDF
 Address: SSFL                           City: Simi Hills           State: CA
Comments: for demonstrating doses below 1% requirement.
    Year: 1990
                      Dose Equivalent Rates to Nearby
                   _________Individuals (mrem/year)_________
     Effective     ¦¦                                      ¦¦
  Dose Equivalent  ¦¦                0.0005                ¦¦
                   ¦¦______________________________________¦¦
    Highest Organ  ¦¦                                      ¦¦
     Dose is to    ¦¦                0.0013                ¦¦
    ENDOSTEUM      ¦¦______________________________________¦¦

 -----------------------EMISSION INFORMATION------------------------

:--------:-----:----:---------:
¦ Radio- ¦     ¦    ¦  Stack  ¦
¦ nuclide¦Class¦Amad¦  RMDF   ¦
¦        ¦     ¦    ¦ (Ci/y)  ¦
¦--------¦-----¦----¦---------¦
¦ CO-60  ¦  Y  ¦ 1.0¦ 2.3E-04¦
¦ SR-90  ¦  D  ¦ 1.0¦ 1.4E-05¦
¦ CS-137 ¦  D  ¦ 1.0¦ 1.5E-04¦
¦ U-234  ¦  Y  ¦ 1.0¦ 7.4E-09¦
¦ PU-239 ¦  Y  ¦ 1.0¦ 1.2E-06¦
¦BA-137M ¦  D  ¦ 1.0¦ 1.5E-04¦
¦BA-137M ¦  D  ¦ 1.0¦ 0.0E-01¦
¦________¦_____¦____¦________¦
  Stack Height (m) ¦   39.60¦
Stack Diameter (m) ¦    0.91¦
    Momentum (m/s) ¦    13.6¦
                   ¦________¦

 -------------------------SITE INFORMATION-------------------------

                 :-----------------:              :---------------:
     Wind Data   ¦   BUR1051.WND   ¦  Temperature (C) ¦      17       ¦
   Food Source   ¦     LOCAL       ¦  Rainfall (cm/y) ¦      44       ¦
   Distance to   ¦     2065        ¦   Lid Height (m) ¦     366       ¦
Individuals (m)  :_________________:              :_______________:

    *NOTE:  The results of this computer model are dose estimates.
            They are only to be used for the purpose of determining
            compliance and reporting per 40 CFR 61.93 and 40 CFR 61.94.
```

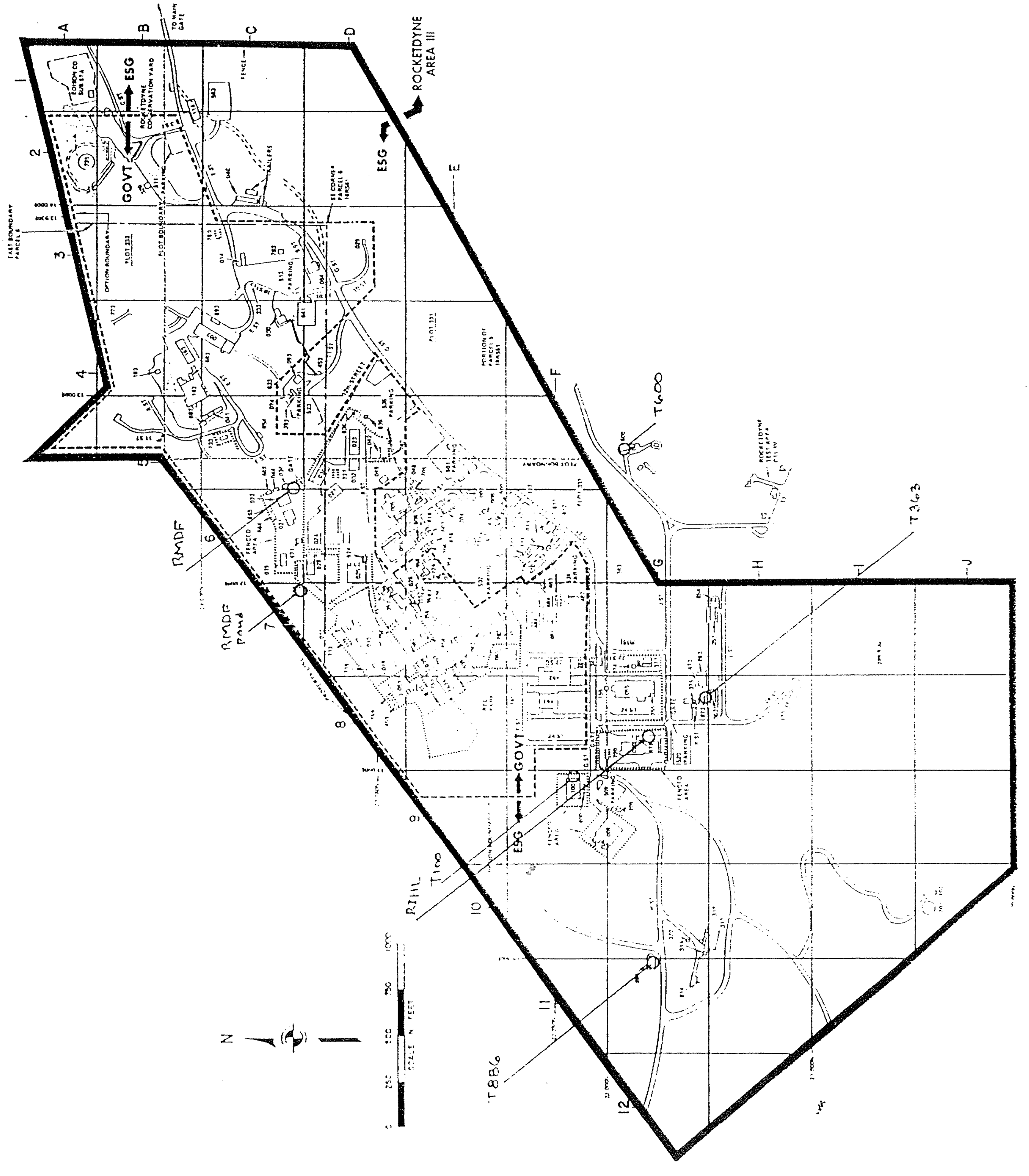
Attachment 3

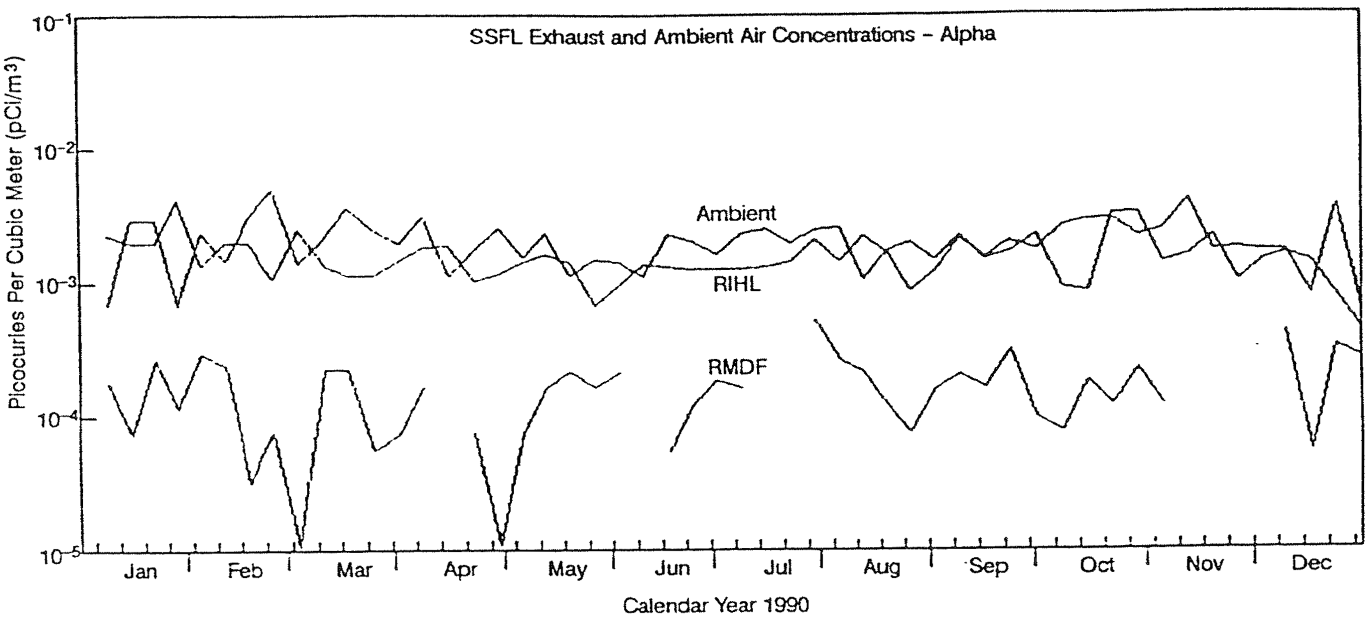
```
                    CLEAN AIR ACT COMPLIANCE REPORT      5/29/92  4:48 PM


Facility: RMDF
 Address: SSFL                         City: Simi Hills          State: CA
Comments: for demonstrating doses below 1% requirement.
    Year: 1990
                        Dose Equivalent Rates to Nearby
                       ________Individuals (mrem/year)________
     Effective       ||                                      ||
  Dose Equivalent    ||                0.1000                ||
                     ||______________________________________||
   Highest Organ     ||                                      ||
    Dose is to       ||                0.2300                ||
   ENDOSTEUM         ||______________________________________||

  -----------------------EMISSION INFORMATION-----------------------

:---------:-----:----:---------:
| Radio-  |     |    |  Stack  |
| nuclide |Class|Amad|  RMDF   |
|         |     |    |  (Ci/y) |
|---------|-----|----|---------|
| CO-60   |  Y  | 1.0| 4.1E-02|
| SR-90   |  D  | 1.0| 2.5E-03|
| CS-137  |  D  | 1.0| 2.8E-02|
| U-234   |  Y  | 1.0| 1.3E-06|
| PU-239  |  Y  | 1.0| 2.1E-04|
|BA-137M  |  D  | 1.0| 2.8E-02|
|BA-137M  |  D  | 1.0| 0.0E-01|
|_________|_____|____|_________|
   Stack Height (m) |   39.60|
 Stack Diameter (m) |    0.91|
     Momentum (m/s) |    13.6|
                    |________|

  -------------------------SITE INFORMATION-------------------------

                      :------------------:             :---------------:
       Wind Data |   BUR1051.WND      |  Temperature (C) |      17       |
     Food Source |      LOCAL         |  Rainfall (cm/y) |      44       |
     Distance to |      2065          |   Lid Height (m) |     366       |
  Individuals (m) :__________________:                  :_______________:

