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ABSTRACT

Data on employee exposures, bioassay results, effluent releases, in-plant airborne radioactivities, and environmental monitoring for Rocketdyne operations during 1988 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 further reduced.

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

One filter plenum did not pass the required efficiency test; however, continued operation was permitted after reviewing the materials involved.

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

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INTRODUCTION

The Rocketdyne special nuclear materials license[1] requires that an annual report be made to the Radiation Safety Committee of the Nuclear Safeguards Review Panel reviewing personnel exposure and effluent release data. The format and content of this report have been well established in prior issues.[2-14] While this report is prepared primarily to satisfy a requirement of the NRC license, all operations with radioactive material and radiation-producing devices have been included.

These reports for the years 1975 through 1987[2-14] 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 and workplace radiation exposure) have not been made separately for each type of activity.

Additionally, it is not practical to separate the personnel doses to those attributable to nonlicensed activities for the DOE or the activities licensed by NRC or the State of California.

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

1. Rockwell International Hot Laboratory (RIHL) - Building 020, Santa Susana Field Laboratories
2. Radioactive Material Disposal Facility (RMDF) - Buildings 021, 022, and related facilities at Santa Susana Field Laboratories (DOE jurisdiction)
3. Applied Nuclear Technology (ANT) - The Gamma Irradiation Facility and Laboratories in Building 104 at De Soto.

Work at various facilities during 1988 is briefly described below:

- RIHL--Development of D&D techniques and procedures for the Hot Lab continued. These included honing, electropolishing, and sandblasting for through-tubes, and the development of a special radiation detector for determination of residual radioactivity inside through-tubes and drain lines. The SEFOR filter plenum was disposed of, and some TRU waste was repackaged for disposal. Decontamination work included cleanup of all four cells and decon rooms 1, 3, and 4. Surveys show that more cleanup is needed in cells 2, 3, and 4. Some floor scabbling was done, and some overhead structures were removed. A gamma irradiator was moved from the Rockwell International Science Center, unloaded, and prepared for shipment to Washington State University.

- RMDF--Waste characterization, repackaging, and shipping occupied a major part of the year. Most of the disassembled Fermi fuel assemblies were shipped to INEL for reprocessing, but this was halted when the trailer carrying an empty shipping cask back to RMDF tipped over just before entering the RMDF. A DOE investigation found that weld areas had cracked and weakened the trailer frame. During the earlier fuel shipping operations, a canister was dropped. Subsequent leak testing showed that there was no damage to the integrity of the canister. Water from decontamination operations was evaporated and the sludge packaged for disposal.

- Decontamination and Decommissioning--The decontamination of the ground floor of DS104 was completed, and demolition was done to permit renovation of the area. Most of the drainlines that had served radioactive labs were removed. At Building T059, the remaining sand and the vacuum dust were removed from the Pipe Chase Room and disposed of as radioactive waste. Building T028 was decontaminated to permit conventional demolition of the above-grade portion, with the basement vault left in place.

- GIF--Electronic equipment from the Rockwell Science Center was irradiated to test for radiation hardness, using the Co-60 sources. Following the restriction by DOE to not use the WESF Cs-137 sources, these sources were kept in the storage cask. A leak test was performed by smearing the exits of the cooling air channels (no activity was found).

- Applied Nuclear Technology--The mass-spectrometer lab performed measurements on fusion materials, on tritium "tricked" samples for tritium storage, irradiated reactor pressure vessel materials. Some research work was also done on fusion neutron dosimetry.

- Industrial Radiography--All X-ray machine operations at Canoga and De Soto were inspected by L.A. County, for the State of California. In response to the findings of this inspection, improvements in the shielding of six X-ray booths at CA were developed and approved. Warning lights were installed on portable X-ray heads. Requirements for X-ray operations at Stennis Space Center (in Mississippi) were investigated, and a cooperative arrangement with the operating contractor was formalized. There were five film badge problems (lost, or accidentally exposed). Industrial radiography managers were provided with radiation safety training.

- Miscellaneous--No ISI operations were performed this year. Generally routine work was performed in other operations.

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 deposition of radioactivity via inhalation, ingestion, skin absorption, or through wounds (bioassays). These measurement methods provide a natural separation 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 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 and 5 rem for DOE operations. The highest exposure shown, 1170 mrem, resulted from an X-ray industrial radiographer, whose film badge showed this during the first calendar of the year. While the exposure seemed unlikely, there was no data available to refute the film badge, and so the exposure had to be accepted. Otherwise, the data show good implementation of the goal of 1 rem per year maximum.

For comparison, the distributions of exposures reported for NRC licensees[15] and DOE contractors[16] for 1983 are shown as solid curves.

