Rockwell International
Rocketdyne Division

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ABSTRACT

Data on employee exposures, bioassay results, effluent releases, in-plant airborne radioactivities, and environmental monitoring for ESG operations during 1984 are reviewed. This review is prepared, as required by Special Nuclear Materials License No. SNM-21, to determine (1) if there are any upward trends developing in personnel exposures for identifiable categories of workers or types of operations or effluent releases, (2) if exposures and effluents might be lowered under the concept of as low as reasonably achievable, and (3) if equipment for effluent and exposure control is being properly used, maintained, and inspected.

Personnel exposures have been markedly reduced.

Effluent releases are at insignificant levels compared to regulatory standards, do not shown any upward trends, and do not appear to be reducible by reasonable means.

To the extent covered by this review, equipment for effluent and exposure control was properly used, maintained, and inspected.

CONTENTS

TABLES

TABLES

FIGURES

INTRODUCTION

The Energy Systems Group special nuclear materials license[1] requires that an annual report shall be made to the Isotopes Committee of the NSRP reviewing personnel exposure and effluent release data. The format and content of this report have been well established in prior issues.[2-10] While this report is prepared primarily to satisfy a requirement of the NRC license, all operations have been included.

These reports for the years 1975 through 1983[2-10] provide a historical basis for the identification of trends. It should be noted that, in some instances, both NRC-licensed and non-NRC-licensed activities take place in the same building. In these cases, certain measurements (e.g., ventilation air exhaust radioactivity) have not been made separately for each type of activity.

Additionally, it is not possible to separate the integrated personnel radiological doses to that attributable to either nonlicensed activities for the DOE or the activities licensed by NRC or the State of California. In October of 1984, the Energy Systems Group (California) was merged with the Rocketdyne Division.

The following ESG/Rocketdyne facilities and operations are specifically covered in this report:

1) Fuel Fabrication Decommissioning - Supporting operations in Building 004, De Soto Facility, Canoga Park, California

2) Rockwell International Hot Laboratory (RIHL) - Building 020, Santa Susana Field Laboratories

3) Nuclear Material Development Facility (NMDF) - Building 055, Santa Susana Field Laboratories

4) Radioactive Material Disposal Facility (RMDF) - Buildings 021, 022, and related facilities at Santa Susana Field Laboratories (DOE jurisdiction)

Personnel exposures and dosimetry in all activities with radioactive material, except certain pre-existing Rocketdyne operations, are included in this report.

I. PERSONNEL DOSIMETRY

Personnel dosimetry techniques generally consist of two types: those which measure radiation incident on the body from external sources (film badges) and those which measure internal body organ accumulations of radioactivity via inhalation, ingestion, or through cuts or puncture wounds (bioassays). These measurement methods provide a natural separator of the exposure modes to (1) permit an evaluation of the more significant exposure routes and (2) to allow a differentiation between those exposure sources which are external and controllable in the future and those which may continue to irradiate the body for some time period (i.e., internal body deposits).

A. FILM/TLD DATA

1. Whole Body Monitoring

Personnel external radiation exposures for the pertinent activities for the year are shown in Figure 1 as a cumulative log-normal distribution. It should be noted (see Summary, Section VI) that all whole-body exposures were less than 2 rem and were well below the allowable annual occupational total of 12 rem (for NRC and State-licensed operations).

For comparison, the distributions of exposures reported for NRC licensees[11] and DOE contractors[12] for 1983 are shown as solid curves.

The ESG dose distribution is well below the NRC distribution and generally approaches the DOE distribution. A more significant comparison can be made in terms of the group dose. The group dose received by ESG employees in 1984 amounted to 45.2 person-rem. If the distribution of doses had been that shown for NRC licensees, the group dose would have been 141.3 person-rem. If the doses had been those shown for DOE, the group dose would have been 44.6 person-rem. However, comparisons such as these should be viewed with caution because of differences in the type of work between the ESG workforce and both the NRC licensees and the DOE contractors.

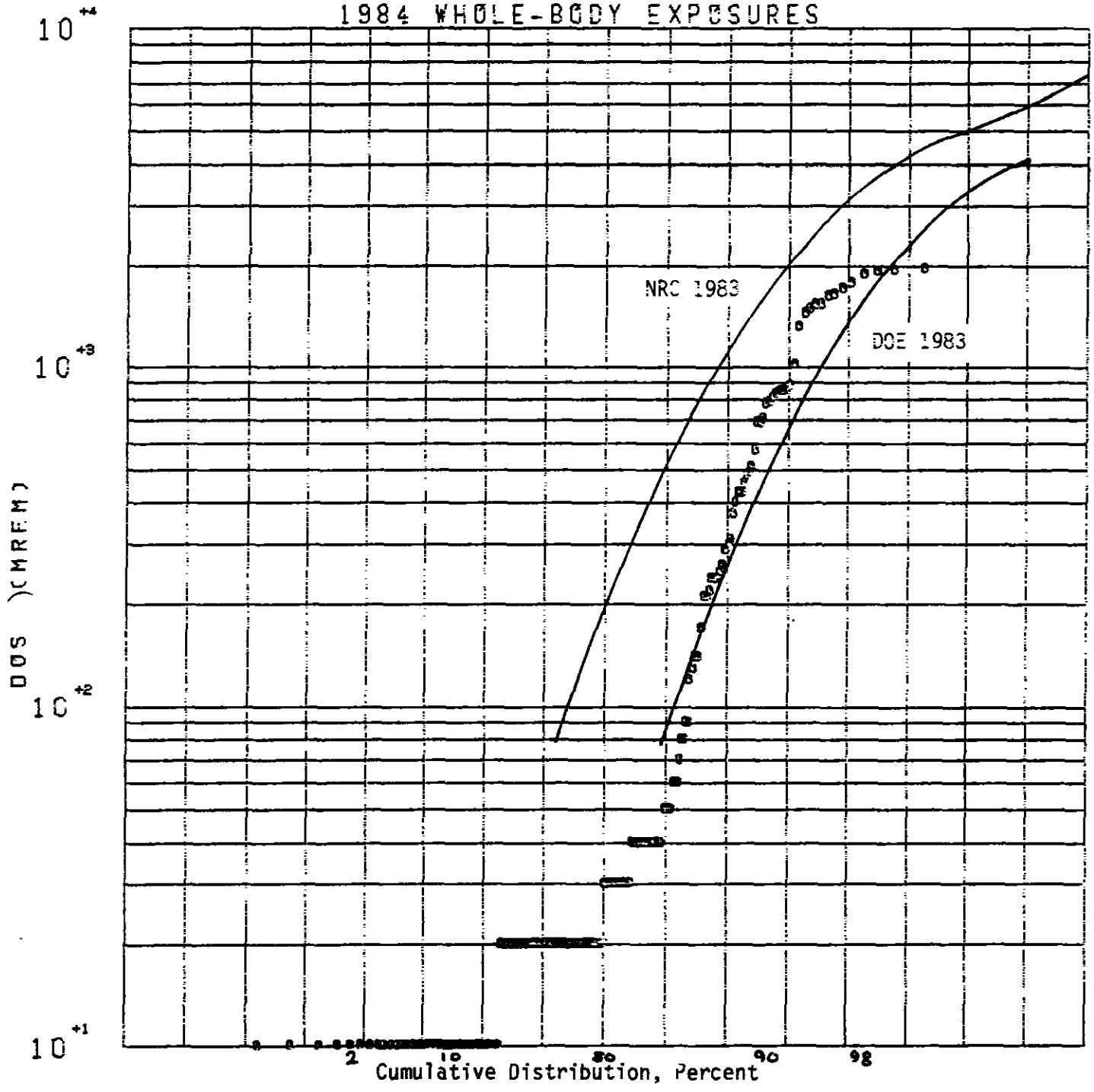

Figure 1. Cumulative Log-Normal Distribution for Whole-Body Radiation Exposures of Occupationally Exposed Individuals in 1984

2. Extremity Monitoring

Hand exposures were the limiting factor during the first 4 months of the SEFOR decladding project (in 1982) while the fuel was being removed from the cladding in a "hands-on" manner in the glove box. While the change to manipulators in the glove box in October of 1982 greatly reduced hand exposures, these exposures were carefully monitored for the rest of the project. After the initial completion of the decladding and clean up of the glove box, the need for separately monitoring hand exposure decreased greatly. The results of this monitoring are shown in Figure 2.

All extremity exposures were below the allowable quarterly limit of 18.75 rem and the adopted administrative guides of 2 rem per quarter and 5 rem per year except for two cases. In one, an employee's hands were exposed to 7.7 (right) and 7.5 (left) rems. Another individual received 2.3 rem to the left hand, which exceeded the design guide (2.0 rem per quarter) but did not exceed the action guide of 4.5 rem per quarter. The dose to the right hand was 1.2 rem.

B. BIOASSAYS

Bioassays normally consist of analysis of urine and occasionally fecal samples. Personnel whose work assignments potentially expose them to respirable-sized radioactive aerosols are routinely evaluated in this manner. Normally, urinalyses are performed quarterly and fecal analysis only when gross internal contamination is suspected. A statistical summary of the results for 1984 appears in Table 1, while a detailed listing of the positive results are shown in Table 2. Only three types of analyses showed positive results this year: FP3A, FP3B, and PUA. The PUA analysis is chemically selective for plutonium and excludes Am-241, which is generally present with plutonium such as in the SEFOR fuel. The FP3A analysis is assumed to be indicative of Sr-90, although other radionuclides, such as Co-60, may also be detected. Further analysis could specifically quantify Sr-90, and identify interfering radionuclides, if significant activities were found. The FP3B