    *NOTE:  The results of this computer model are dose estimates.
            They are only to be used for the purpose of determining
            compliance and reporting per 40 CFR 61.93 and 40 CFR 61.94.
```

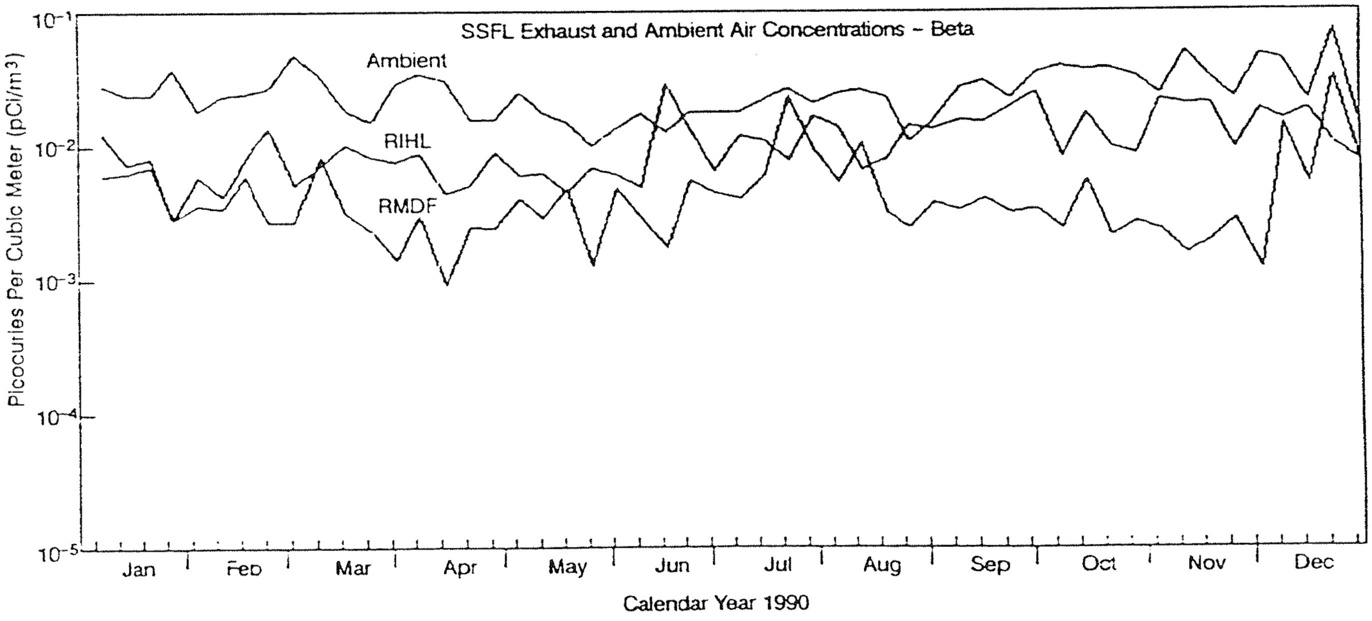
Attachment 4

```
                     CLEAN AIR ACT COMPLIANCE REPORT      5/29/92  4:46 PM


 Facility: RMDF
  Address: SSFL                            City: Simi Hills            State: CA
 Comments: for demonstrating doses below 1% requirement.
     Year: 1990
                           Dose Equivalent Rates to Nearby
                        _______Individuals (mrem/year)_______
        Effective      ¦¦                                   ¦¦
     Dose Equivalent   ¦¦              0.4600               ¦¦
                       ¦¦___________________________________¦¦
      Highest Organ    ¦¦                                   ¦¦
       Dose is to      ¦¦                1.0                ¦¦
      ENDOSTEUM        ¦¦___________________________________¦¦

  ------------------------EMISSION INFORMATION------------------------

 :--------:-----:----:--------:
 ¦ Radio- ¦     ¦    ¦  Stack ¦
 ¦ nuclide¦Class¦Amad¦  RMDF  ¦
 ¦        ¦     ¦    ¦ (Ci/y) ¦
 ¦________¦_____¦____¦________¦
 ¦ CO-60  ¦  Y  ¦ 1.0¦ 4.1E-02¦
 ¦ SR-90  ¦  D  ¦ 1.0¦ 2.5E-03¦
 ¦ CS-137 ¦  D  ¦ 1.0¦ 2.8E-02¦
 ¦ U-234  ¦  Y  ¦ 1.0¦ 1.3E-06¦
 ¦ PU-239 ¦  Y  ¦ 1.0¦ 2.1E-04¦
 ¦BA-137M ¦  D  ¦ 1.0¦ 2.8E-02¦
 ¦BA-137M ¦  D  ¦ 1.0¦ 0.0E-01¦
 ¦________¦_____¦____¦________¦
    Stack Height (m) ¦   39.60¦
  Stack Diameter (m) ¦    0.91¦
      Momentum (m/s) ¦    13.6¦
                     ¦________¦

  -------------------------SITE INFORMATION--------------------------

                       :------------------:                  :---------------:
        Wind Data      ¦   BUR1051.WND    ¦  Temperature (C) ¦       17      ¦
      Food Source      ¦      LOCAL       ¦  Rainfall (cm/y) ¦       44      ¦
      Distance to      ¦       300        ¦   Lid Height (m) ¦      366      ¦
   Individuals (m)     :__________________:                  :_______________:


    *NOTE:  The results of this computer model are dose estimates.
            They are only to be used for the purpose of determining
            compliance and reporting per 40 CFR 61.93 and 40 CFR 61.94.
```

Attachment 5





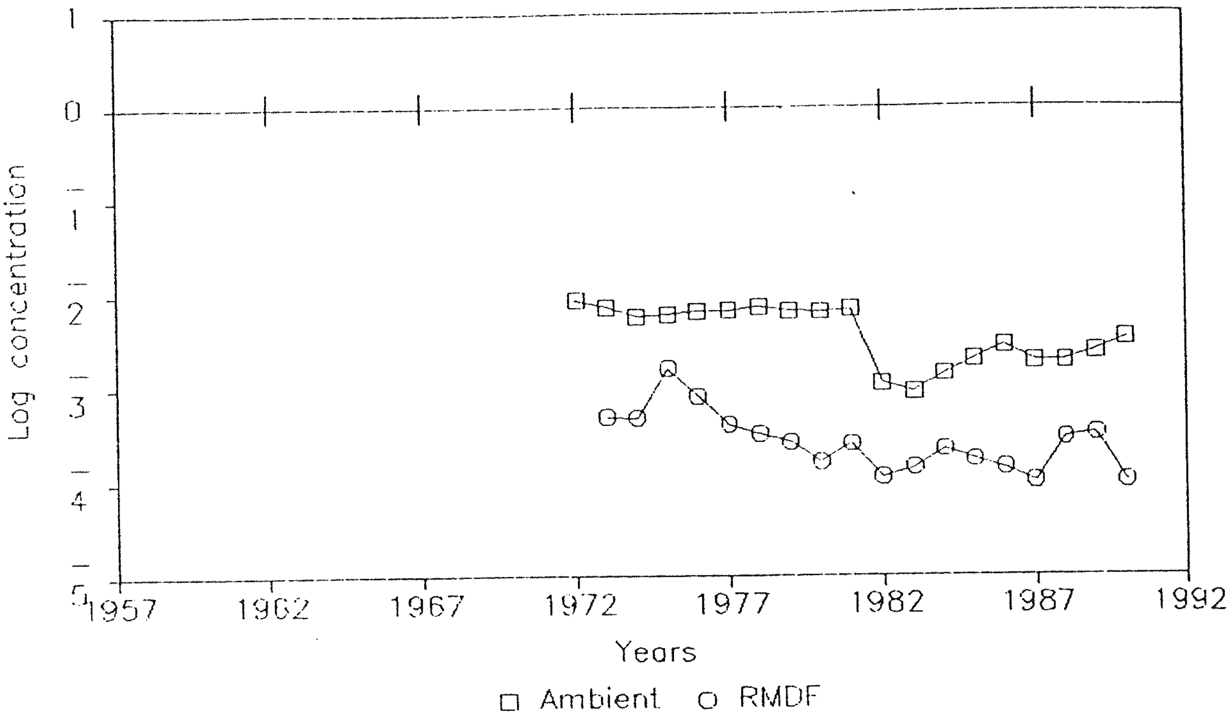


5857-7

Figure 5–2. Comparison of Filtered Exhaust and Ambient Air Radioactivity

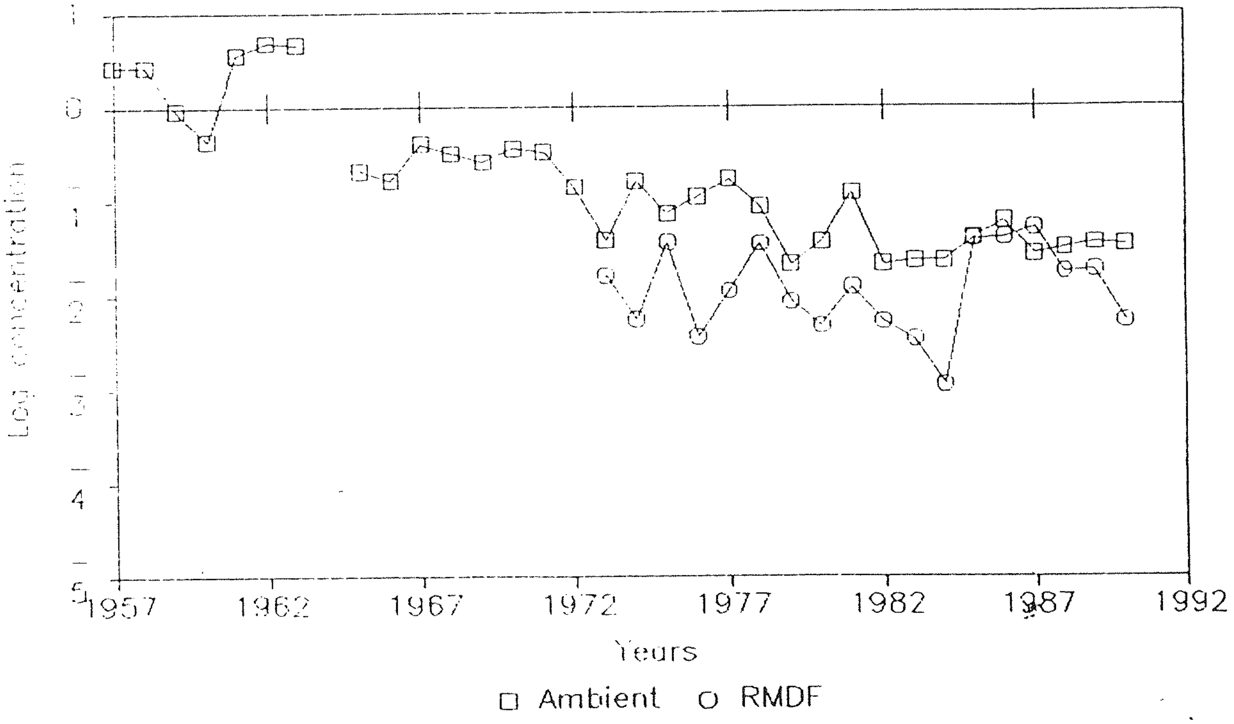
Attachment 7

Ambient and Exhaust Air Radioactivity
Alpha
RMDF



3/19/92

Ambient and Exhaust Air Radioactivity
Beta
RMDF



3/19/92

SUPPLEMENT

HEPA FILTER EFFICIENCY

Generally, when HEPA filter efficiency is discussed, the efficiency measured by a DOP or DOS aerosol, which may be monodisperse (single size) or polydisperse (broad range of sizes) is used. This efficiency is based on a measurement which counts particles, independently of size, by use of a forward-scattered light photometer. Efficiencies typically range from 99.7% to 99.999%. However, in calculating release of radioactive material, the transmission of mass is what must be estimated, and this is generally greater than would be estimated from the test results.

There are three specific differences which affect these results. The DOP/DOS aerosol is generally much coarser-grained than a reasonable airborne material, since it is generated much more violently and has little opportunity to settle, being immediately entrained in the exhaust airstream. The DOP/DOS material has a density slightly less than 1 g/cm^3, while most radioactive particulates will have densities in the range of 2 to 12 g/cm^3. The measure of "efficiency" (or transmission) is based on particle count in the test, but on mass (or activity) in the practical application.

Comparison of the generated particle size distribution for DOP/DOS, and the distribution transmitted through a HEPA filter is shown in the upper graph of Figure S1. A similar comparison of the activity distribution before and after filtration of a modeled airborne radioactive material is shown in the lower graph. The differences, which result in an "efficiency" for the DOP/DOS aerosol of 99.9884% and an "efficiency" for the radioactive material of 99.7845%, are clear.

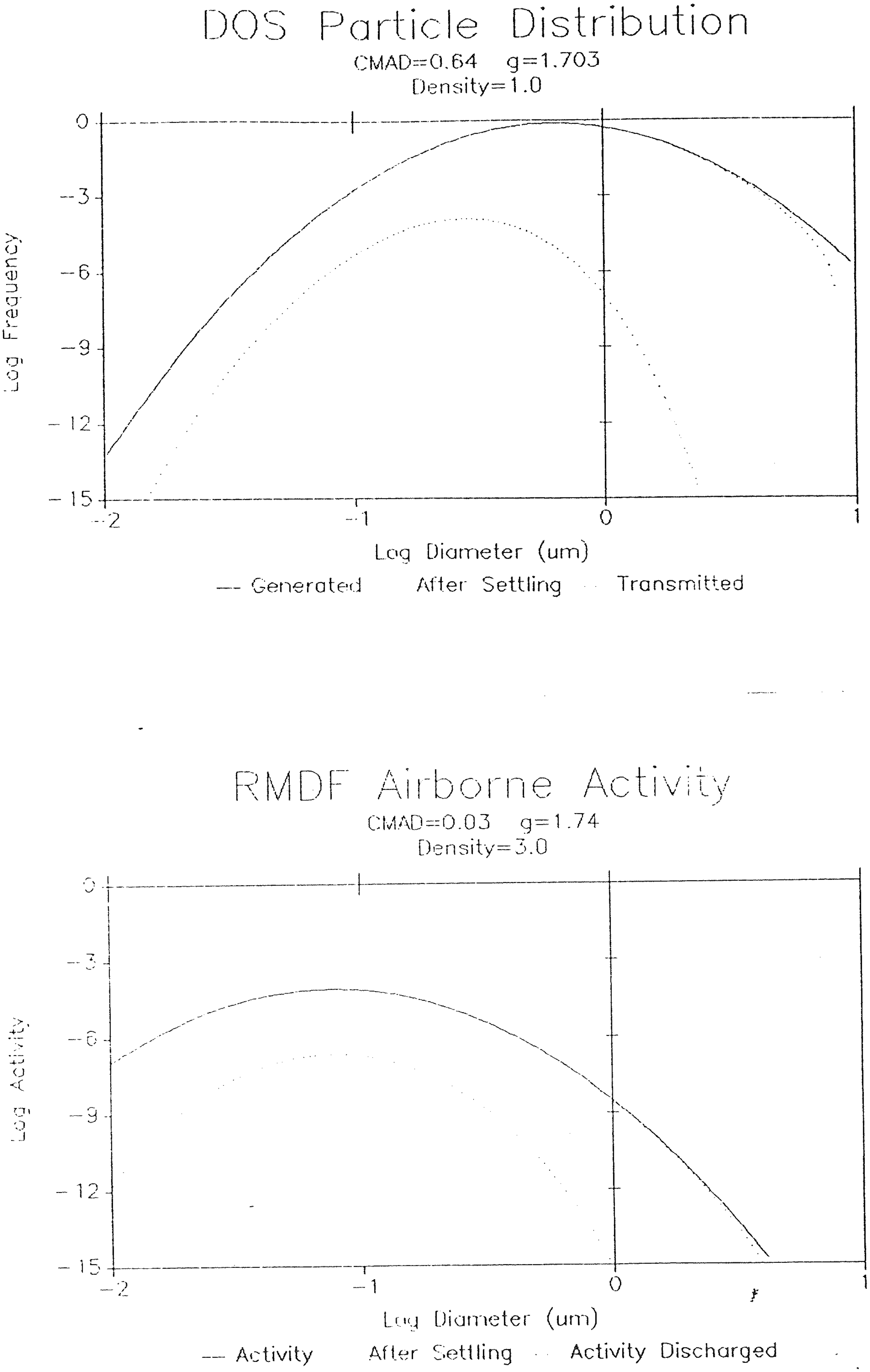

DOS Particle Distribution
CMAD=0.64 g=1.703
Density=1.0
Log Frequency
0
-3
-6
-9
-12
-15
-2
-1
0
1
Log Diameter (um)
— Generated
After Settling
Transmitted
RMDF Airborne Activity
CMAD=0.03 g=1.74
Density=3.0
Log Activity
0
-3
-6
-9
-12
-15
-2
-1
0
1
Log Diameter (um)
— Activity
After Settling
Activity Discharged

Figure S1

Attachment 3

"Conservative Estimates of Offsite Exposures Due to Fugitive Sources of Airborne Radioactive Effluent at SSFL"

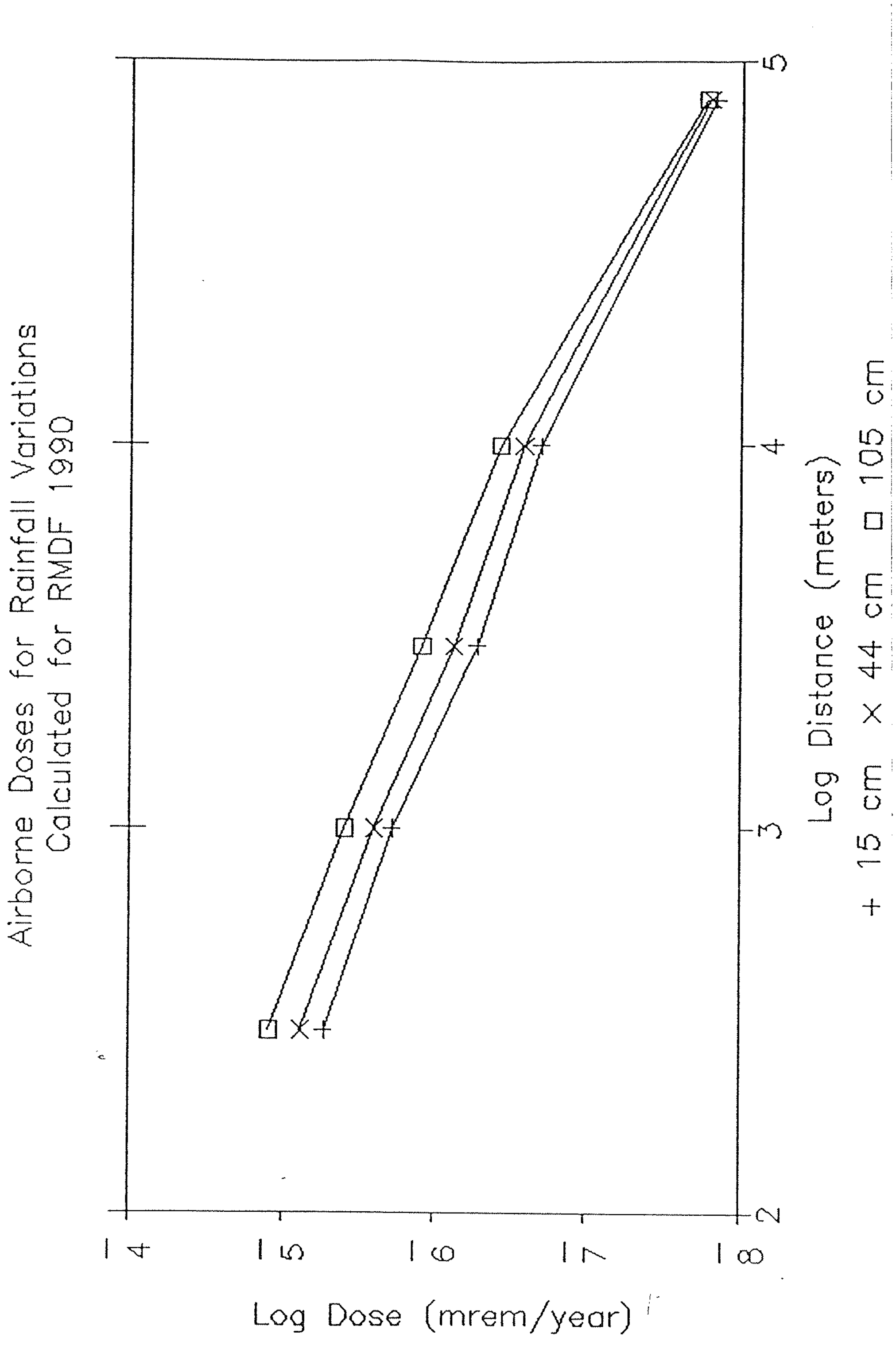

Airborne Doses for Rainfall Variations
Calculated for RMDF 1990
Log Dose (mrem/year)
4
5
6
7
8
Log Distance (meters)
2
3
4
5
+ 15 cm × 44 cm □ 105 cm

Figure 3

Table 1. Calculated Maximum Doses for Various Wind-Sets

.WND variations:

	300		1000		3000		10000		80000
SSFLNRC	7.54E-06	MWH0486	3.00E-06	MWH0486	1.10E-06	MWH0486	3.30E-07	MWH0486	1.90E-08
MWH0486	5.79E-06	SUU0316	2.70E-06	SUU0316	9.20E-07	TYS1328	2.80E-07	SUU0316	1.60E-08
BUR1051	5.52E-06	BUR1051	2.60E-06	TYS1328	9.20E-07	SUU0316	2.60E-07	SSFLNRC	1.60E-08
TYS1328	4.71E-06	SSFLNRC	2.50E-06	ALB0523	8.60E-07	SSFLNRC	2.60E-07	TYS1328	1.60E-08
SUU0316	4.14E-06	TYS1328	2.50E-06	HTS0019	8.00E-07	ALB0523	2.50E-07	DEN0618	1.50E-08
HTS0019	3.61E-06	ALB0523	2.40E-06	BUR1051	8.00E-07	HTS0019	2.40E-07	UCC1026	1.50E-08
ALB0523	3.40E-06	HTS0019	2.10E-06	UCC1026	7.80E-07	UCC1026	2.30E-07	BUR1051	1.40E-08
ABQ0282	3.38E-06	OAK0319	2.10E-06	DEN0618	7.50E-07	DEN0618	2.20E-07	ALB0523	1.40E-08
OAK0319	3.11E-06	BDL1262	2.00E-06	ERI0610	7.50E-07	BUR1051	2.20E-07	ERI0610	1.40E-08
PIT1440	2.86E-06	UCC1026	1.90E-06	SSFLNRC	7.30E-07	ERI0610	2.10E-07	MDW0675	1.30E-08
DEN0618	2.72E-06	ERI0610	1.90E-06	BDL1262	7.10E-07	BDL1262	1.90E-07	HTS0019	1.30E-08
BDL1262	2.60E-06	DEN0618	1.80E-06	CMH0243	7.00E-07	ABQ0282	1.90E-07	BDL1262	1.20E-08
UCC1026	2.58E-06	CMH0243	1.80E-06	OAK0319	6.80E-07	PAH0479	1.90E-07	OAK0319	1.20E-08
AGS1018	2.53E-06	PIH0359	1.70E-06	ABQ0282	6.00E-07	OAK0319	1.70E-07	ABQ0282	1.20E-08
CMH0243	2.52E-06	ABQ0282	1.60E-06	PIH0359	5.70E-07	CMH0243	1.60E-07	PAH0479	1.00E-08
PAH0479	2.50E-06	PAH0479	1.50E-06	PAH0479	5.70E-07	CVE0403	1.60E-07	PIH0359	9.70E-09
MDW0675	2.31E-06	CVE0403	1.40E-06	CVE0403	5.50E-07	ORD0452	1.50E-07	CVE0403	9.70E-09
ORD0452	2.25E-06	ORD0452	1.40E-06	MDW0675	5.30E-07	PIH0359	1.50E-07	CMH0243	9.40E-09
CVE0403	2.10E-06	PIT1440	1.40E-06	ORD0452	5.20E-07	PIT1440	1.50E-07	ORD0452	9.20E-09
ERI0610	2.07E-06	MDW0675	1.40E-06	PIT1440	4.70E-07	MDW0675	1.40E-07	PIT1440	8.40E-09
PIH0359	1.90E-06	LEA0433	1.40E-06	AGS1018	4.60E-07	AGS1018	1.30E-07	ALO0729	8.10E-09
ALO0729	1.82E-06	AGS1018	1.30E-06	ALO0729	4.60E-07	ALO0729	1.30E-07	AGS1018	8.00E-09
SAF1184	1.81E-06	ALO0729	1.30E-06	SAF1184	4.20E-07	SAF1184	1.10E-07	SAF1184	7.80E-09
DAY1502	1.68E-06	DAY1502	1.20E-06	DAY1502	4.10E-07	DAY1502	9.90E-08	DAY1502	7.40E-09
LEA0433	1.62E-06	SAF1184	1.10E-06	LEA0433	4.10E-07	LEA0433	9.60E-08	LEA0433	7.00E-09
AMA0621	1.35E-06	AMA0621	1.00E-06	AMA0621	3.50E-07	AMA0621	8.60E-08	AMA0621	6.40E-09
TPA0662	9.88E-07	TPA0662	8.20E-07	TPA0662	3.10E-07	TPA0662	8.00E-08	TPA0662	6.00E-09

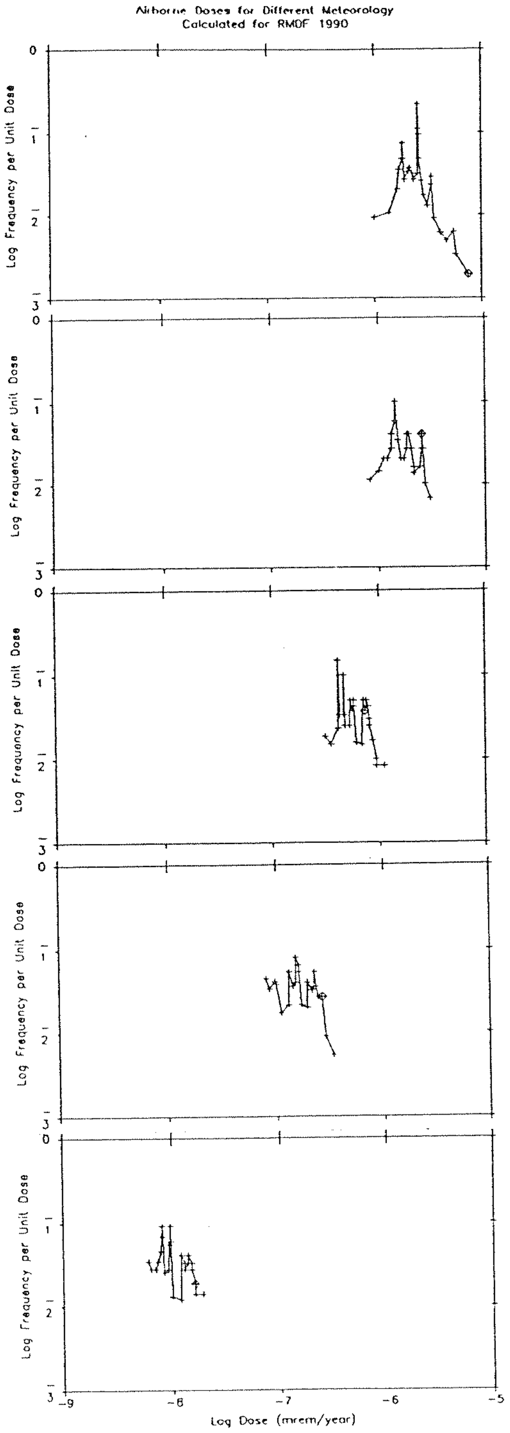
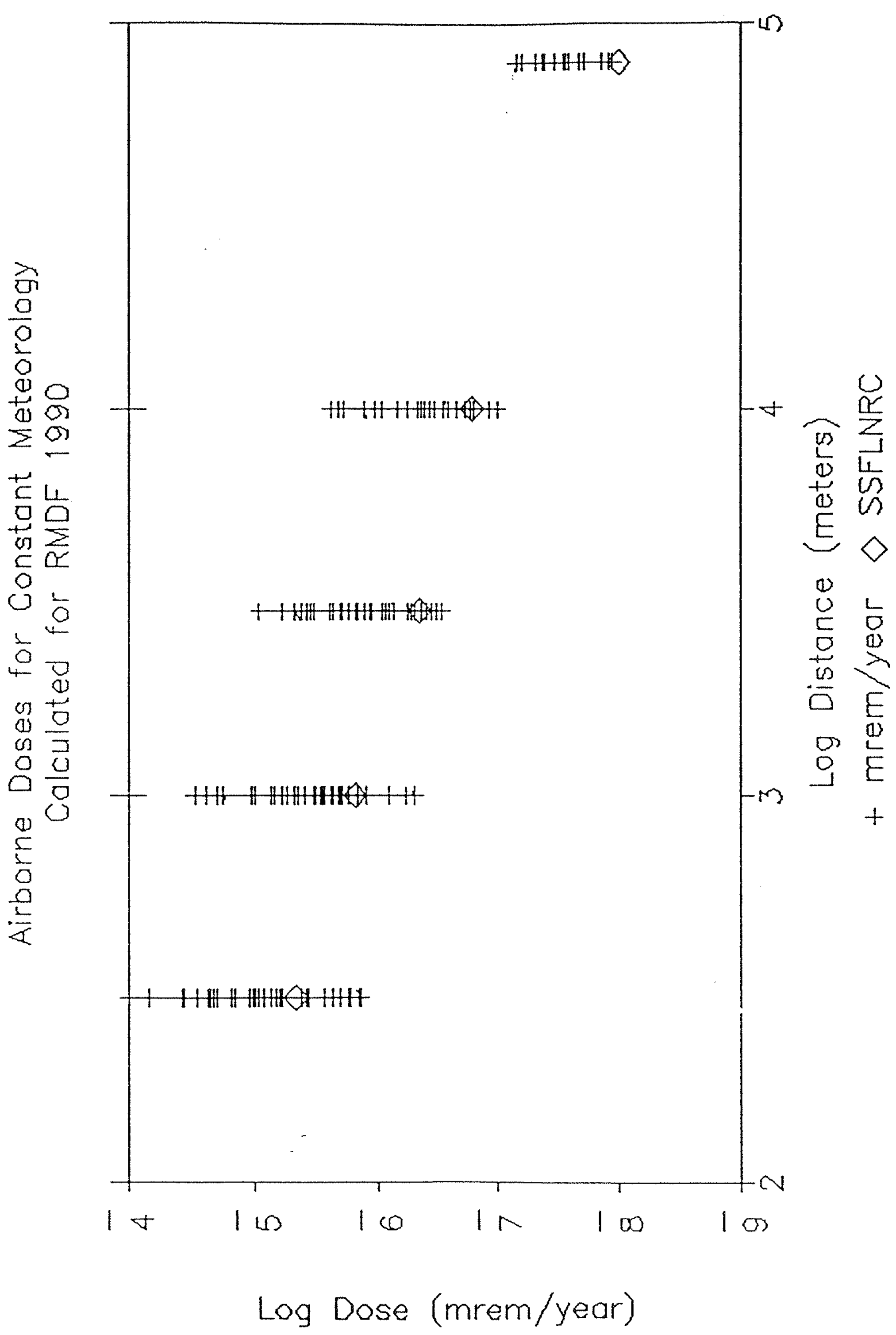

Airborne Doses for Different Meteorology
Calculated for RMOF 1990
Log Frequency per Unit Dose
0
-1
-2
-3
-9
-8
-7
-6
-5
Log Dose (mrem/year)

Figure 1



Airborne Doses for Constant Meteorology
Calculated for RMDF 1990
Log Dose (mrem/year)
-4
-5
-6
-7
-8
-9
Log Distance (meters)
2
3
4
5
+ mrem/year ◇ SSFLNRC

Figure 2

3. Rainfall

The annual rainfall rate was varied from 15 cm/year (6 inches/year) to 105 cm/year (41 inches/year). The average rainfall is 44 cm/year (17 inches/year). The higher rainfall results in a slight increase in the calculated doses because of an increase in the local deposition of airborne radioactivity. Doses for these three cases are shown in Figure 3.

4. Lid Height

The lid height refers to the layer of the atmosphere adjacent to the ground in which general mixing occurs. The lid is generally a temperature inversion that develops during the day and keeps airborne material "trapped" below the elevation corresponding to the lid height. In this study, the lid height was varied from 40 meters above the ground to 9,000 meters above the ground. The value of 366 meters used in the reference case had been recommended by a member of the DOE Tiger Team. The results of this comparison for the three greatest distances are shown in Figure 4. The effect of a lower lid height is to increase close–in doses and reduce the more distant doses. At the shortest distance (300 meters) there was no effect, and at 1,000 meters, the effect was less than at 3,000 meters. It appears that the maximum effect of a reduced lid height is to increase close–in doses by a factor of 3 at most, and reduce distant doses by a factor of about 0.6.