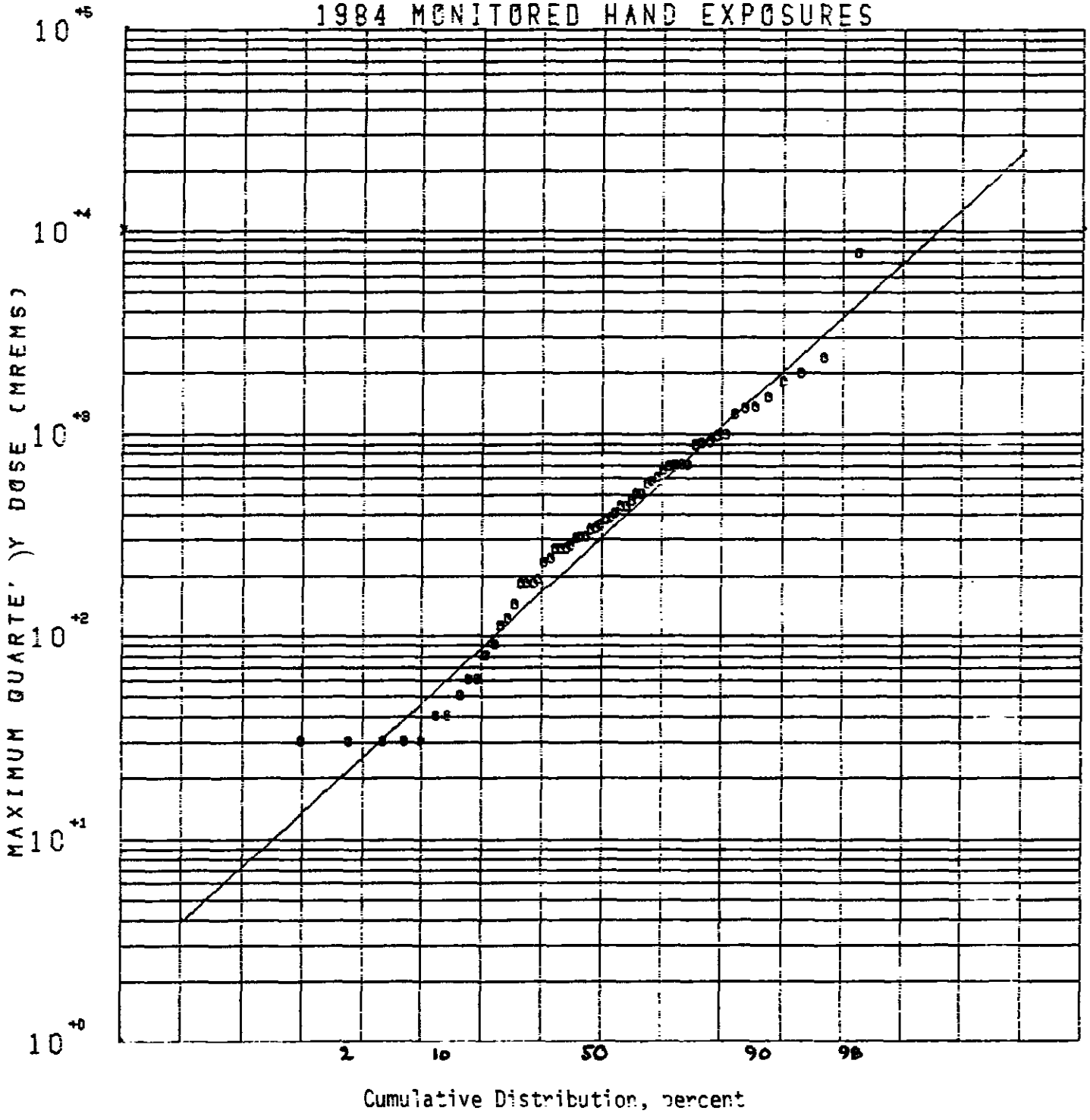

Figure 2. Hand Exposure Values (higher exposed hand from each individual) for RIHL During 1984

TABLE 1

SUMMARY OF BIOASSAYS - 1984

Measurement Type*	Total Tests	Total Positive Results	Total Individuals With Positive Results
GB	2	0	0
UF	15	0	0
UR	15	0	0
GBH	2	0	0
PUA	66	3	3
FP3A	136	15	12
FP3B	136	30	19
GA1B	1	0	0
Total	373	48	34

*UF = Uranium - Fluorometric
UR = Uranium - Radiometric
GB,G3H = Gross beta
PUA = Gross Plutonium-alpha
FP = Fission Products
GA1B = Gross alpha

(For a discussion of specific analytical techniques employed, as identified by "TYPE," see Appendix B in Reference 9)

TABLE 2

POSITIVE BIOASSAY RESULT SUMMARY - 1984
(Sheet 1 of 3)

H&S Number	Sample Date	Analysis Type*	Results		Assumed Specific Radionuclide	Assumed Critical Nuclide Equivalent MPBB (%)
			Per Vol. Anal.	Per 1500 ml-day		
1226	041584	FP3B	8.22 dpm	61.65 dpm	Cs-137	0.01
1226	022485	FP3B	2.69 dpm	20.18 dpm	Cs-137	0.00
1139	111984	FP3B	13.04 dpm	97.80 dpm	Cs-137	0.01
1139	012385	FP3B	0	-	Cs-137	0
4382	041484	FP3A	4.12 dpm	30.93 dpm	Sr-90	6.44
4382	041484	FP3B	10.27 dpm	77.03 dpm	Cs-137	0.01
4382	053284	FP3A	6.23 dpm	46.70 dpm	Sr-90	9.73
4382	053184	FP3B	10.20 dpm	76.50 dpm	Cs-137	0.01
4382	012285	FP3A	0.43 dpm	3.22 dpm	Sr-90	0.67
4382	012285	FP3B	0	-	Cs-137	0
2312	041684	FP3B	11.35 dpm	85.13 dpm	Cs-137	0.01
2312	060684	FP3B	11.50 dpm	86.25 dpm	Cs-137	0.01
2312	021895	FP3B	1.55 dpm	11.62 dpm	Cs-137	0.00
1166	041684	FP3B	8.40 dpm	63.00 dpm	Cs-137	0.01
1166	060184	FP3B	0	-	Cs-137	0
0863	040984	FP3B	8.93 dpm	66.97 dpm	Cs-137	0.01
AWC	041384	FP3B	13.02 dpm	97.65 dpm	Cs-137	0.01
AWC	053184	FP3A	4.78 dpm	35.87 dpm	Sr-90	7.47
AWC	053184	FP3B	12.72 dpm	95.40 dpm	Cs-137	0.01
AWC	011384	FP3A	3.09 dpm	23.20 dpm	Sr-90	4.83
AWC	011386	FP3B	0	-	Cs-137	0
AWC	111684	PUA	0.04 dpm	0.06 dpm	Pu	0.05
AWC	011985	PUA	0	-	Pu	0
0501	071184	FP3B	13.70 dpm	102.00 dpm	Cs-137	0.01
3912	041584	FP3A	6.97 dpm	52.28 dpm	Sr-90	10.89
3912	041584	FP3B	9.68 dpm	72.60 dpm	Cs-137	0.01
3912	061184	FP3A	1.50 dpm	11.25 dpm	Sr-90	2.34
3912	061184	FP3B	0	-	Cs-137	0

TABLE 2

POSITIVE BIOASSAY RESULT SUMMARY - 1984
(Sheet 2 of 3)

H&S Number	Sample Date	Analysis Type*	Results		Assumed Specific Radionuclide	Assumed Critical Nuclide Equivalent MPBB (%)
			Per Vol. Anal.	Per 1500 ml-day		
3983	101884	FP3B	8.50 dpm	63.70 dpm	Cs-137	0.01
3983	021585	FP3B	0	-	Cs-137	0
4183	060784	FP3A	4.06 dpm	30.45 dpm	Sr-90	6.34
3920	041584	FP3A	28.78 dpm	215.89 dpm	Sr-90	44.98
3920	052584	FP3A	0.56 dpm	4.17 dpm	Sr-90	0.87
4401	041584	FP3B	13.69 dpm	102.68 dpm	Cs-137	0.02
4401	121685	FP3B				
4362	032284	FP3B	474.40 dpm	4744.00 dpm	Cs-137	0.72
4362	032284	FP3A	10.37 dpm	103.68 dpm	Sr-90	21.60
4362	032384	FP3A	4.89 dpm	36.67 dpm	Sr-90	7.64
4362	032384	FP3B	80.20 dpm	601.50 dpm	Cs-137	0.09
4362	032784	PUA	0.09 dpm	0.14 dpm	Pu	0.12
4362	033184	FP3B	56.50 dpm	423.75 dpm	Cs-137	0.06
4362	041584	FP3A	5.24 dpm	39.28 dpm	Sr-90	8.18
4362	041584	FP3B	53.54 dpm	401.55 dpm	Cs-137	0.06
4362	042184	PUA	0.01 dpm	0.01 dpm	Pu	0.00
4362	061484	FP3B	21.40 dpm	160.50 dpm	Cs-137	0.02
4362	061484	FP3A	1.82 dpm	14.02 dpm	Sr-90	2.92
4362	061984	FP3B	40.57 dpm	304.27 dpm	Cs-137	0.05
4362	072284	FP3B	2.10 dpm	15.75 dpm	Cs-137	0.00
1362	040384	FP3B	13.55 dpm	101.63 dpm	Cs-137	0.02
1362	052484	FP3B	18.40 dpm	138.00 dpm	Cs-137	0.02
1362	111984	FP3B	23.20 dpm	174.00 dpm	Cs-137	0.03
1362	012485	FP3B	8.02 dpm	60.15 dpm	Cs-137	0.01
1362	012585	FP3B	0	-	Cs-137	0
2041	041484	FP3B	8.71 dpm	65.32 dpm	Cs-137	0.01
2041	060184	FP3A	9.91 dpm	74.34 dpm	Sr-90	15.49
2041	060184	FP3B	13.03 dpm	97.72 dpm	Cs-137	0.01
2041	101584	FP3A	3.82 dpm	29.65 dpm	Sr-90	6.00
2041	101584	FP3B	0.40 dpm	3.00 dpm	Cs-137	0.00
4910	102684	FP3B	11.32 dpm	84.90 dpm	Cs-137	0.01
4910	012285	FP3B	4.25 dpm	35.62 dpm	Cs-137	0.01

TABLE 2

POSITIVE BIOASSAY RESULT SUMMARY - 1984
(Sheet 3 of 3)

H&S Number	Sample Date	Analysis Type*	Results		Assumed Specific Radionuclide	Assumed Critical Nuclide Equivalent MPBB (%)
			Per Vol. Anal.	Per 1500 ml-day		
3726	111884	PUA	0.05 dpm	0.08 dpm	Pu	0.07
3726	010785	PUA	0	-	Pu	0
4566	062284	FP3A	5.32 dpm	39.90 dpm	Sr-90	8.31
4566	012985	FP3A	0.29 dpm	2.18 dpm	Sr-90	0.45
4137	041784	FP3B	11.13 dpm	83.47 dpm	Cs-137	0.01
4137	061484	FP3A	4.08 dpm	30.60 dpm	Sr-90	6.38
4137	061484	FP3B	0	-	Cs-137	0
4137	101684	FP3A	2.68 dpm	20.10 dpm	Sr-90	4.19
1754	042384	FP3A	4.95 dpm	37.12 dpm	Sr-90	7.73
1754	101584	FP3A	1.38 dpm	10.35 dpm	Sr-90	2.16
4404	101884	FP3B	14.15 dpm	106.10 dpm	Cs-137	0.06
4404	021185	FP3B	0	-	Cs-137	0
4906	110284	FP3B	10.70 dpm	80.20 dpm	Cs-137	0.01
4407	041684	FP3A	4.06 dpm	30.46 dpm	Sr-90	6.35
4407	101584	FP3A	4.40 dpm	33.00 dpm	Sr-90	6.88
4407	012385	FP3A	0	-	Sr-90	0
4651	050984	FP3A	6.64 dpm	49.80 dpm	Sr-90	10.38
4651	050984	FP3B	12.36 dpm	92.70 dpm	Cs-137	0.01

Pu: Gross Plutonium
FP: Fission Products

(For a brief description of the specific analytical techniques, see Appendix B of Reference 9)

(FP3A is predominantly Sr-90; FP3B is predominantly Cs-137)

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analysis is radiometrically selective for Cs-137, using gamma-ray spectrometry to measure this radionuclide.

Followup results are shown, where available, to indicate the decrease of detected activity to negligible levels.

The excretion rates assumed to be indicative of 1 MPBB for various radionuclides are:

Radionuclides	Standard Excretion Rate
Sr-90	480 dpm/day
Cs-137	660,000 dpm/day
Ra-226	10 dpm/day
Normal U (NU)	100 ug/day
Highly Enriched U (HEU)	220 dpm/day
Pu-239	121.4 dpm/day

These excretion rates are based on an assumption of equilibrium between intake and elimination. Transient elimination following an acute exposure will generally indicate a much higher body burden than actually exists.

II. RADIATION/RADIOACTIVITY MEASUREMENTS

The measurements and surveillance performed to determine local radiation levels in the working areas where licensed activities are performed are described below.

A. AREA RADIATION LEVELS

Film badges ("location badges") are placed throughout the facilities, and are kept in place during the entire calendar quarter. Some of these are in nominally low-exposure areas while some are in relatively high-exposure (but low-occupancy) areas. The average and maximum exposure rates determined for each quarter are shown in Table 3.

TABLE 3
LOCATION BADGE RADIATION EXPOSURE - 1984

Facility	Calendar Quarter Q1	Q2	Q3	Q4
	Average Exposure Rate (mR/h) / Maximum Exposure Rate (mR/h)			
Fuel Fabrication	Decommissioned			
RIHL	0.09 / 0.60	0.11 / 0.68	0.15 / 1.15	0.16 / 1.13
NMDF	0.10 / 0.66	0.03 / 0.20	0 / 0	0 / 0
RMDF	2.60 / 7.06	0.69* / 1.04*	1.08 / 1.53	1.49 / 3.97

*Dosimeters judged to be defective by vendor.

B. INTERIOR AIR SAMPLES - WORKING AREAS

In those working areas where the nature of the tasks being performed and the materials in use might lead to the potential for generation of respirable airborne radioactivity, periodic local air sampling is performed. A summary of these results for 1984 is given in Table 4.

TABLE 4

INTERIOR AIR SAMPLE SUMMARY - 1984

Area	Sample	Airborne Activity Concentration (μCi/ml) Calendar Quarter Q1	Q2	Q3	Q4	MPC
Fuel Fab		Decommissioned				
RIHL	Unposted α	1×10^{-15}	1×10^{-15}	1×10^{-15}	1×10^{-15}	2×10^{-12}
	β	1×10^{-14}	1×10^{-14}	1×10^{-14}	1×10^{-14}	1×10^{-9}
	Posted α	1×10^{-14}	1×10^{-14}	1×10^{-14}	1×10^{-14}	2×10^{-12}
	β	1×10^{-13}	1×10^{-13}	1×10^{-13}	1×10^{-13}	1×10^{-9}
	Maximum α	1×10^{-12}	2×10^{-12}	2×10^{-11}	2×10^{-13}	2×10^{-12}
	β	2×10^{-11}	4×10^{-12}	1×10^{-11}	1×10^{-14}	1×10^{-9}
NMDF	Stationary Max Week	9×10^{-15}	1.2×10^{-14}	1.6×10^{-14}	1×10^{-14}	1.3×10^{-12}
	Average	5×10^{-15}	5×10^{-15}	7×10^{-15}	7×10^{-15}	1.3×10^{-12}

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III. EFFLUENT MONITORING

Effluents which may contain radioactive material are generated at certain ESG facilities as a result of operations performed either under contract to DOE, or under the NRC Special Nuclear Materials License SNM-21, or under the State of California Radioactive Material License 0015-70. The specific facilities identified with the NRC license are Building 004 at the headquarters site and Buildings 020 and 055 at the SSFL at Santa Susana.

An annual report of effluent releases, prepared by Radiation & Nuclear Safety in the HS&RS Department, describes in detail the monitoring program at ESG for gaseous effluents from the ESG facilities. The data reported in the 1984 edition of that report[13] for atmospherically discharged effluents for the facilities identified above is presented in Table 5. (No releases of radioactively contaminated liquids were made, either to the sewer or to the environment.)

TABLE 5

ATMOSPHERIC EMISSIONS TO UNRESTRICTED AREAS--1984

	Approximate Emissions Volume (m^3)	Activity Monitored	Approximate Minimum Detection Level ($\mu Ci/ml$)	Annual Average Concentration[a] ($\mu Ci/ml$)	Sampling Period Maximum Observed Concentration[a] ($\mu Ci/ml$)	Total Radioactivity Released[a] (Ci)	Percent of Guide	Percent of Samples with Activity $\leq$ MDL
104 De Soto	1.3×10^8	α	2.1×10^{-16}	3.4×10^{-15}	1.4×10^{-14}	4.4×10^{-7}	0.11	5
		β	7.2×10^{-16}	4.5×10^{-15}	1.7×10^{-14}	5.9×10^{-7}	0.002	11
020 SSFL	3.4×10^8	α	0.9×10^{-16}	3.2×10^{-16}	4.0×10^{-15}	1.0×10^{-7}	0.53	63
		β	3.0×10^{-16}	1.4×10^{-14}	1.1×10^{-13}	4.5×10^{-6}	0.050	0
021-022 SSFL	3.4×10^8	α	0.9×10^{-16}	2.2×10^{-16}	1.4×10^{-15}	7.4×10^{-8}	0.37	50
		β	3.0×10^{-16}	1.1×10^{-15}	9.2×10^{-14}	3.7×10^{-6}	0.004	0
055 SSFL	2.6×10^8	α	2.9×10^{-16}	1.6×10^{-16}	1.5×10^{-15}	4.0×10^{-8}	0.27	63
		β	9.6×10^{-16}	3.8×10^{-15}	1.0×10^{-14}	9.8×10^{-7}	0.13	0
Total	1.1×10^9				Total	1.0×10^{-5}		
Annual average ambient air radioactivity concentration[b] ($\mu Ci/ml$) - 1984		α		1.9×10^{-15}	Ambient equivalent[c]	3.8×10^{-5}		
		β		3.3×10^{-14}				

[a]Assuming all radioactivity detected is from Rocketdyne nuclear operations.
Guide: De Soto site: 3×10^{-12} $\mu Ci/ml$ alpha, 3×10^{-10} $\mu Ci/ml$ beta; 10 CFR 20 Appendix B.
SSFL site: 6×10^{-14} $\mu Ci/ml$ alpha, 3×10^{-11} $\mu Ci/ml$ beta, 3×10^{-12} $\mu Ci/ml$ beta (055 only); 10 CFR 20 Appendix B, CAC-17, and DOE Order 5480.1 Chapter XI.

[b]Averaged result for 7-day (202 m^3) De Soto continuous air sampler.

[c]*Natural radioactivity contained in equivalent volume of air discharged through exhaust systems after filtration.*

Note: All release points are at the stack exit.

IV. ENVIRONMENTAL MONITORING PROGRAM

The basic policy for control of radiological and toxicological hazards at ESG requires that adequate containment of such materials be provided through engineering controls and, through rigid operational controls, that facility effluent releases and external radiation levels are reduced to a minimum. The environmental monitoring program provides a measure of the effectiveness of the ESG safety procedures and of the engineering safeguards incorporated into facility designs. Specific radionuclides in facility effluent or environmental samples are not routinely identified due to the extremely low radioactivity levels normally detected, but may be identified by analytical or radiochemistry techniques if significantly increased radioactivity levels are observed.

The annual report of environmental monitoring, prepared by Radiation & Nuclear Safety in the HS&RS Department, describes in detail the ESG environmental monitoring program.

Some of the data reported in the 1984 edition of that report[13] are presented here. It is important to remember that the radiological activity levels reported can be attributed not only to operations at NRC licensed, DOE-sponsored, and State of California-licensed facilities, but also to external influences such as fallout from nuclear weapon testing and naturally occurring radioactive materials.

These data are:

- Soil gross radioactivity data presented in Table 6
- Soil plutonium radioactivity data presented in Table 7
- Vegetation radioactivity data presented in Table 8
- SSFL Site - Domestic water radioactivity data presented in Table 9
- Bell Creek and Rocketdyne site retention pond radioactivity data presented in Table 10
- Ambient air radioactivity data presented in Table 11 (and shown graphically in Figure 3).
- Ambient radiation data presented in Table 12.

TABLE 6
SOIL RADIOACTIVITY DATA--1984

Area	Activity	Number of Samples	Gross Radioactivity (μ Ci/g)	
			Annual Average Value and Dispersion	Maximum Observed Value[a] and Month Observed
Onsite (monthly)	α	144	$(25.8 \pm 6.0)\ 10^{-6}$	43.35×10^{-6} (May)
	β	144	$(24.2 \pm 2.0)\ 10^{-6}$	30.1×10^{-6} (December)
Offsite (quarterly)	α	48	$(26.2 \pm 7.2)\ 10^{-6}$	51.31×10^{-6} (July)
	β	48	$(23.3 \pm 2.9)\ 10^{-6}$	28.2×10^{-6} (January)