5. Exhaust Height

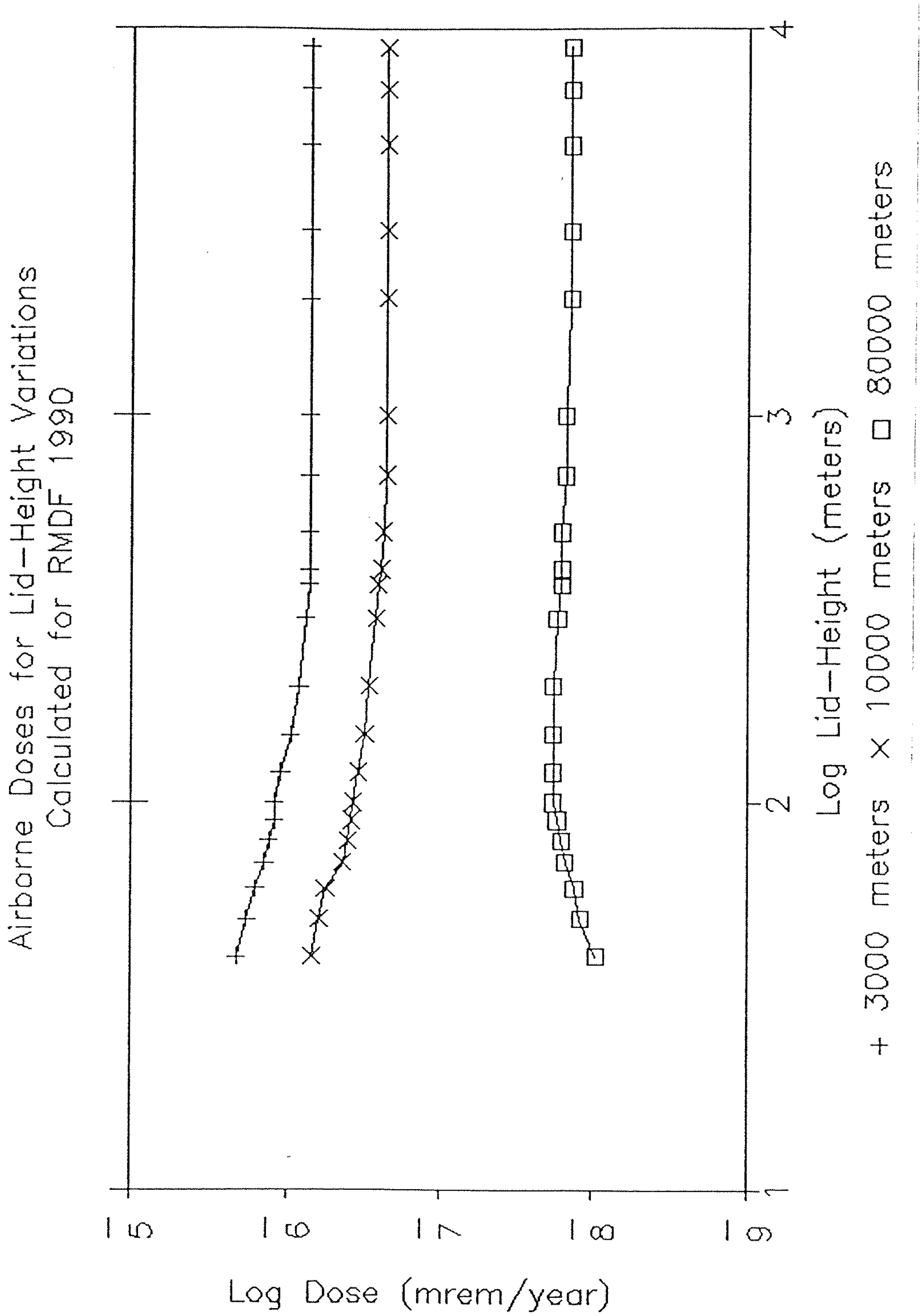
The nominal stack height of 39.6 meters was increased and decreased by 10%. The results of these variations are shown in Figure 5. The differences are small.

6. Stack Diameter

The nominal stack diameter of 0.91 meters was increased and decreased by 10%. The results of these variations are shown in Figure 6. The differences are almost undetectable.

7. Effluent Velocity

The nominal effluent velocity of 13.6 m/sec, which increases the effective release height over the physical height of the stack due to the momentum effect, was increased and decreased by 10%. The results of these variations are shown in Figure 7. The differences are almost undetectable.



Airborne Doses for Lid-Height Variations
Calculated for RMDF 1990
Log Dose (mrem/year)
-5
-6
-7
-8
-9
Log Lid-Height (meters)
1
2
3
4
+ 3000 meters
× 10000 meters
□ 80000 meters

Figure 4

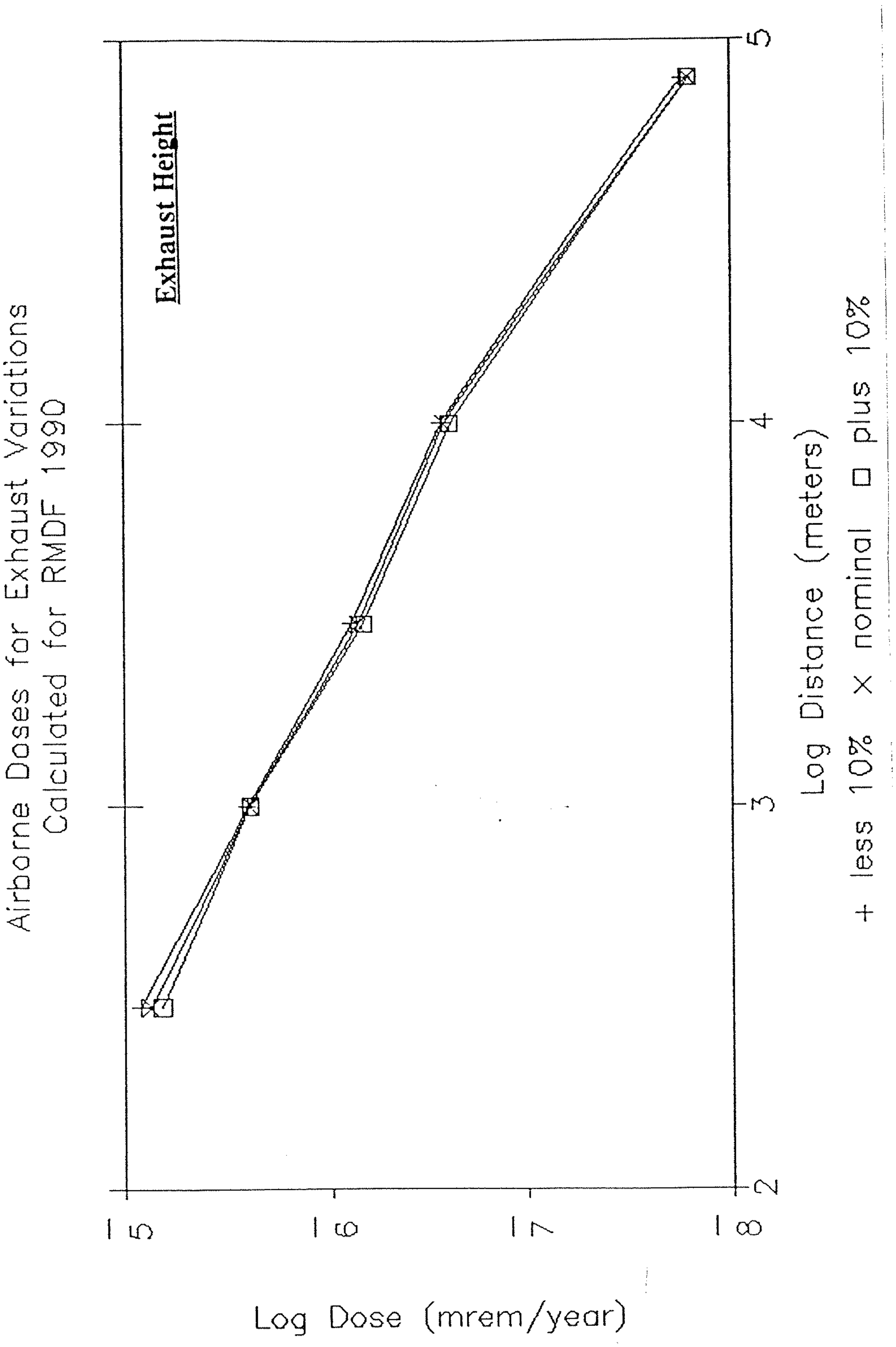

Airborne Doses for Exhaust Variations
Calculated for RMDF 1990
Exhaust Height
Log Dose (mrem/year)
-5
-6
-7
-8
Log Distance (meters)
2
3
4
5
+ less 10% × nominal □ plus 10%

Figure 5

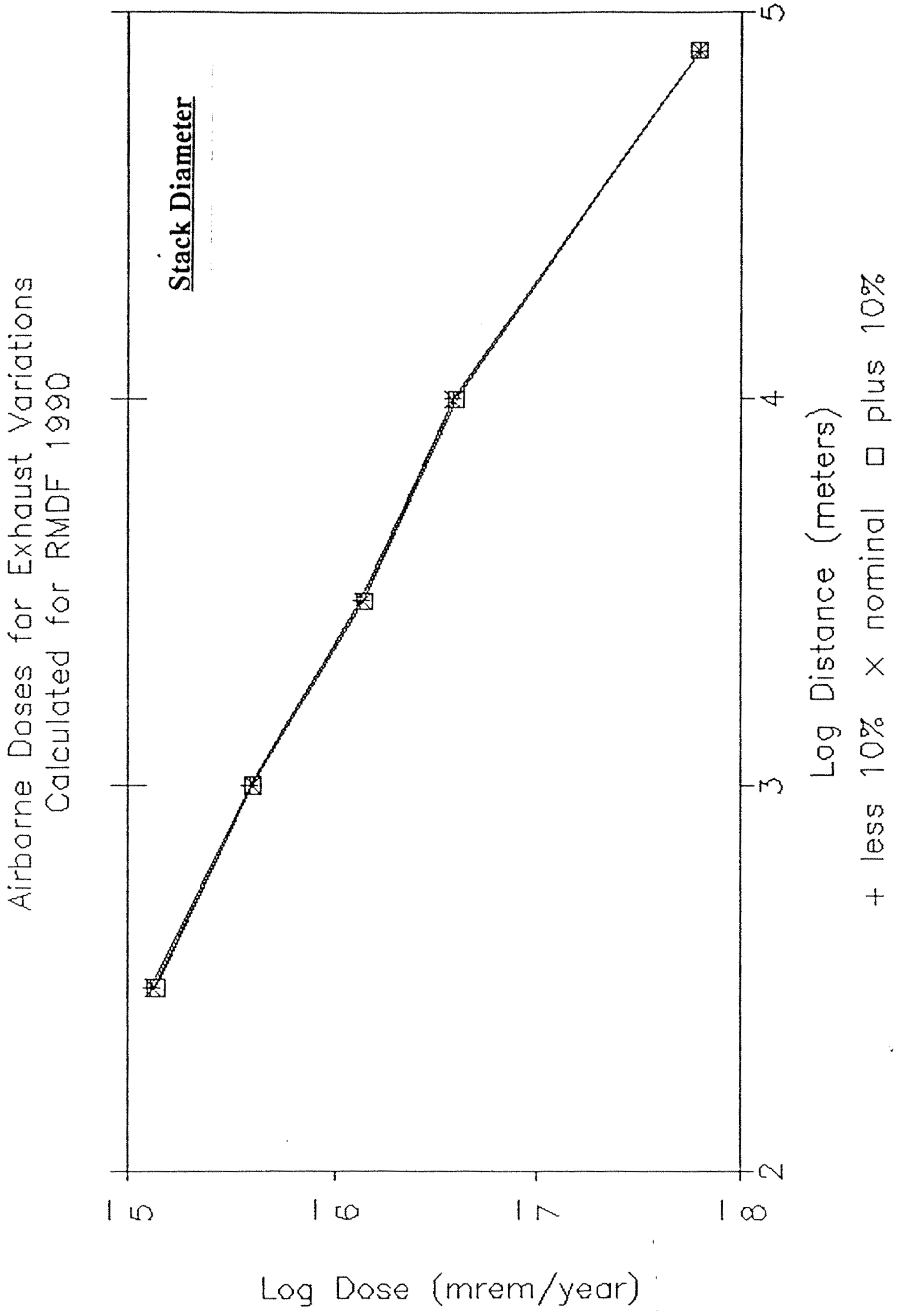

Airborne Doses for Exhaust Variations
Calculated for RMDF 1990
Stack Diameter
Log Dose (mrem/year)
-5
-6
-7
-8
Log Distance (meters)
2
3
4
5
+ less 10% × nominal □ plus 10%

Figure 6

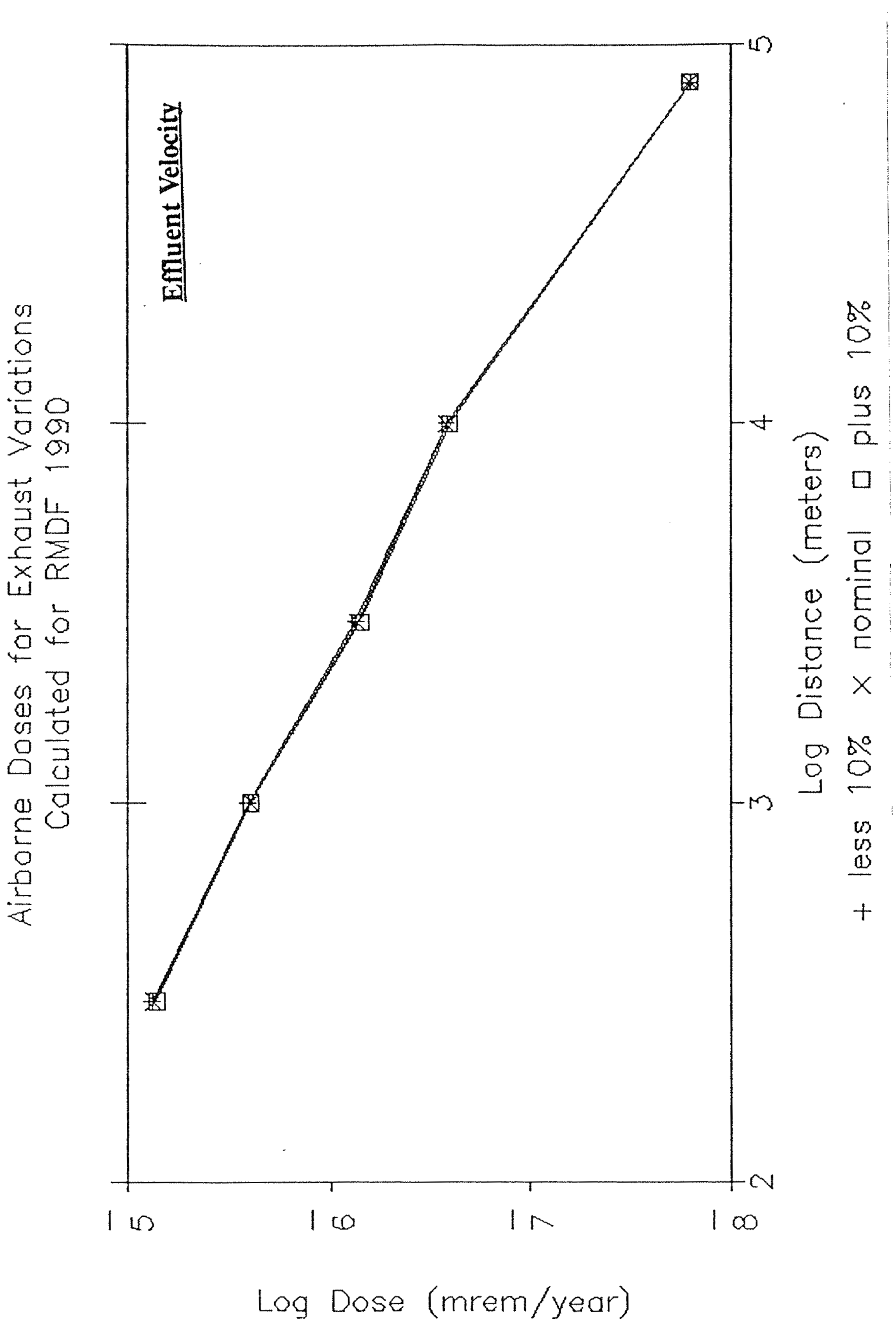

Airborne Doses for Exhaust Variations
Calculated for RMDF 1990
Effluent Velocity
Log Dose (mrem/year)
-5
-6
-7
-8
Log Distance (meters)
2
3
4
5
+ less 10%
× nominal
□ plus 10%

Figure 7

8. Radionuclide Class

AIRDOS–PC provides for lung clearance classes, D, W, and Y, representing materials with rapid clearance (Days), intermediate (Weeks), and long–term retention (Years). These comparisons showed a maximum increase of 8% in changing the class for Pu–239 from Y (appropriate for oxides) to W (appropriate for nitrates). Potential Pu–239 release at SSFL would be in the form of oxide. Changes in class for other radionuclides had smaller effects.

Summary

This study shows that the special wind–set SSFLNRC.WND may produce dose estimates that are conservatively high, and that other reasonable variations have comparatively little impact. Lowering the lid height to the level of the stack exhaust increases nearby doses by approximately a factor of 3 and reduces distant doses. The extreme case of constant wind (speed, direction, and stability) results in an increases of about 20 times the nominal calculation. All these variations are small in comparison to the roughly 10 million times margin between offsite doses and the EPA standard of 10 mrem/y.

References

1. "Tiger Team Assessment - Energy Technology Engineering Center," DOE/EH–0175, April 1991.
2. "Action Plan in Response to the April, 1991 Tiger Team Assessment at the Energy Technology Engineering Center," GEN–AR–0031, October 1, 1991.

Appendix B
DOE Tiger Team Findings Applicable to Effluent Monitoring and Interpretation

3.5.1.2 Compliance Findings

FINDING A/CF-1: Inadequate Stack Emissions Monitoring Methods for Radioactive Particulates

Performance Objective

The primary requirements for DOE to monitor radioactive particulates emissions from stacks and vents are provided in 40 CFR 61 Subpart H, National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities. The stack and vent emissions monitoring and test procedures are provided in 40 CFR 61.93 which, in part, requires determination of radionuclide emissions.

Paragraph (4)(i) of 40 CFR 61.93 states, "Radionuclide emission measurements in conformance with the requirements of paragraph (b) of this section shall be made at all release points which have a potential to discharge radionuclides into the air in quantities which could cause an effective dose equivalent in excess of 1 percent of the standard," and "For other release points which have a potential to release radionuclides into the air, periodic confirmatory measurements shall be made to verify the low emissions."

Paragraph (4)(ii) of 40 CFR 61.93 states, "To determine whether a release point is subject to the emission measurement requirements of paragraph (b) of this section, it is necessary to evaluate the potential for radionuclide emissions from that release point. In evaluating the potential of a release point to discharge radionuclides into the air for the purposes of this section, the estimated radionuclide release rates shall be based on the discharge of the effluent stream that would result if all pollution control equipment did not exist, but the facilities operations were otherwise normal."

The methods required by the National Emission Standards for Hazardous Air Pollutants (NESHAP) to determine actual emissions if continuous monitoring is required are specified in 40 CFR 60 Appendix A, and in the American National Standard Institute Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities (ANSI N13.1-1969). Method 1 in 40 CFR Appendix A is the required method for determining the correct stack sampling location. Method 2 is the required method for determining stack velocity and volumetric flow rate. The majority of other stack sampling requirements are controlled by ANSI N13.1-1969. The long-term acceptance of these methods make it a best management practice to use these methods even when not specifically required by regulation.

The requirements for evaluating and monitoring all radioactive sources are contained in DOE 5400.xy (Draft), and DOE 5400.1 and DOE 5400.5. In addition, provisions for monitoring of atmospheric emissions during accident situations must be considered when determining routine atmospheric emission monitoring program needs.

DOE 5400.5, I.8.a, states, "Demonstrations of compliance with requirements of this Order generally will be based upon calculations that make use of information obtained from monitoring and surveillance programs. The abilities to detect, quantify and adequately respond to unplanned releases of radioactive material to the environment also rely on in-place effluent monitoring, monitoring of environmental transport and diffusion conditions, and assessment capabilities. This will enable DOE to develop useful data and to collect and analyze pertinent information on unplanned releases in a timely manner. It is the intent of DOE that the monitoring and surveillance programs for the DOE activities, facilities, and locations be of high quality. Although some differences result from specific site or specific activity conditions, uniformity in the methods performance criteria used in obtaining the information is desirable."

DOE 5400.xy (Draft) provides for recommended stack sampling methods, which are essentially the same as those required under NESHAP, and the primary method reference is ANSI N13.1-1969. If continuous monitoring is required, specific methods are required by NESHAP. If periodic monitoring is required, the same monitoring methods are recommended by DOE 5400.xy (Draft).

Specific requirements for stack monitoring include:

- Sampling locations shall be at least eight stack diameters downstream from the nearest upstream disturbance in flow, and at least two stack diameters upstream from the nearest downstream disturbance, in accordance with 40 CFR 60, Appendix A, Method 1.

- In accordance with ANSI N13.1-1969, the particle and gaseous composition in a stack shall be representative at the sampling point selected, or enough sampling points shall be sampled simultaneously to provide a representative sample. The flow distribution at the selected location shall be known so the rate of sampling can be near isokinetic for particles larger than 2 to 5 microns in diameter.

- The velocity distribution within the stack or duct shall be known at the sampling location to determine the isokinetic sampling rate in accordance with ANSI N13.1-1969, A3.3.

- Multiple sampling points across the stack shall be established in accordance with ANSI N13.1-1969, A3.2, if the stack diameter is greater than 8 inches unless careful studies show that uniformity of composition exists throughout the cross section of the duct.

- Sample location selection requires the consideration of changes in the quality of the particles and gases carried in the air stream as the air moves along the passage in accordance with ANSI N13.1-1969, A2. Changes which can occur and which shall be considered include:

    - Contaminated corrosion products from walls of ducts or the stack which may enter the stream.

    - Earlier-deposited material which may break off and enter the air stream.

Finding

Particulate radionuclide stack sampling within Area IV of the SSFL had not been evaluated in accordance with 40 CFR 61, and deficiencies in the radioactive stack monitoring were noted at the active Radioactive Materials Disposal Facility (RMDF), the inactive Hot Lab, and the former Space Nuclear Auxiliary Power (SNAP) reactor facility which are not in accordance with 40 CFR 61, DOE 5400.xy (Draft), or best management practice. Also, siting rationale had not been developed in accordance with DOE 5400.xy (Draft) using the methods specified by 40 CFR 61.

Discussion

Stack sampling for particulate radionuclides is conducted in the stacks servicing Buildings 021 and 022 (RMDF), Building 020 (Hot Laboratory), and Building 059 (SNAP D&D). Although the radionuclide emissions from these stacks are considered to be very low, the emissions from these stacks have not undergone formal evaluation for the potential of radionuclide emissions to the air in accordance with established NESHAP regulations.

Since the site had not formally demonstrated the low radioactive emissions from the stacks, it was required to conduct stack monitoring in accordance with the NESHAP regulation. Although the samplers at the RMDF and the Hot Laboratory had the required continuous radiation monitors to detect sudden increases in radiation during accident situations, deficiencies in the radionuclide particulate sampling systems, which have been in use since 1970, prevented the samplers from meeting established NESHAP requirements. Examples of the noted stack sampling deficiencies are as follows:

- An insufficient determination was made concerning the suitability of the DOE sampling location, and the necessary number of sampling points for each of the stacks within Area IV as required by NESHAP, ANSI N13.1-1969, and DOE 5400.xy (Draft). 40 CFR 60, Appendix A, Method 2 requires two complete traverses at right angles to each other across the full stack diameter. This had been done only at the stack servicing Building 020. The stack servicing the RMDF had only a single traverse done, and the stack at Building 059 had not been measured.

- The stacks servicing the RMDF, the Hot Laboratory, and the SNAP D&D did not have multiple sampling points. All of those facilities had stacks greater than eight inches in diameter. An insufficient characterization of the sampling sites had been done to be in accordance with ANSI N13.1-1969 to justify use of a single sampling point.

- The location of the stack sampler at the SNAP D&D was less than one stack diameter from the nearest flow disturbance, which was not in accordance with the requirements of 40 CFR 60, Appendix A, Method 1. The filter was not rigidly mounted, and it moved continuously, with the filter face at varying angles relative to the air flow, which was not in accordance with ANSI N13.1-1969.

- There was no alarm at the SNAP D&D to provide timely warning when the concentration of radionuclides increased significantly in the exhaust stream during accident situations as required by ANSI N13.1-1969.

- The samplers at the RMDF and at the Hot Laboratory were not designed to monitor the large range of particulates which may have been present as a result of High Efficient Particulate Air (HEPA) filter problems, deposition inside the stack, or corrosion buildup in the stack as required by ANSI N13.1-1969.

- The Site Contractor had not measured the size distribution in the stacks to determine the corrections required for an isokinetic sampling as required by ANSI N13.1-1969.
- The Site Contractor had not evaluated the line losses in the stack sampling system in accordance with ANSI N13.1-1969.
- The rationale for the design of the effluent monitoring systems had not been documented in the Environmental Monitoring Plan as required in DOE 5400.xy (Draft). The facility Environmental Monitoring Plan had not been developed (see Finding QA/BMPF-1). There was a written rationale developed in 1970, but it was not in accordance with ANSI N13.1-1969 as would be recommended by best management practice at that time, and later required by NESHAP until a determination was made that all of the sources met the requirement of having a potential to discharge radionuclides into the air in quantities which could cause an effective dose equivalent in excess of 1 percent of the standard.

If the site had evaluated the stack emission and had determined that the potential radionuclide exposure via the air was less than 1 percent of the effective dose equivalent of 10 millirem per year, the site could have conducted periodic, rather than continuous, sampling. Even if periodic sampling were allowed based on low exposure potential, best management practice would still dictate the need for the Site to comply with the NESHAP stack sampling methods.

Neither the SAN nor the Site Contractor's Self-Assessments included all of the deficiencies in the stack sampling systems with their findings (A-2 and A-3, respectively). The Site Contractor's Self-Assessment did mention overall lack of training of sampling personnel and some of the sampling deficiencies, and the SAN Self-Assessment mentioned that the stack sampling appeared to be nonisokinetic and that the sampling lines were too long.