[a]Maximum value observed for single sample

TABLE 7
SOIL PLUTONIUM RADIOACTIVITY DATA--1984

Sample Location	25 June 1984 Survey Results		4 December 1984 Survey Results	
	^{238}Pu (μCi/g)	$^{239}Pu + ^{240}Pu$ (μCi/g)	^{238}Pu (μCi/g)	$^{239}Pu + ^{240}Pu$ (μCi/g)
S-56	$(0.1 \pm 0.1)\ 10^{-9}$	$(0.9 \pm 0.3)\ 10^{-9}$	$(0.1 \pm 0.1)\ 10^{-9}$	$(2.3 \pm 0.5)\ 10^{-9}$
S-57	$(0.1 \pm 0.1)\ 10^{-9}$	$(5.2 \pm 0.7)\ 10^{-9}$	$(0.4 \pm 0.1)\ 10^{-9}$	$(2.2 \pm 0.4)\ 10^{-9}$
S-58	$(0.1 \pm 0.1)\ 10^{-9}$	$(2.9 \pm 0.4)\ 10^{-9}$	$(0.1 \pm 0.1)\ 10^{-9}$	$(3.6 \pm 0.6)\ 10^{-9}$
S-59	$(0.1 \pm 0.1)\ 10^{-9}$	$(3.5 \pm 0.4)\ 10^{-9}$	$(0.2 \pm 0.2)\ 10^{-9}$	$(5.0 \pm 0.1)\ 10^{-9}$
S-60	$(0.2 \pm 0.1)\ 10^{-9}$	$(2.3 \pm 0.3)\ 10^{-9}$	$(0.5 \pm 0.2)\ 10^{-9}$	$(3.0 \pm 0.4)\ 10^{-9}$
S-61[a]	$(0.1 \pm 0.1)\ 10^{-9}$	$(0.3 \pm 0.1)\ 10^{-9}$	$(0.1 \pm 0.1)\ 10^{-9}$	$(0.6 \pm 0.2)\ 10^{-9}$

[a]Offsite location

TABLE 8

VEGETATION RADIOACTIVITY DATA--1984

Area	Activity	Number of Samples	Gross Radioactivity (µCi/g) Dry Weight: Annual Average Value and Dispersion	Gross Radioactivity (µCi/g) Ash: Annual Average Value and Dispersion	Gross Radioactivity (µCi/g) Ash: Maximum Value[a] and Month Observed	Percent of Samples With Activity ≤ MDL[b]
Onsite (monthly)	α	144	$(0.57 \pm 0.76)\ 10^{-6}$	$(3.97 \pm 3.78)\ 10^{-6}$	2.04×10^{-5} (November)	35
	β	144	$(23.1 \pm 11.3)\ 10^{-6}$	$(136.2 \pm 47.1)\ 10^{-6}$	253.5×10^{-6} (December)	0
Offsite (quarterly)	α	48	$(0.94 \pm 1.13)\ 10^{-6}$	$(3.97 \pm 4.53)\ 10^{-6}$	3.08×10^{-5} (July)	27
	β	48	$(30.9 \pm 12.0)\ 10^{-6}$	$(136.0 \pm 44.6)\ 10^{-6}$	278.2×10^{-6} (January)	0

[a]Maximum value observed for single sample
[b]Minimum detection level: 2.27×10^{-6} µCi/g alpha; 0.36×10^{-6} µCi/g beta (ash)

TABLE 9

SUPPLY WATER RADIOACTIVITY DATA--1984

Area	Activity	Number of Samples	Gross Radioactivity (µ Ci/g) Average Value and Dispersion	Gross Radioactivity (µ Ci/g) Maximum Value[a] and Month Observed
De Soto (monthly)	α	12	$(3.82 \pm 0.93)\ 10^{-9}$	5.87×10^{-9} (April)
	β	12	$(3.40 \pm 0.45)\ 10^{-9}$	4.3×10^{-9} (May)
SSFL (monthly)	α	24	$(3.53 \pm 3.94)\ 10^{-9}$	1.33×10^{-8} (November)
	β	24	$(2.93 \pm 0.60)\ 10^{-9}$	4.01×10^{-9} (March)

[a]Maximum value observed for single sample

TABLE 10

BELL CREEK AND RETENTION POND RADIOACTIVITY DATA--1984

Area (monthly)	Activity	Number of Samples	Gross Radioactivity Concentrations		
			Annual Average Value and Dispersion	Maximum Value[a] and Month Observed	Percent of Samples With Activity ≤ MDL[b]
Bell Creek mud no. 54 (μCi/g)	α	12	$(21.9 \pm 4.4)\ 10^{-6}$	42.96×10^{-6} (May)	0
	β	12	$(23.5 \pm 2.7)\ 10^{-6}$	31.2×10^{-6} (May)	0
Pond R-2A mud no. 55 (μCi/g)	α	12	$(25.8 \pm 6.0)\ 10^{-6}$	34.60×10^{-6} (January)	0
	β	12	$(23.2 \pm 1.6)\ 10^{-6}$	26.4×10^{-6} (February)	0
Bell Creek vegetation no. 54 (μCi/g Ash)	α	12	$(1.70 \pm 1.70)\ 10^{-6}$	5.67×10^{-6} (July)	67
	β	12	$(138.1 \pm 27.0)\ 10^{-6}$	184.4×10^{-6} (November)	0
Bell Creek vegetation no. 54 (μCi/g dry weight)	α	12	$(0.38 \pm 0.57)\ 10^{-6}$	2.27×10^{-6} (July)	67
	β	12	$(26.4 \pm 7.7)\ 10^{-6}$	42.8×10^{-6} (September)	0
Bell Creek water no. 16 (μCi/ml)	α	12	$(4.15 \pm 8.30)\ 10^{-9}$	2.87×10^{-8} (January)	92
	β	12	$(2.88 \pm 0.58)\ 10^{-9}$	4.6×10^{-9} (January)	0
Pond Water no. 6 (μCi/ml)	α	12	$(4.90 \pm 9.11)\ 10^{-9}$	25.92×10^{-9} (September)	92
	β	12	$(4.58 \pm 0.75)\ 10^{-9}$	5.66×10^{-9} (May)	0
SSFL pond R-2A water no. 12 (μCi/ml)	α	12	$(0.15 \pm 1.70)\ 10^{-9}$	2.70×10^{-9} (March)	100
	β	12	$(4.25 \pm 0.85)\ 10^{-9}$	5.87×10^{-9} (May)	0

[a]Maximum value observed for single sample
[b]Minimum detection level: Approximately 6.40×10^{-9} μCi/ml alpha; 0.64×10^{-9} μCi/ml beta

TABLE 17

AMBIENT AIR RADIOACTIVITY DATA--1984

Area (monthly)	Activity	Number of Samples	Gross Radioactivity Concentrations			
			Annual Average Value and Dispersion	Maximum Value[a] and Month Observed	Percent of Guide[b]	Percent of Samples With Activity ≥ MDL
De Soto Onsite (μCi/ml) (2 locations)	α	712	$(1.9 \pm 9.3)\ 10^{-15}$	3.2×10^{-14} (04/22)	0.06	90[c]
	β		$(2.7 \pm 2.7)\ 10^{-14}$	2.5×10^{-13} (02/21)	0.009	15[d]
SSFL Onsite (μCi/ml) (5 locations)	α	1730	$(1.4 \pm 3.4)\ 10^{-15}$	2.9×10^{-14} (11/14)	2.3	93[c]
	β		$(2.3 \pm 1.4)\ 10^{-14}$	2.0×10^{-13} (02/22)	0.08	20[d]
SSFL sewage treatment plant (μCi/ml)	α	365	$(1.4 \pm 3.0)\ 10^{-15}$	1.6×10^{-14} (10/07)	2.3	93[c]
	β		$(2.6 \pm 2.5)\ 10^{-14}$	2.0×10^{-13} (04/06)	0.09	15[d]
SSFL Control Center (μCi/ml)	α	366	$(1.4 \pm 3.1)\ 10^{-15}$	1.1×10^{-14} (12/21)	2.3	95[c]
	β		$(2.3 \pm 1.4)\ 10^{-14}$	6.4×10^{-14} (07/07)	0.08	18[d]

[a]Maximum value observed for single sample.
[b]Guide: 3×10^{-12} μCi/ml alpha, 3×10^{-10} μCi/ml beta; 10 CFR 20 Appendix B. SSFL site: 6×10^{-14} μCi/ml alpha, 3×10^{-11} μCi/ml beta; 10 CFR 20 Appendix B, CAC 17, DOE Order 5480.1A
[c]MDL = 6.4×10^{-15} μCi/ml alpha
[d]MDL = 1.3×10^{-14} μCi/ml beta

TABLE 12

DE SOTO AND SSFL SITES--AMBIENT RADIATION DOSIMETRY DATA--1984

TLD Location		Quarterly Exposure (mR)				Annual Exposure (mR)	Equivalent Exposure at 1000 ft ASL[b]	
		Q-1	Q-2	Q-3	Q-4		(mR)	(μR/h)
De Soto	DS-1	27	31	25	19	102	104	12
	DS-2	28	28	22	18	96	98	11
	DS-3	29	28	26	18	101	103	12
	DS-4	30	31	22	20	103	105	12
	DS-5	27	27	21	17	92	94	11
	DS-6	30	30	25	21	106	108	12
	DS-7	24	26	22	16	88	90	10
	DS-8	25	26	23	19	93	95	11
Mean value		28	28	23	19	98	100	11
SSFL	SS-1	36	33	31	20	120	108	12
	SS-2	31	35	26	23	115	103	12
	SS-3	33	36	29	23	121	109	12
	SS-4	36	33	28	21	118	105	12
	SS-5	36	32	26	a	112	99	11
	SS-6	a	34	22	22	104	93	11
	SS-7	35	31	39	21	126	114	13
Mean value		33	33	29	22	117	104	12
Offsite	OS-1	30	29	26	19	104	106	12
	OS-2	26	23	22	18	89	87	10
	OS-3	26	29	23	18	96	98	11
	OS-4	31	29	27	18	105	103	12
	OS-5	29	31	27	21	108	109	12
Mean value		28	28	25	19	100	101	11

[a] Missing dosimeter; annual exposure based on data for three quarters.
[b] Above sea level

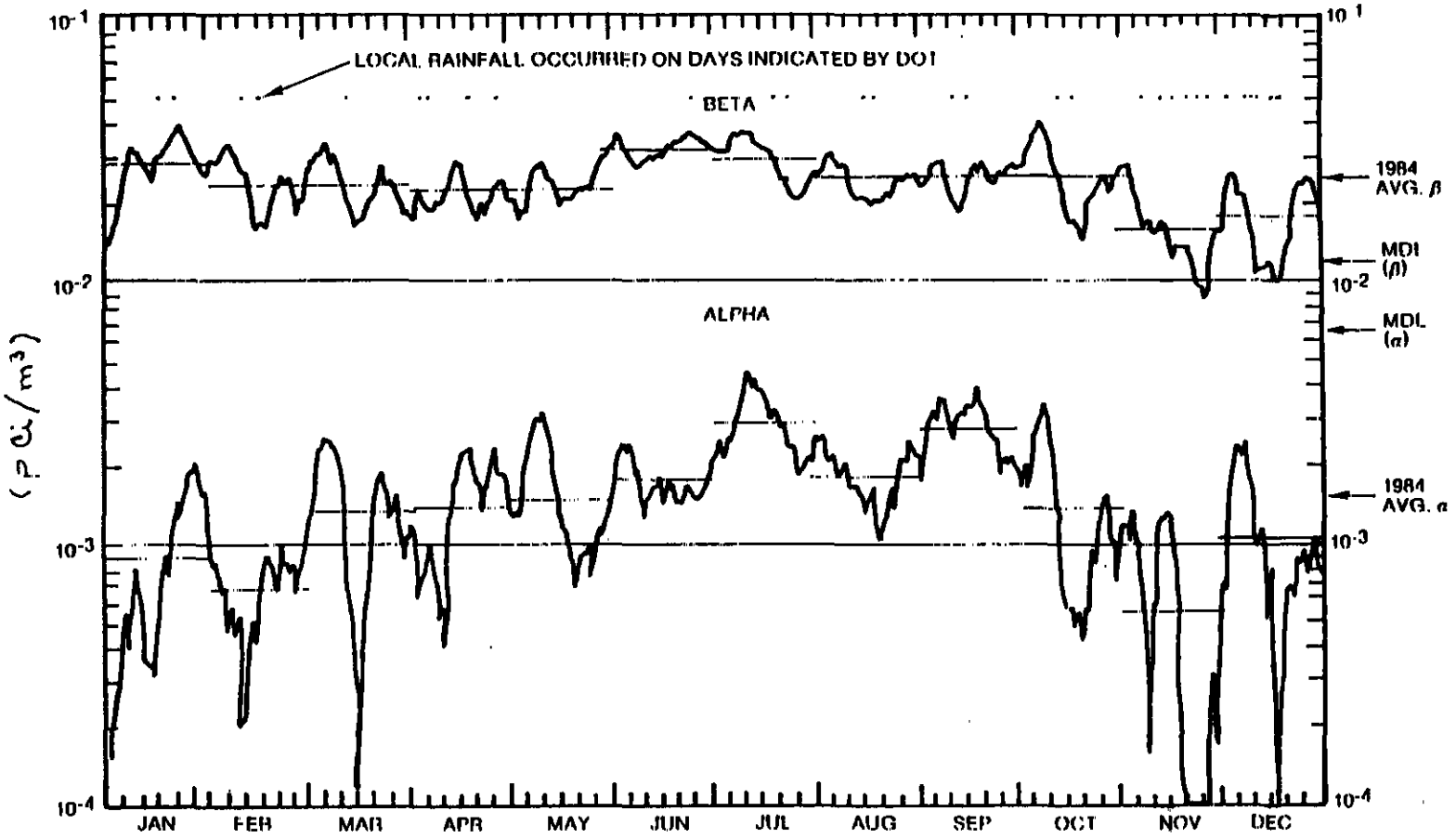

Figure 3. Average Long-Lived Airborne Radioactivity at the De Soto and Santa Susana Field Laboratories Sites - 1984

V. UNUSUAL EVENTS

There were several unusual events at facilities involving radiation or radioactive materials. These events are summarized below.

A. REPORTABLE INCIDENTS

None.

B. NONREPORTABLE INCIDENTS

January 30, 1984

A radioactive contamination incident involving tantalum-182 was detected at the RIHL.

During a Rad Pac sealed source encapsulation operation on January 9, 1984, the heliarc welding electrode stuck to the source capsule during a weld closure. Apparently some tantalum-182 source material (~2 microcuries) stuck to the electrode and remained with it when it was wrenched loose. This electrode was changed out and placed on the welder power transformer and forgotten. Upon completion of the encapsulation process, the welding machine with the contaminated electrode was returned to the RIHL clean machine shop.

On Saturday, January 28, 1984, a crew was installing a new section of alpha glove box exhaust ducting in the RIHL basement. The duct had to be welded in place. The weld transformer was on the main floor in the heating and ventilating room; the power leads were wrapped in plastic and dropped through a pipeway to the radiologically controlled area of the basement. During the welding operation, a new electrode for the stinger was required. A RIHL staff member searched around and found one on the transformer. He ground a new point on the electrode using the tool grinder in the clean machine shop, not suspecting the electrode was radioactively contaminated. The welding job was completed and personnel were surveyed as clean from the basement. The weld cables also surveyed clean.

Upon returning to work Monday, January 30, 1984, and after making the morning rounds in the service gallery, the Radiation and Nuclear Safety representative detected slight radioactive contamination on his shoes. A maslin mopping of the area was requested. The mop cloth was gamma scanned with the Canberra gamma spectrometer which indicated the presence of tantalum-182. Using more mops in other areas, it was quickly determined that this contamination was widespread throughout the RIHL.

The building was secured to personnel traffic. The source of contamination was found to be the tool grinder area in the clean machine shop with activity levels up to 90,000 d/m on and around the grinder. A reconstruction of time and sequence of events indicated the grinder contamination occurred on Saturday.

The RIHL staff member who assisted during the duct welding on January 28, 1984, was called in from vacation. A survey of the shoes and clothing he wore on that date indicated the presence of tantalum-182 with activity levels to 8,000 d/m. The bottom of his shoes were clean. A subsequent radiological survey of his car and home showed no detectable activity.

Two painters from SSFL maintenance and their supervisor, who worked in the operating gallery of the RIHL on Saturday, were surveyed, along with their tools and equipment. No activity was detected.

Eighteen security personnel who might have entered the area were surveyed with no activity detected.

Bioassay samples for two employees who were radioactively contaminated were submitted for analysis, the results of which indicated that no internal exposure had occurred.

March 22, 1984

During decontamination of the electropolishing hood and transfer drawer in Cell 3 at the RIHL, a worker got alkaline rust remover solution on his

forearm. Apparently, his plastic rain suit separated from his gloves or the joint had not been properly taped. Some activity was absorbed by the skin and was detected by urinalysis. This activity decreased to undetectable levels 4 months later.

May 23, 1984

While removing a grinding wheel from the centerless grinder used for Fermi fuel in Cell 2 at the RIHL, a mechanic received hand exposures amounting to 2.33 rem to the left hand and 1.16 rem to the right hand. These were above the ESG design guide of 2 rem per quarter but were well below the allowable limit of 18.75 rem per quarter. The whole-body dose received during this job was not high. Apparently the hand dose was due predominantly to beta radiation from contamination of parts the individual handled directly.

August 20, 1984

A radiation worker entered cell 3 of the RIHL for repair of the laser used for fuel rod decladding. During the repair, the individual bumped his head on a metal framework in-cell which resulted in a skin abrasion with some bleeding. The worker's forehead was covered with protective clothing at the injury site; however, it was felt that the abrasion resulted from the respirator head harness buckle-retaining rivet being pressed into the skin by the framework. A wound contamination survey performed after the worker left the cell did not detect any radioactivity. The worker was subsequently directed to the Medical Department for preparation of an injury report.

August 21, 1984

Two recently hired radiation workers were performing general cleanup in decontamination cell 3. They found an open bag of tools and proceeded to wipe them down. After leaving the cell, a routine personal survey found radioactive contamination on their pants of up to 50,000 dpm beta. There was no contamination to their persons as indicated by direct skin monitoring and nasal

smears. Follow-up bioassay studies for possible internal exposure to radioactive materials by inhalation or ingestion were negative.

October 26, 1984

During the process of double bagging dry radioactive waste at the RIHL, a radiation worker inadvertently grasped a contaminated bag with bare hands. The left hand was radioactively contaminated to about 5,000 dpm beta, the right hand to about 7,500 dpm beta as measured with a GM-type pancake thin window detector survey meter. Both hands were readily decontaminated to less than detectable levels with three successive applications of soap with brush scrubbing. A bioassay specimen was taken to evaluate possible internal exposure to radioactive material. The results indicated that an extremely small amount of radioactive material intake had occurred. Resultant recommendation was to require "coldmen" to wear gloves and laboratory coats during bagout operations.

December 6, 1984

During the routine cleanup of cell 1, a radiation worker reached upward causing his protective clothing-surgeon glove taped interface to become separated with bare wrist skin exposure. The worker immediately retreated to the decontamination room for re-taping. On completion of the job, he was monitored for contamination with the right forearm indicating 500,000 dpm beta and 200 dpm alpha. After considerable decontamination effort, these levels were reduced to background levels and the worker was released for normal work. A bioassay specimen was taken the following day to evaluate the possible internal exposure to radioactive material. The results indicated a small amount of radioactive material intake. Resultant recommendation was for workers to fully test protective apparel interface seals prior to entry into a contaminated area.

December 10, 1984

A cell 1 (RIHL) exit survey of a radiation worker detected radioactive contamination to the neck and to the left forearm. The contamination levels of 25,000 dpm beta and 5,000 dpm beta, respectively, were decontaminated to background. Evaluation of the event indicated that no specific cause can be identified, however, this type of skin contamination usually occurs when the head covering hood opens and exposes the skin. The Radiological Safety Incident Report for this event indicates that a bioassay specimen was requested from the worker, however, no specimen was received until February 12, 1985.

December 10, 1984

A cell 1 (RIHL) exit survey of a radiation worker detected radioactive contamination to the left hand of up to 1,500 dpm beta. After decontamination, the worker was released for normal work assignment. Bioassay specimen was not requested. Resultant recommendation is that worker(s) should exercise more caution in dressing-out and in glove changing in areas where gross contamination in the form of fine powder is present.

December 7 and 10, 1984

A radiation worker made an entry into cell 1 (RIHL) to bag and remove equipment and material from the cell which required decontamination and clean-out for another job. The worker was directly handling and monitoring (for penetrating radiation only) each item being removed. On December 11, the in-house TLD finger ring dosimeters worn on each hand by the worker during both entries were evaluated. These data are not used for the permanent exposure record but are used for exposure planning purposes only. The results were 11,954 mrem right hand and 5,927 mrem for the left hand. The workers vendor-supplied extremity dosimeters were immediately sent out for processing by the NVLAP Certified vendor and were reported as 7,750 mrem right hand and 7,710 mrem left hand. These values were greater than the Rocketdyne internal limit for hand exposure of 2 rem/quarter; therefore, an investigation to

determine the cause of the exposure was started. Among the several findings and conclusions produced by the investigation, the most significant finding with respect to radiological monitoring was the relative inattention to nonpenetrating radiation (compared to penetrating radiation) fields in the cell. The beta radiation from radionuclides present in the irradiated fuel could contribute a large fraction of the recorded exposure.