During the Tiger Team Assessment, the Site Contractor conducted a potential emissions evaluation of one of the three sources, the SNAP D&D, and demonstrated to their own satisfaction that the emissions from this unit did not cause an effective dose equivalent in excess of 1 percent of the NESHAP standard. The Site Contractor also reported that it had subsequently evaluated the line losses in the sampler at the RMDF and had provided a fixed mount for the sampling filter at the SNAP D&D.

The causal factors for this finding appear to be inadequate Site Contractor training of appropriate Site Contractor personnel in sampling system design, operation, monitoring and maintenance, and inadequate Site Contractor procedures on stack sampling, stack sampling operations, monitoring, maintenance and routine training. In addition, the formal appraisals/reviews conducted by the Site Contractor and SAN did not detect most of these deficiencies in the emissions monitoring program.

FINDING A/CF-2: Inadequate Meteorological Data

Performance Objective

DOE 5400.1 requires DOE facilities to have representative meteorological data to support environmental monitoring activities. Offsite data may be used if it is representative of site conditions. If a determination has been made that offsite data are not representative of the site meteorology, the site must provide representative data by installing and operating meteorological instrumentation.

DOE 5400.xy (Draft) states, "Meteorological measurements shall be made in locations that provide data representative of the atmospheric conditions into which material will be released and transported. A meteorologist or other atmospheric scientist with experience in atmospheric dispersion and meteorological instrumentation should be consulted in determining whether onsite data are required and, if so, in selecting measurement locations and in the design and installation of the meteorological measurement system. Factors to be considered in selecting measurement locations and installation of the instruments include the prevailing wind direction, topography, and obstructions. Also, any special meteorological monitoring requirements imposed by other agencies (outside DOE) should be taken into consideration when designing meteorological measurement systems and establishing measurement locations."

Finding

The Site Contractor does not use meteorological data which are representative of site conditions as required by DOE 5400.1.

Discussion

The Site Contractor currently uses meteorological monitoring data from the Burbank Airport. The data from Burbank are not representative of site conditions. The Burbank Airport is located approximately 15 miles from the site and on the floor of the San Fernando Valley. The SSFL is located in a mountainous region approximately 1,000 feet higher in elevation than the airport.

The SAN Site-Assessment (A-2) did not identify any problems associated with meteorology, while the Site Contractor Self-Assessment did note some of the deficiencies with the meteorological data (A-3).

The causal factors for this finding appear to be no Site Contractor or SAN <u>procedures</u> requiring the use and development of meteorological siting criteria and the implementation of routine training in those procedures, and the Site Contractor and SAN have not provided needed <u>training</u> in the requirements of ambient monitoring programs.

3.5.8.2 Compliance Findings

FINDING RAD/CF-1: AIRDOS-PC Modeling Deficiencies

Performance Objective

DOE 5400.5 states that the dose limit to the public must be evaluated considering all exposure modes from all DOE activities including remedial actions. According to DOE 5400.1, the public dose component that is attributable to airborne releases of radioactivity must comply with the Clean Air Act standards set forth in Title 40 CFR 61, Subpart H, and be monitored according to 40 CFR 60, Appendix A, ANSI N13.1-1969, and DOE 5400.xy (Draft). Title 40 CFR 61.93, Subpart H, requires that compliance with the Clean Air Act Standards be demonstrated using AIRDOS-PC or other EPA approved models or procedures. DOE 5400.xy (Draft), Chapter IV, Section 3(d)(2), states that Gaussian models or other EPA-approved straight line models used to demonstrate compliance with 40 CFR 61.93 should use an additional dose assessment to realistically account for temporal and spatial variations in atmospheric conditions and release rates. In DOE 5400.5, Chapter II, Section 6(c), it is stated that if available data are not sufficient to evaluate factors germane to dose, or if they are too costly to determine, the assumed parametric values must be sufficiently conservative such that it would be unlikely for individuals to actually receive a dose that would exceed the dose calculated using the values assumed.

Finding

Some assumptions and data used in the EPA AIRDOS-PC model by Site Contractor personnel are not conservative in that not all emission sources are included in the model and the radioactive emission release rates and meteorological data used in the model are not in accordance with DOE 5400.5.

Discussion

DOE requires the estimating of radiological dose to the public using an appropriate model for the site location, which relies upon providing accurate meteorological data and accurate values of radioactive particulate releases to the atmosphere. The discussion that follows presents those parameters for which model input data were not conservative.

<u>Airborne Emissions</u>

The current sampling design and technology used to develop data for calculating doses to the public has been in place since 1970 (see Finding A/CF-1). Detectable radioactive airborne releases from the decontamination and decommissioning of Building 059 have not been included in AIRDOS-PC calculations (R-50). The requirement to monitor all radionuclide emission rates from point sources, including those from remedial actions, is found in 40 CFR 61.93(b) and DOE 5400.5. Also, the design of the sampling system that is used to detect radioactive particulate releases from Building 059 does not meet the guidelines of ANSI N13.1-1969 (see Finding A/CF-1).

Stack Sampling

By assessing the emission of radioactive particulates, and hence, total radioactivity released, the AIRDOS-PC model is used to estimate the radiation dose to the public. The design of the stack emission sampling systems for the Radioactive Material Disposal Facility (RMDF), Building 020, and Building 059 do not meet the requirements of 40 CFR 61, and ANSI N13.1-1969 (see Finding A/CF-1). Since the sampling design does not meet the requirements of ANSI N13.1-1969, the radioactive particulate emission release rates that are supplied to the model by the Site Contractor are determined from air filter samples which are collected in a manner that may not be representative of actual emissions (see Finding A/CF-1). The changing and handling practice, as observed by the Tiger Team, of the filter samples collected for radioactivity at the RMDF, Building 059, and Building 020 stack emission points revealed that loss of some particulate matter may occur (see Finding A/CF-1).

Meteorological Data