VI. SUMMARY/TRENDS - EXPOSURE, EFFLUENTS

A. PERSONNEL EXPOSURES

Personnel exposures due to external radiation are summarized by year in the following table:

	Number of Persons in Exposure Range (rem)											
Year	0 0.1	0.1 0.25	0.25 0.5	0.5 0.75	0.75 1.0	1.0 2.0	2.0 3.0	3.0 4.0	4.0 5.0	Total Exposed Persons	Group Dose (Person rems)	Average Dose (rems)
1984	178	16	14	5	8	14				235	45	0.192
1983	281	9	5	4	5	13	8	2	17	344	138	0.402
1982	349	29	8	3	6	15	4	7	8	429	116	0.271
1981	192	55	13	4	6	4				274	33	0.121
1980	357	39	10	3	5	9	3			426	56*	0.131*
1979	347	39	19	10	4	15	8	2		444	91*	0.204*
1978	432	60	18	16	4	18	9	1	1	559	110*	0.197*
1977	340	31	29	7	5	11	13			436	91*	0.209*
1976	295	38	17	14	5	9	2			380	59*	0.156*
1975	170	24	12	4	5	6	1	1		223	39*	0.175*

*Determined by use of mid point of range

Data shown for 1980 and prior years include visitors. Visitor exposures rarely exceed 0.25 rem. Data for 1981 through 1984 represent occupationally exposed ESG employees. The group dose was calculated exactly for these four years. This results in values that are approximately 10% lower than those calculated by use of the mid point of the exposure ranges.

Exposures during 1984 showed a significant reduction in group dose. This resulted both from a change in the type of work being done (SEFOR decladding

was completed in 1983) and very effective implementation of the ESG administrative limits for radiation exposure. This improvement is shown in both the group dose and the average dose, and also in the reduced number of personnel exposed over 1 rem.

Internal dosimetry for the estimation of organ doses or dose commitments that have been received from internally deposited radioactive material has not been generally done. It is complicated and time consuming, and the detected amounts of radioactive material have been so small as to not warrant it.

Internal depositions of radioactive material, as monitored by the bioassay program, are shown in the table below.

Year	Number of Tests Performed	Number of Tests with Positive Results	Percent Positive
1984	373	48	12.9
1983	527	30	5.7
1982	742	66	8.9
1981	768	66	8.6
1980	864	44	5.1
1979	1099	79	1.2
1978	1022	80	8.7
1977	1272	158	12.4
1976	1481	67	4.5
1975	1483	57	3.8

This table shows, for the past 10 years, all the tests performed and the number of tests that were considered to be "positive." A "positive" result is one that exceeds the minimum detectable activity (MDA) for the particular analysis. During the time covered by this series of reports, the number of

bioassays has generally declined as the number of people working with unencapsulated radioactive material has decreased. The number of positive results has stayed roughly constant for the past 5 years, resulting in an increase of the percentage of positive tests. Most of these positive results have been due to work at the RIHL, which has remained relatively steady during these years. Following tables show the distribution for the three major radionuclides tested during this time period: Cs-173 (FP3B), Sr-90 (FP3A), and highly enriched uranium (HEU). While the FP3A analysis is not specifically selective for Sr-90, that is the most restrictive radionuclide likely to be present and detected. The results for HEU (highly enriched uranium) are from Helgeson lung counts which, as discussed in detail in the 1983 report,[10] appear to be markedly biased in the high direction and may be totally incorrect in indicating the presence of U-235 at these levels.

The highest result for Cs-137 in 1984 was due to a skin-absorption incident (see Section V, "March 22, 1984"). All other cases showed less than 0.1% of a maximum permissible body burden for Cs-137.

Cs-137

Year	Number of FP3B Tests	Number with Positive Results	Fraction with less than 0.01% MPBB	Maximum % MPBB
1984	136	30	0.656	0.72
1983	76	6	0.833	0.02
1982	171	4	0.667	0.03
1981	141	3	0	0.02
1980	116	4	0	0.04
1979	233	27	0	1.2
1978	271	22	Incomplete data	
1977	298	43	Incomplete data	
1976	171	6	0	0.02
1975	190	1	1.0	0.01

The highest results shown for Sr-90, 45%, was essentially gone 40 days later, and may have resulted from an anomaly at the laboratory, or may have represented some other beta-emitting radionuclide, such as Co-60, which has a relatively short biological half-life (9.5 days).

Sr-90

Year	Number of FP3A Tests	Number with Positive Results	Fraction with less than 10% MPBB	Maximum % MPBB
1984	136	15	0.800	45.0
1983	74	0	None	
1982	174	32	0.407	59.8
1981	141	31	0.485	61.9
1980	116	7	0.286	58.8
1979	233	14	Incomplete data	
1978	271	45	Incomplete data	
1977	298	62	Incomplete data	
1976	169	10	0	21.7
1975	194	4	0.333	14.4

With the completion of all work with unirradiated highly enriched uranium (HEU) in 1983, no further lung counts have been done. The reader is cautioned to be aware that the values reported are incorrectly high and in most cases do not represent real depositions of HEU.

Highly Enriched Uranium

Year	Number of HEU Tests	Number with Positive Results	Fraction with less than 25% MPBB	Maximum % MPBB
1984	None done			
1983	150	8	1.0	21.1
1982	206	21	0.900	27.3
1981	215	28	0.964	25.3
1980	259	16	1.0	21.2
1979	276	9	1.0	22.4
1978	249	11	1.0	20.5
1977	280	22	0.955	34.4
1976	469	16	0.938	26.8
1975	373	1	1.0	23.5

B. WORK PLACE RADIATION AND RADIOACTIVITY

The general radiation levels in the work place, as determined by readings from location badges, are summarized in the table below:

	Facility			
	Average Exposure Rate (mR/h) / Maximum Exposure Rate (mR/h)			
Year	Fuels	RIHL	NMDF	RMDF
1984	-	0.13 / 1.15	0.03 / 0.66	1.72 / 7.06
1983	0.02 / 0.03	0.47 / 6.42	0.01 / 0.05	0.82 / 4.15
1982		0.10 / 0.21	0.02 / 1.21	4.24 / 42.4

Variations reflect changes in workload, with some deliberate improvement at the RMDF.

Airborne radioactivity, in terms of the average percentage of the maximum permissible (occupational) concentration (MPC) is shown for monitored areas below:

	Percent of MPC			
Year	Fuels	RIHL	NMDF	RMDF
1984	-	0.5	0.5	-
1983	1.1	0.5	0.5	-
1982	2.8	0.06	0.2	-
1981	0.1	0.05	1.8	-
1980	5.0 (lapel)	0.20	-	-

C. ATMOSPHERIC EFFLUENT RELEASES

Atmospheric effluent releases are monitored by use of stack samplers at the major facilities. The results are shown below in terms of the total activity released. In some cases, the releases were at concentrations less than the ambient (natural) airborne radioactivity; in others, much of the activity is natural resulting from the use of unfiltered bypass air in the exhaust system.

A significant change has been made in the manner in which those releases are calculated from the effluent sampling measurements. Prior to 1982, all concentration values less than the minimum detection level (MDL) were set equal to the MDL in calculating the average concentration release. This was done on the basis of DOE requirements. It was recognized that this practice biased the reported results upwards by a considerable amount, and DOE changed its guidance. Now, all measured values, even zeroes and negative ("less than background") values, are used in the calculation.

The major fluctuation observed in the beta activity released from the RIHL is due primarily to changes in the work in the hot cells. With these exceptions, a major fraction of the activity reported as discharged from the RIHL and the NMDF actually came from natural radioactivity in the unfiltered bypass air taken into the exhaust systems near the blowers to prevent excessive suction.

RADIOACTIVITY DISCHARGED TO ATMOSPHERE
(microcuries)

	De Soto		Santa Susana		
	001	004	RIHL	RMDF	NMDF
1984 α	-	0.44	0.10	0.074	0.04
β	-	0.59	4.5	3.7	0.98
1983 α	52.0	1.1	0.024	0.047	0.08
β	19.0	1.1	1.3	1.1	1.1
1982 α	1.2	0.24	0.03	0.024	0.023
β	0.94	1.1	14.0	0.61	1.0
1981 α	2.8	0.39	0.069	0.087	0.059
β	2.7	4.1	14.0	4.0	2.0
1980 α	5.3	1.0	0.17	0.061	0.082
β	4.3	4.9	17.0	1.7	1.1
1979 α	2.1	1.1	0.18	0.085	0.053
β	5.8	5.7	44.0	2.7	0.21
1978 α	16.0	0.65	0.13	0.1	0.081
β	5.0	4.3	59.0	11.0	-
1977 α	10.0	0.88	0.1	0.11	0.15
β	4.1	7.5	13.0	3.0	-
1976 α	64.0	8.1	0.15	0.23	0.15
β	17.0	8.9	5.8	1.1	-
1975 α	3.7	5.4	0.15	0.45	0.19
β	2.6	12.0	6700.0*	10.0	-

*Released from burned fuel slug.

5041Y/slw

D. AMBIENT (ENVIRONMENTAL) RADIATION EXPOSURE

Ambient (environmental) radiation exposure rates as measured by CaF_2:Mn TLDs and averaged for all locations are shown below.

	Quarterly Dose (mrem)				Annual Dose (mrem)
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	
1984	29.9	30.1	25.6	19.6	105.2
1983	30.1	28.9	30.2	27.4	116.6
1982	29.1	30.8	31.8	31.9	123.8
1981	38.2	33.5	35.2	43.9	150.8
1980	35.0	34.4	37.7	49.1	157.3
1979	32.1	38.1	38.0	39.4	147.8
1978	27.3	35.5	33.4	36.6	133.1
1977	24.2	29.2	32.9	30.9	117.5
1976	21.6	24.8	22.5	25.0	93.9
1875	21.3	24.6	26.2	25.4	97.6

The quarterly doses are plotted as a histogram in Figure 4. This graph, and the tabulated annual doses, show a clear increase from 1976 to 1980, followed by a decrease for 1981, 1982, 1983, and 1984. All data prior to 1982 were obtained using an EG&G TL-3 reader. Data for 1982 and later were obtained using a Victoreen Model 2810. This is a new reader, built on the basic design of the TL-3 reader, but with modern electronics and digital adjustments and readout.

The increasing trend (from 1976 to 1980) was also observed in data for the Rocky Flats Plant, the only other DOE facility where the same type dosimeters are used, but not at any other facility. The cause has not been identified, but since the trend exists equally for the De Soto, Santa Susana, and off-site TLDs, at this time it is assumed to be either a true environmental effect, or an artifact of the TLD reading or calibration.

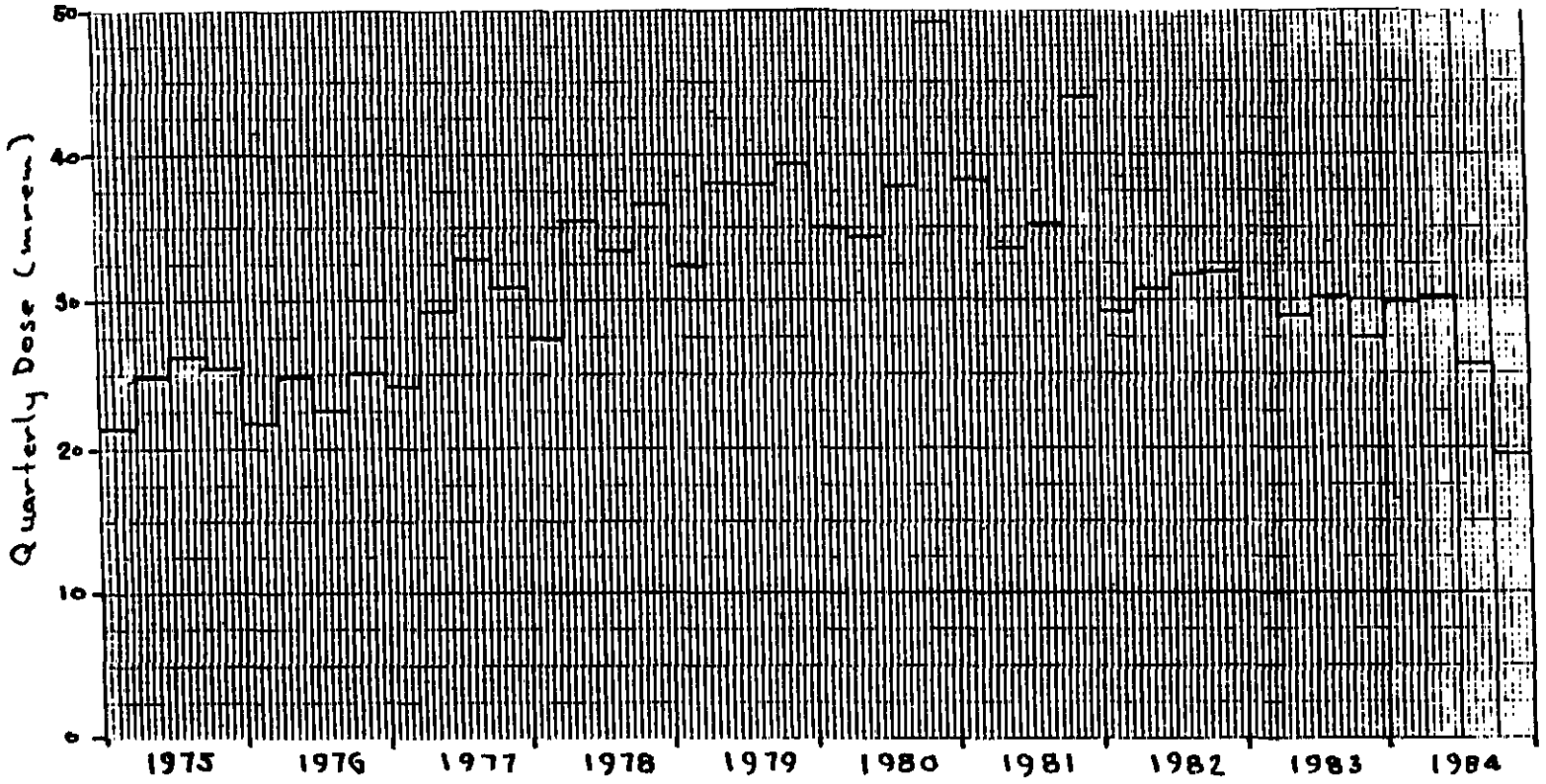

Figure 4. Averaged Quarterly Dose Recorded by Environmental TLDs

The annual ambient exposure rates (mrem/year) measured at De Soto, SSFL, and the several offsite locations are shown below:

	De Soto		SSFL		Offsite	
Year	Average	Maximum	Average	Maximum	Average	Maximum
1984	98	106	117	126	100	108
1983	110	123	126	136	115	123
1982	118	135	132	144	124	128
1981	144	159	162	188	148	162
1980	164	193	166	184	163	166
1979	138	149	161	193	131	140
1978	128	140	143	149	126	131
1977	116	125	121	138	106	108
1976	89	99	101	124	91	101
1975	96	105	104	123	94	105

Comparison of the average values and the maximum location values for the three types of sites snows the same increase from 1976 to 1980 and then a decrease to 1984. The cause of this behavior is under continuing study with no definite conclusions produced as yet. The values at SSFL are all somewhat greater than De Soto and offsite locations due to the significantly greater elevation of the SSFL site, and possibly also due to the greater outcropping of uranium-mineral-bearing sandstone. There is no indication of significant exposure resulting from operations with radioactive material.

Average and maximum values for soil readioactivity are shown in Table 13. This table shows tne change in reported alpha activity resulting from adoption of a calibration factor for thick soil samples. Prior to 1984, only relative values were reported, which served the function of monitoring for changes quite well but produced values that did not reflect the correlation of alpha and beta activity from naturally present radioactive elements (potassium, 0 alphas, 1 beta per decay; uranium chain, 8 alphas, 6 betas; thorium chain, 6 alphas, 4 betas).

Four high values of soil beta activity have been detected onsite (out of 1440 samples): those shown as maximum values for the years 1978-1981. The maximum values for 1979 and 1980 were along the southwest side of the RMDF and may have resulted from a cleanup of the so-called "West Bank" near the RMDF just prior to these years. The 1978 and 1981 values were from samples taken near the SS Vault (T064). Follow-up surveys failed to locate additional, significant contamination. (It should be noted that only tne 1980 value exceeds the working limit of 100 pCi/g gross detectable beta activity adopted for our decontamination work.)

Results for the semiannual plutonium soil analyses are shown in Tables 14 and 15. The onsite averages are generally higher than offsite but not greatly so. This may represent differences between the set of five onsite locations and the single offsite location. While plutonium is found in low concentrations everywhere as a result of atmospheric nuclear weapons tests at several different locations around the world, the concentration at a given location is affected by meteorological conditions following the test explosion and after deposition. Comparison of the onsite values shows no systematic variation with location relative to the NMDF.

TABLE 13
SOIL RADIOACTIVITY SUMMARY
1975-1984
(pCi/g)

		Onsite				Offsite			
		Alpha		Beta		Alpha		Beta	
	Year	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value
	1984	25.8 ± 6.0	43.4	24.2 ± 2.0	30.1	26.2 ± 7.2	51.3	23.3 ± 2.9	28.2
a	1983	0.6 ± 0.2	1.1	24.2 ± 2.0	29.7	0.6 ± 0.2	1.1	23.0 ± 2.8	27.8
	1982	0.7 ± 0.2	1.2	24.6 ± 2.3	30.1	0.7 ± 0.2	1.2	23.3 ± 3.7	32.9
	1981	0.7 ± 0.2	1.3	25.4 ± 3.5	38.2	0.6 ± 0.2	1.3	22.8 ± 4.5	33.2
b	1980	0.6 ± 0.2	1.1	24.0 ± 1.0	110.0	0.6 ± 0.2	1.0	23.0 ± 1.0	30.0
	1979	0.6 ± 0.2	1.1	25.0 ± 1.0	97.0	0.5 ± 0.1	0.8	23.0 ± 1.0	29.0
	1978	0.6 ± 0.2	1.0	24.0 ± 0.9	48.0	0.5 ± 0.1	1.0	24.0 ± 0.9	34.0
	1977	0.6 ± 0.2	1.1	24.0 ± 0.9	31.0	0.5 ± 0.2	0.8	23.0 ± 0.8	27.0
	1976	0.6 ± 0.2	0.8	25.0 ± 1.0	32.0	0.6 ± 0.2	1.0	24.0 ± 1.0	30.0
	1975	0.6 ± 0.1	1.0	25.0 ± 1.0	35.0	0.6 ± 0.2	1.0	24.0 ± 1.0	27.0

[a]Values reported for alpha activity in soil before 1984 are relative values only. The 1984 values reflect correction for self absorption of alpha particles by the thick soil samples.
[b]Prior to 1981, data less than the MDL were treated equal to the MDL. For 1981 and later, actual measured values were used.

5041Y/sjh

TABLE 14

PLUTONIUM IN SOIL SUMMARY
1978-1984
(Pu-239 + Pu-240, fCi/g)

	Onsite		Offsite
Year	Average ± Dispersion	Maximum Value	Average ± Dispersion
1984	3.1 ± 1.3	5.2	0.4 ± 0.2
1983	5.2 ± 4.4	14.4	7.0 ± 0.2
1982	4.0 ± 2.4	7.3	2.7 ± 3.3
1982	4.2 ± 4.5	15.9	1.2 ± 1.0
1980	8.4 ± 8.5	29.5	1.3 ± 0.9
1979	7.0 ± 6.7	18.9	2.6 ± 1.3
1978	4.5 ± 2.9	9.0	4.4 ± 1.6

TABLE 15

SUMMARY OF PLUTONIUM IN SOIL
(Pu-239 + Pu-240, fCi/g)

	Location	Average ± Dispersion	Maximum Value	Date
S-56	1100 ft NW NMDF	4.7 ± 4.9	14.4	December 1983
S-57	900 ft SE NMDF	4.1 ± 2.4	9.5	June 1980
S-58	500 ft SE NMDF	5.7 ± 4.9	18.9	December 1979
S-59	900 ft ESE NMDF	5.2 ± 4.4	18.6	December 1979
S-60	2000 ft SE NMDF	6.3 ± 7.7	29.5	December 1980
S-61	2.7 mi. NE NMDF	2.8 ± 2.3	7.1	June 1983

5041Y/bes

Onsite and offsite vegetation radioactivity measurements are summarized in Table 16. As with the gross alpha determination in soil, a change was made in 1984 to more correctly report the alpha activity naturally present in vegetation. While one value for beta activity in onsite vegetation (1977) is considerably higher than the rest, the average for that year is not noticeably different from the others.

Alpha and beta radioactivity in the supply water at the De Soto and SSFL sites are shown in Table 17. Water for the De Soto site is supplied by the Los Angeles Department of Water and Power from the Metropolitan Water District. Water for the SSFL site is supplied by Ventura County Water District No. 17, with varying amounts of supplemental water (up to 100%) from onsite wells operated by Rocketdyne. The water at De Soto is consistently, but not significantly, more radioactive than that at SSFL.

A change in the method of correcting for alpha attenuation in the mineral deposit from the water samples permits more accurate reporting of the alpha activity in 1984.

Alpha and beta radioactivity in environmental waters is shown in Tables 18A and 18B. The radioactivity concentrations in all three water sources sampled are quite similar. (Pond R-2A receives runoff and effluent from the Santa Susana nuclear facilities, Pond 6 receives runoff and effluent from the other facilities, and Bell Creek appears to be mostly seepage from the Bell Creek community.) The results for the pond water are generally about 45% higher than the supply water. This may result from concentration of the natural radioactivity by evaporation and also from "nonradioactive" discharges such as floor cleaning using soaps containing natural radioactive elements. No radionuclides present at the nuclear facilities have been found.