The meteorological data used in the model by the Site Contractor do not reflect the meteorological conditions that exist at the site, which is a requirement of DOE 5400.5, Chapter II, Section 6.b(1), and DOE 5400.xy (Draft). The noted deficiencies in the meteorological data used in the model by the Site Contractor are as follows:

- Atmospheric data supplied to the model by the Site Contractor were generated at the Burbank Airport which possesses substantial differences in topography and elevation compared to the Contractor's site. (The use of these data for the Site Contractor was suggested by EPA.)

- A height to the "cap" of the mixing layer (air inversion) in which all residents reside was estimated by the Site Contractor as 9,000 meters (30,000 feet). South Coast Air Quality Management District reports the annual average afternoon height of the inversion as approximately 900 meters (3,000 feet) in the region in which the Contractor's site is located (I-RAD-23).

- The height to the "cap" of the mixing layer (inversion) in which the nearest residents reside was estimated by the Site Contractor as 9,000 meters (30,000 feet). Since the nearest residents reside at approximately the same elevation as the Contractor's site (1800 feet), the height to the "cap" is approximately 366 meters (1,200 feet) for these individuals.

It should be noted that radionuclide releases resulting from DOE activities in Area IV of the Santa Susana Field Laboratory are now limited to cleanup activities and that the current doses to the public attributed to these activities is viewed by the Site Contractor and the Environmental Subteam to be well below the regulatory effective dose limit to the public of 10 millirem per year, even when the noted deficiencies are included in the EPA AIRDOS-PC model. However, additional work will be required to define the actual value of the effective dose.

This finding was partially identified in the Site Contractor and SAN Self-Assessments. The portion that was identified in the assessments was the inadequacy of the main stack monitoring [SAN Assessment of ETEC, Finding II.1(a), Site Contractor Self-Assessment, Finding 2.2.1.12(26)].

The apparent causal factors for the finding are human factors in that regulatory and DOE guidance were not rigorously followed and inadequate Site Contractor, SAN, and Site Office appraisals/reviews which did not fully identify this finding.

Appendix C
AIRDOS-PC Reports for DOE Operations at SSFL

40 CFR Part 61
National Emission Standards
for Hazardous Air Pollutants

CLEAN AIR ACT COMPLIANCE REPORT
(Version 3.0 November 1989)

Facility: DOE Operations at Santa Susana

Address: Santa Susana Field Lab
Simi Hills , CA. 91311
Annual Assessment for Year: 1991
Date Submitted: 4/16/92

Comments: Compliance calculation for RMDF and T059, for 1991.

Prepared By:

Name: R. J. Tuttle
Title: Health Physicist
Phone #: (818) 586-6135

Prepared for:
U.S. Environmental Protection Agency
Office of Radiation Programs
Washington, D.C. 20460

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                          CLEAN AIR ACT COMPLIANCE REPORT      4/16/92 12:46 AM

Facility: DOE Operations at Santa Susana
 Address: Santa Susana Field Lab          City: Simi Hills            State: CA
Comments: Compliance calculation for RMDF and T059, for 1991.
    Year: 1991
                               Dose Equivalent Rates to Nearby
                          ________Individuals (mrem/year)________
       Effective     ¦¦                                      ¦¦
    Dose Equivalent  ¦¦               2.69E-06               ¦¦
                     ¦¦______________________________________¦¦
      Highest Organ  ¦¦                                      ¦¦
       Dose is to    ¦¦               7.79E-06               ¦¦
      ENDOSTEUM      ¦¦______________________________________¦¦

  ------------------------EMISSION INFORMATION------------------------

 :---------:-----:----:--------:--------:
 ¦ Radio-  ¦     ¦    ¦ Stack  ¦ Stack  ¦
 ¦ nuclide ¦Class¦Amad¦  RMDF  ¦  T059  ¦
 ¦         ¦     ¦    ¦ (Ci/y) ¦ (Ci/y) ¦
 ¦---------¦-----¦----¦--------¦--------¦
 ¦ SR-90   ¦  Y  ¦ 1.0¦ 6.8E-08¦ 0.0E-01¦
 ¦ PU-239  ¦  Y  ¦ 1.0¦ 5.7E-09¦ 1.1E-09¦
 ¦ CS-137  ¦  D  ¦ 1.0¦ 1.2E-06¦ 0.0E-01¦
 ¦ CO-60   ¦  Y  ¦ 1.0¦ 6.3E-07¦ 8.1E-08¦
 ¦ TH-230  ¦  Y  ¦ 1.0¦ 2.0E-09¦ 0.0E-01¦
 ¦ U-234   ¦  Y  ¦ 1.0¦ 8.9E-09¦ 0.0E-01¦
 ¦ U-235   ¦  Y  ¦ 1.0¦ 2.8E-09¦ 0.0E-01¦
 ¦ U-238   ¦  Y  ¦ 1.0¦ 3.6E-09¦ 0.0E-01¦
 ¦BA-137M  ¦  D  ¦ 1.0¦ 0.0E-01¦ 0.0E-01¦
 ¦_________¦_____¦____¦________¦________¦
   Stack Height (m) ¦   39.60¦    5.18¦
 Stack Diameter (m) ¦    0.92¦    0.31¦
     Momentum (m/s) ¦    10.5¦    10.3¦
                    ¦________¦________¦

  --------------------------SITE INFORMATION--------------------------

                   :-----------------:                     :---------------:
       Wind Data   ¦   SSFLNRC.WND   ¦  Temperature (C)    ¦      17       ¦
     Food Source   ¦     LOCAL       ¦  Rainfall (cm/y)    ¦      51       ¦
     Distance to   ¦     3009        ¦   Lid Height (m)    ¦     366       ¦
 Individuals (m)   :_________________:                     :_______________:

      *NOTE:  The results of this computer model are dose estimates.
              They are only to be used for the purpose of determining
              compliance and reporting per 40 CFR 61.93 and 40 CFR 61.94.
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4/16/92 12:46 AM

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION OF ALL DISTANCES AND ALL DIRECTIONS FOR ALL RADIONUCLIDES AND ALL PATHWAYS

DIRECTIONS:	N	NNE	NE	ENE	E	ESE	SE	SSE
DISTANCE (METERS):								
3009	5.1E-07	4.9E-07	4.6E-07	4.1E-07	3.6E-07	1.0E-06	1.7E-06	1.1E-06
10000	1.6E-07	1.5E-07	1.4E-07	1.2E-07	1.1E-07	3.0E-07	4.9E-07	3.3E-07
80000	7.7E-09	7.5E-09	7.3E-09	6.1E-09	5.0E-09	1.9E-08	3.2E-08	2.0E-08

	S	SSW	SW	WSW	W	WNW	NW	NNW
DISTANCE (METERS):								
3009	5.4E-07	5.8E-07	6.3E-07	5.8E-07	4.4E-07	1.6E-06	2.7E-06	1.6E-06
10000	1.6E-07	1.7E-07	1.8E-07	1.7E-07	1.4E-07	4.7E-07	7.9E-07	4.8E-07
80000	8.6E-09	1.1E-08	1.3E-08	1.0E-08	6.3E-09	2.5E-08	4.3E-08	2.6E-08

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION OF ALL DISTANCES AND ALL DIRECTIONS FOR ALL RADIONUCLIDES AND ALL PATHWAYS

DIRECTIONS: DISTANCE (METERS):	N	NNE	NE	ENE	E	ESE	SE	SSE
2301	6.5E-07	6.2E-07	5.9E-07	5.2E-07	4.5E-07	1.3E-06	2.2E-06	1.5E-06
3000	5.1E-07	4.8E-07	4.6E-07	4.0E-07	3.6E-07	1.0E-06	1.7E-06	1.1E-06
10000	1.6E-07	1.5E-07	1.4E-07	1.2E-07	1.1E-07	3.0E-07	4.9E-07	3.3E-07
80000	7.7E-09	7.5E-09	7.3E-09	6.1E-09	5.0E-09	1.9E-08	3.2E-08	2.0E-08

DISTANCE (METERS):	S	SSW	SW	WSW	W	WNW	NW	NNW
2301	6.8E-07	7.6E-07	8.4E-07	7.3E-07	5.4E-07	2.0E-06	3.4E-06	2.0E-06
3000	5.4E-07	5.8E-07	6.2E-07	5.7E-07	4.4E-07	1.6E-06	2.7E-06	1.6E-06
10000	1.6E-07	1.7E-07	1.8E-07	1.7E-07	1.4E-07	4.7E-07	7.9E-07	4.8E-07
80000	8.6E-09	1.1E-08	1.3E-08	1.0E-08	6.3E-09	2.5E-08	4.3E-08	2.6E-08

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EFFECTIVE DOSE EQUIVALENT AS A FUNCTION OF ALL DISTANCES AND ALL DIRECTIONS FOR ALL RADIONUCLIDES AND ALL PATHWAYS