TABLE 16
VEGETATION RADIOACTIVITY SUMMARY
1975-1984
(pCi/g)

		Onsite				Offsite			
		Alpha		Beta		Alpha		Beta	
	Year	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value
	1984	4.0 ± 3.9	20.4	136 ± 47	254	4.0 ± 4.5	30.8	136 ± 45	278
a	1983	0.18 ± 0.14	0.91	149 ± 42	241	0.24 ± 0.28	1.5	143 ± 47	227
	1982	0.16 ± 0.22	1.25	140 ± 48	260	0.17 ± 0.14	0.6	130 ± 52	258
	1981	0.16 ± 0.20	1.23	137 ± 52	257	0.18 ± 0.17	0.52	129 ± 58	221
b	1980	0.25 ± 0.02	1.30	160 ± 30	271	0.14 ± 0.15	0.52	142 ± 30	221
	1979	0.24 ± 0.16	1.40	139 ± 20	248	0.23 ± 0.16	0.86	134 ± 20	230
	1978	0.24 ± 0.17	0.96	166 ± 30	319	0.24 ± 0.16	0.66	143 ± 30	241
	1977	0.22 ± 0.17	1.10	162 ± 30	587	0.21 ± 0.16	1.00	142 ± 30	257
	1976	0.19 ± 0.16	1.20	170 ± 30	299	0.22 ± 0.17	0.84	147 ± 30	274
	1975	0.21 ± 0.16	0.84	155 ± 30	261	0.21 ± 0.16	0.89	141 ± 30	240

[a]Values reported for alpha activity in vegetation before 1984 are relative values only. The 1984 values reflect correction for self absorption of alpha particles by the brick ash samples.
[b]Prior to 1981, data less than the MDL were treated equal to the MDL. For 1981 and later, actual measured values were used.

5041Y/sjh

TABLE 17
SUPPLY WATER RADIOACTIVITY SUMMARY
1975-1984
(pCi/g)

		De Soto				SSFL			
		Alpha		Beta		Alpha		Beta	
	Year	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value
	1984	3.82 ± 0.93	5.87	3.40 ± 0.45	4.3	3.53 ± 3.94	13.3	2.93 ± 0.60	4.01
a	1983	0.34 ± 0.23	0.88	3.53 ± 0.97	5.1	0.12 ± 0.13	0.41	3.00 ± 0.60	4.45
	1982	0.36 ± 0.23	0.79	3.97 ± 1.19	6.6	0.14 ± 0.12	0.38	3.01 ± 0.67	4.91
	1981	0.36 ± 0.20	0.77	3.78 ± 0.68	4.7	0.11 ± 0.12	0.44	2.79 ± 0.55	3.65
b	1980	not analyzed				0.22 ± 0.27	0.22	2.4 ± 0.7	3.4
	1979	not analyzed				0.23 ± 0.27	0.23	1.8 ± 0.7	3.9
	1978	not analyzed				0.26 ± 0.28	0.44	3.0 ± 0.8	3.6
	1977	not analyzed				0.25 ± 0.29	0.30	2.5 ± 0.7	3.6
	1976	not analyzed				0.25 ± 0.29	0.42	2.0 ± 0.7	2.5
	1975	not analyzed				0.24 ± 0.27	0.55	2.3 ± 0.7	3.2

[a]Values reported for alpha activity in water before 1984 are relative values only. The 1984 values reflect correction for self absorption of alpha particles by the thick mineral deposit of the counting sample.
[b]Prior to 1981, data less than the MDL were treated equal to the MDL. For 1981 and later, actual measured values were used.

5041Y/sjn

TABLE 18A

ENVIRONMENTAL WATER RADIOACTIVITY SUMMARY
1975-1984
(Alpha, pCi/L)

	Year	Pond R-2A Average ± Dispersion	Pond R-2A Maximum Value	Pond 6 Average ± Dispersion	Pond 6 Maximum Value	Bell Creek Average ± Dispersion	Bell Creek Maximum Value
	1984	0.15 ± 1.70	2.70	4.90 ± 9.11	25.9	4.15 ± 8.30	28.7
a	1983	0.13 ± 0.12	0.35	0.12 ± 0.11	0.27	0.08 ± 0.12	0.39
	1982	0.11 ± 0.13	0.28	0.17 ± 0.08	0.35	0.03 ± 0.06	0.14
	1981	0.07 ± 0.15	0.37	0.05 ± 0.08	0.17	0.05 ± 0.06	0.20
b	1980	0.23 ± 0.27	0.23	0.23 ± 0.27	0.23	0.23 ± 0.27	0.23
	1979	0.23 ± 0.27	0.25	0.25 ± 0.28	0.55	0.23 ± 0.27	0.24
	1978	0.25 ± 0.28	0.27	0.25 ± 0.28	0.35	0.24 ± 0.28	0.24
	1977	0.25 ± 0.29	0.28	0.24 ± 0.29	0.25	0.24 ± 0.29	0.24
	1976	0.28 ± 0.30	0.53	0.24 ± 0.29	0.24	0.25 ± 0.29	0.28
	1975	0.31 ± 0.29	1.2	0.24 ± 0.27	0.55	0.22 ± 0.27	0.28

[a]Values reported for alpha activity in water before 1984 are relative values only. The 1984 values reflect correction for self absorption of alpha activity by the thick mineral deposit of the counting sample.
[b]Prior to 1981, data less than the MDL were treated as equal to the MDL. For 1981 and later, actual measured values are used.

5041Y/bes

TABLE 18B

ENVIRONMENTAL WATER RADIOACTIVITY SUMMARY
1975-1984
(Beta, pCi/L)

	Pond R-2A		Pond 6		Bell Creek	
Year	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value
1984	4.25 ± 0.85	5.87	4.58 ± 0.75	5.66	2.88 ± 0.58	4.60
1983	4.44 ± 1.84	9.15	3.57 ± 0.92	4.80	3.30 ± 0.60	4.20
1982	3.93 ± 0.83	5.81	3.91 ± 1.08	5.34	3.29 ± 0.70	4.40
1981	5.16 ± 1.22	8.30	4.25 ± 0.63	5.26	3.78 ± 0.65	5.00
a 1980	3.9 ± 0.8	5.70	2.9 ± 0.7	4.7	2.9 ± 0.8	5.2
1979	4.5 ± 0.8	10.0	3.1 ± 0.8	4.7	3.2 ± 0.9	8.2
1978	4.6 ± 0.8	6.3	4.3 ± 0.8	7.0	2.5 ± 0.8	3.5
1977	5.2 ± 0.9	13.0	4.3 ± 0.8	6.4	1.8 ± 0.8	2.6
1976	4.4 ± 0.8	7.0	4.3 ± 0.8	5.5	2.2 ± 0.8	2.9
1975	4.5 ± 0.8	5.4	4.2 ± 0.8	5.5	2.4 ± 0.8	3.4

[a]Prior to 1981, data less than the MDL were treated as equal to the MDL. For 1981 and later, actual measured values are used.

5041Y/bes

Tables 19A and 19B show the results of alpha and beta radioactivity measurements on ambient air samples. An apparent extreme decrease in alpha radioactivity after 1981 is due simply to a change in the method of treating the very low-level values. Until the end of 1981, each value that was less than the MDL for a single measurement was set equal to the MDL before inclusion in the average. This artificially elevated the average value. This effect was not nearly so great for the beta activity measurements. The beta values for De Soto, SSFL, and offsite samples are essentially identical. (The "offsite" samples are located at SSFL but at a considerable distance from the nuclear facilities.)

TABLE 19A

AMBIENT AIR RADIOACTIVITY SUMMARY
1975-1984
(Alpha, fCi/m^3)

	De Soto		SSFL		Offsite	
Year	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value
1984	1.9 ± 9.3	32	1.4 ± 3.4	29	1.4 ± 3.0	16
1983	2.4 ± 3.8	60	0.9 ± 5.4	24	1.2 ± 2.9	11
1982	1.7 ± 3.1	39	1.1 ± 2.6	30	1.7 ± 2.9	16
a 1981	6.9 ± 7.7	25	6.8 ± 7.9	35	6.8 ± 7.2	22
1980	6.5 ± 7.7	45	6.4 ± 7.8	25	6.3 ± 7.8	20
1979	6.6 ± 7.8	45	6.5 ± 7.6	40	6.2 ± 7.9	34
1978	8.4 ± 8.1	95	7.2 ± 7.9	21	7.2 ± 7.3	44
1977	6.6 ± 7.7	39	6.6 ± 7.5	35		
1976	6.7 ± 8.4	140	6.5 ± 7.2	53		
1975	6.3 ± 6.8	60	6.0 ± 6.3	88		

[a]Prior to 1982, data less than the MDL were treated as equal to the MDL. For 1982 and later, actual measured values are used.

5041Y/bes

TABLE 19B

AMBIENT AIR RADIOACTIVITY SUMMARY
1975-1984
(Beta, fCi/m^3)

		De Soto		SSFL		Offsite	
	Year	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value
	1984	27 ± 27	250	23 ± 14	200	24 ± 20	200
	1983	26 ± 21	130	23 ± 17	180	25 ± 12	280
	1982	26 ± 14	260	21 ± 16	180	22 ± 12	88
a	1981	120 ± 20	1100	120 ± 20	1100	120 ± 20	1600
	1980	39 ± 14	380	36 ± 14	450	34 ± 15	360
	1979	21 ± 13	100	21 ± 13	110	19 ± 15	100
	1978	91 ± 17	1400	88 ± 17	1500	86 ± 16	1300
	1977	170 ± 20	3000	170 ± 20	2800		
	1976	96 ± 18	3700	110 ± 20	3400		
	1975	76 ± 16	460	73 ± 15	730		

[a]Prior to 1982, data less than the MDL were treated as equal to the MDL. For 1982 and later, actual measured values are used.

5041Y/bes

VII. ANTICIPATED ACTIVITIES DURING NEXT REPORTING PERIOD (1985)

Building 004

Continuation of low-level research with activated materials and operation of the Gamma Irradiation Facility.

Building 020

Complete cleanup and waste disposal following the SEFOR fuel decladding program. Complete decladding EBR-II blanket fuel, and begin cell cleanup.

Buildings 021/022

Shipment of declad SEFOR fuel and scrap. Receive, store, and transfer EBR-II blanket fuel for decladding. Storage and transfer of declad SEFOR fuel and scrap.

Building 055

Complete the decontamination of glove boxes and ship for disposal.

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