DIRECTIONS:	N	NNE	NE	ENE	E	ESE	SE	SSE
DISTANCE (METERS):								
2816	5.4E-07	5.1E-07	4.8E-07	4.3E-07	3.7E-07	1.1E-06	1.8E-06	1.2E-06
3000	5.1E-07	4.8E-07	4.6E-07	4.0E-07	3.6E-07	1.0E-06	1.7E-06	1.1E-06
10000	1.6E-07	1.5E-07	1.4E-07	1.2E-07	1.1E-07	3.0E-07	4.9E-07	3.3E-07
80000	7.7E-09	7.5E-09	7.3E-09	6.1E-09	5.0E-09	1.9E-08	3.2E-08	2.0E-08

	S	SSW	SW	WSW	W	WNW	NW	NNW
DISTANCE (METERS):								
2816	5.7E-07	6.1E-07	6.7E-07	6.1E-07	4.6E-07	1.7E-06	2.8E-06	1.7E-06
3000	5.4E-07	5.8E-07	6.2E-07	5.7E-07	4.4E-07	1.6E-06	2.7E-06	1.6E-06
10000	1.6E-07	1.7E-07	1.8E-07	1.7E-07	1.4E-07	4.7E-07	7.9E-07	4.8E-07
80000	8.6E-09	1.1E-08	1.3E-08	1.0E-08	6.3E-09	2.5E-08	4.3E-08	2.6E-08

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EFFECTIVE DOSE EQUIVALENT AS A FUNCTION OF ALL DISTANCES AND ALL DIRECTIONS FOR ALL RADIONUCLIDES AND ALL PATHWAYS

DIRECTIONS: DISTANCE (METERS):	N	NNE	NE	ENE	E	ESE	SE	SSE
2334	6.4E-07	6.1E-07	5.8E-07	5.1E-07	4.4E-07	1.3E-06	2.2E-06	1.4E-06
3000	5.1E-07	4.8E-07	4.6E-07	4.0E-07	3.6E-07	1.0E-06	1.7E-06	1.1E-06
10000	1.6E-07	1.5E-07	1.4E-07	1.2E-07	1.1E-07	3.0E-07	4.9E-07	3.3E-07
80000	7.7E-09	7.5E-09	7.3E-09	6.1E-09	5.0E-09	1.9E-08	3.2E-08	2.0E-08

DISTANCE (METERS):	S	SSW	SW	WSW	W	WNW	NW	NNW
2334	6.7E-07	7.4E-07	8.2E-07	7.2E-07	5.4E-07	2.0E-06	3.4E-06	2.0E-06
3000	5.4E-07	5.8E-07	6.2E-07	5.7E-07	4.4E-07	1.6E-06	2.7E-06	1.6E-06
10000	1.6E-07	1.7E-07	1.8E-07	1.7E-07	1.4E-07	4.7E-07	7.9E-07	4.8E-07
80000	8.6E-09	1.1E-08	1.3E-08	1.0E-08	6.3E-09	2.5E-08	4.3E-08	2.6E-08

DOE Operations at Santa Susana

Appendix D
Supplemental Information Requested by DOE

Appendix D
Supplemental Information for DOE

As requested, the following supplemental information is provided for DOE purposes, although it is not required by the NESHAPs regulations under 40CFR61.94.

Collective Effective Dose Equivalent

The collective effective dose equivalent resulting from DOE operations at SSFL was estimated by using AIRDOS–PC to calculate individual doses at incremental distances corresponding to the centroids of polar–coordinate cells established to represent the population distribution around the site. The demography was obtained from Urban Decision Systems, Inc., for the 1990 census. (No adjustments for population growth, decline, or rearrangement for 1991 were made. It is believed these effects were minimal over this time span.) The estimated population dose for each demographic cell is shown in Table D–1.

The collective effective dose equivalent for the population out to 80 km (50 miles) from the site is estimated to be 0.00058 person–rem/year.

Unplanned Releases to the Atmosphere

There were no unplanned releases of radioactive material into the atmosphere.

Releases from Unmonitored Sources

An evaluation of unmonitored sources with a potential for release of radioactive material was performed in March, 1992. The evaluation included (for completeness) several facilities that are not DOE operations and are therefore not covered by Subpart H. The results of this evaluation are discussed in the attached Internal Letter, "Conservative Estimates of Offsite Exposures Due to Fugitive Sources of Airborne Radiation Effluent at SSFL," dated March 18, 1992 (Attachment 3). Very conservative assumptions were made in the hand calculations of Attachment 3. As a result, the doses shown below are relatively higher than the stack release doses calculated using the more realistic and more detailed AIRDOS–PC model.

For DOE facilities, the estimated maximum individual doses are shown below:

Building 064 Side Yard	0.0016 mrem/year
RMDF North Slope	0.036 mrem/year
Building 064	0.00032 mrem/year
RMDF Pond (Sump 614)	0.0000049 mrem/year

Table D-1. Population Dose Estimates for Atmospheric Emissions from DOE Operations at SSFL - 1991

Dose to Population (person-rem/year)

Distance Direction	0-8 km	8-16 km	16-32 km	32-48 km	48-64 km	64-80 km	Total
N	4.2E-06	0.0E+00	3.1E-08	6.4E-09	1.0E-08	7.0E-10	4.2E-06
NNE	2.5E-06	9.8E-09	8.4E-07	6.4E-08	4.1E-08	2.4E-08	3.5E-06
NE	3.0E-06	9.1E-08	4.1E-06	6.0E-07	2.1E-07	1.2E-06	9.2E-06
ENE	3.6E-07	3.4E-06	6.0E-06	4.6E-08	5.4E-08	3.7E-07	1.0E-05
E	8.1E-07	7.0E-06	1.8E-05	5.0E-06	2.3E-06	1.1E-06	3.4E-05
ESE	4.8E-06	2.5E-05	2.9E-05	6.6E-05	4.3E-05	2.2E-05	1.9E-04
SE	7.6E-06	1.8E-05	2.4E-05	6.4E-05	6.6E-05	3.2E-05	2.1E-04
SSE	1.3E-06	2.3E-06	9.5E-07	0.0E+00	1.8E-06	3.4E-07	6.8E-06
S	1.3E-07	5.7E-07	2.9E-07	0.0E+00	0.0E+00	0.0E+00	9.9E-07
SSW	9.1E-07	2.6E-06	3.9E-07	0.0E+00	0.0E+00	0.0E+00	3.9E-06
SW	1.2E-06	3.3E-06	5.4E-07	0.0E+00	0.0E+00	0.0E+00	5.0E-06
WSW	1.5E-07	3.4E-06	3.0E-06	4.5E-07	0.0E+00	2.6E-11	7.0E-06
W	0.0E+00	3.1E-06	2.5E-06	4.5E-06	6.7E-07	3.5E-10	1.1E-05
WNW	1.0E-05	5.5E-06	3.2E-06	2.7E-06	1.4E-06	4.6E-07	2.3E-05
NW	3.7E-05	1.5E-06	3.3E-06	9.0E-07	3.9E-08	1.2E-08	4.3E-05
NNW	1.5E-05	1.1E-07	3.5E-07	0.0E+00	7.4E-09	1.7E-07	1.5E-05
TOTALS	8.8E-05	7.6E-05	9.7E-05	1.4E-04	1.2E-04	5.8E-05	5.8E-04

The estimated doses (with no pollution-control equipment) are well below 1% of the NESHAPs dose standard, and therefore these sources do not require the monitoring described in 40CFR61.93(b).

Sources of Diffuse Emissions

Three areas described in the evaluation discussed above constitute potential diffuse emission sources. These are the Building 064 Side Yard, the RMDF North Slope and the RMDF Pond. As shown above, the estimated doses are small compared to the level requiring monitoring.

Dose Estimates Based on Environmental Monitoring

Potential doses to offsite individuals are too small to be estimated by means of environmental monitoring. However, the operation of several onsite ambient air samplers provides further assurance that airborne releases do not approach the NESHAPs dose standard. For example, the gross beta concentration normally measured with these samples is roughly 20 times below the annual average level that would cause a dose of about 0.1 mrem/year to an individual onsite. Therefore, the ambient airborne radioactivity in the vicinity of some of these air samplers would have to increase by much more than a factor of 20 for offsite doses to approach 10 mrem/year. Such an increase would be readily observable.

40CFR61 Subparts Q and T

Subpart Q, for storage and disposal facilities for radium-containing material, is not applicable. Subpart T, for uranium mill tailings, is not applicable.

Rm-220 Emissions from U-232 and Th-232

No significant quantities of U-232 or Th-232 are at this site.

Nondisposal/Nonstorage Sources of Rn-222

There are no such sources at this site.

Emission Points Requiring Continuous Monitoring

All emission points have been evaluated and shown to have limited potential for causing public airborne radioactive exposure below the 1% of the standard requiring monitoring as described in 40CFR61.93(b). The most significant emission points (RMDF and T059) are continuously monitored for the purpose of maintaining surveillance of atmospheric releases under DOE Order 5400.5.