The Rocketdyne dose distribution is well below the NRC distribution and generally below the DOE distribution. A more significant comparison can be made in terms of the group dose. The group dose received by Rocketdyne employees in 1988 amounted to 18.47 person-rem. This is the lowest group

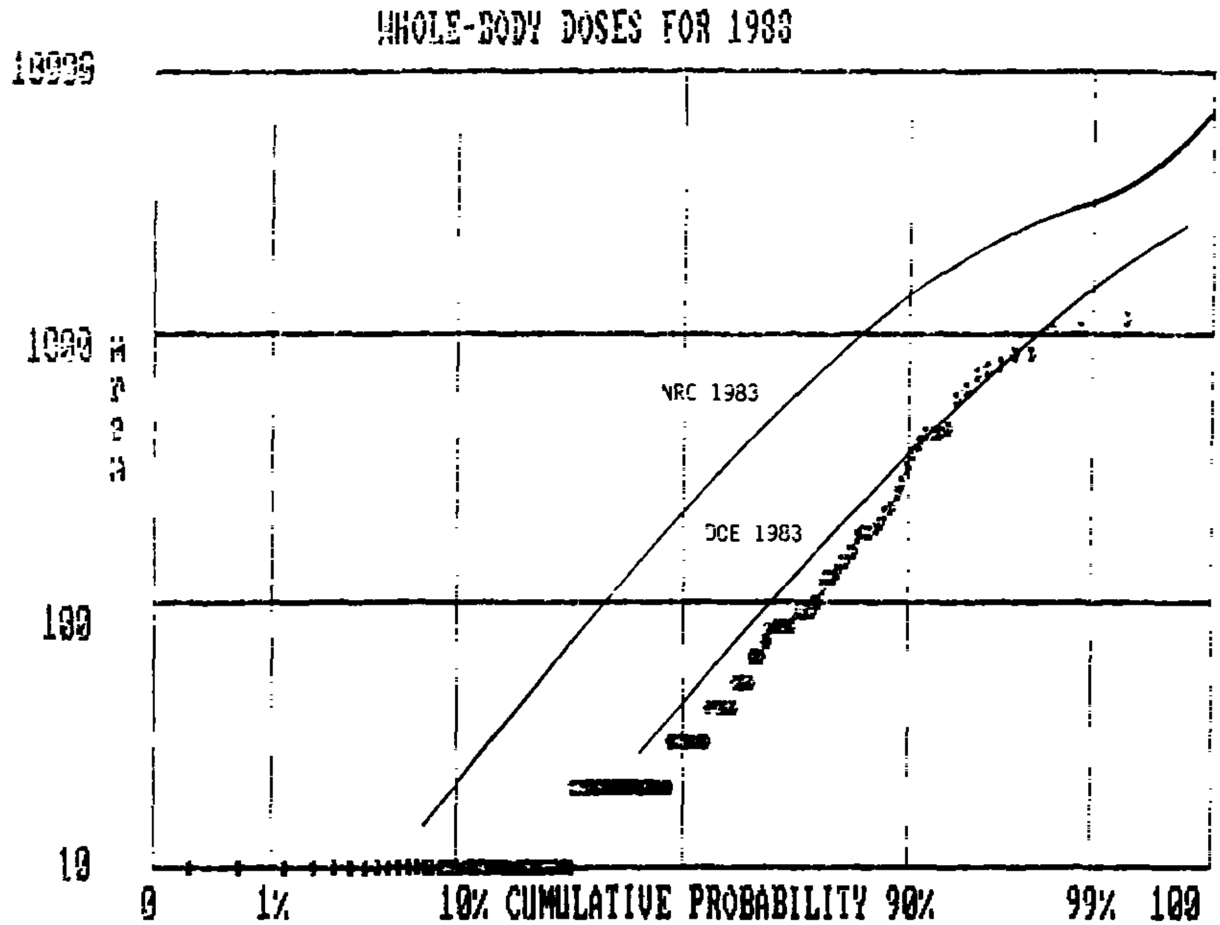

Figure 1. Whole Body Doses for 1988

exposure yet experienced. If the distribution of doses had been the average reported for NRC licensees in 1985, the group dose would have been 70.1 person-rem. If the doses had been those averaged for DOE in 1985, the group dose would have been 30.4 person-rem. Comparisons such as these should be viewed with caution because of differences in the type of work between the Rocketdyne workforce and both the NRC licensees and the DOE contractors, but generally show a much better level of control in our operations.

2. Extremity Monitoring

No specific extremity monitoring was required in 1988.

3. Nuclear Operations Dose Monitoring

The radiation workers in Nuclear Operations are closely monitored for dose by use of direct-reading pocket dosimeters, with the cumulative dose recorded on a weekly basis. The readings are corrected by use of a calibration factor for each dosimeter. These recorded doses are adjusted following reporting of the results of the film badge dosimetry. The dosimeter results are compared with the film doses for group doses (person-millirem) in each quarter:

Quarter	Dosimeter	Film	Overestimate (%)
First	1947	1590	22.5
Second	1429	990	44.3
Third	9975	9010	10.7
Fourth	2761	2010	37.4

This discrepancy seems most likely to be caused by electrical leakage of the dosimeter, as it would be accounted for by a leakage rate of approximately 2-3 mR/week, based on the number of dosimeters used to estimate doses. The average leakage for dosimeters is approximately 5-7 mR/week, so it appears that the dosimeter calibration factors are slightly low.

The weekly cumulative group dose for Nuclear Operations is shown in Figure 2.

The rapid increase during the third calendar quarter is from the exposures received during removal of the activated sand and vacuum dust in Building T059. Since this project dealt with relatively high-activity material in close, unshielded proximity to the workers, considerable effort was made to control doses to levels that were as low as reasonably achievable. Especially effective ventilation, portable shielding, and long tool handles were used to reduce exposures. The total group dose for the project in 1988 was 9.55 person-rem, while the planning estimate had been 5.0 person-rem. The actual

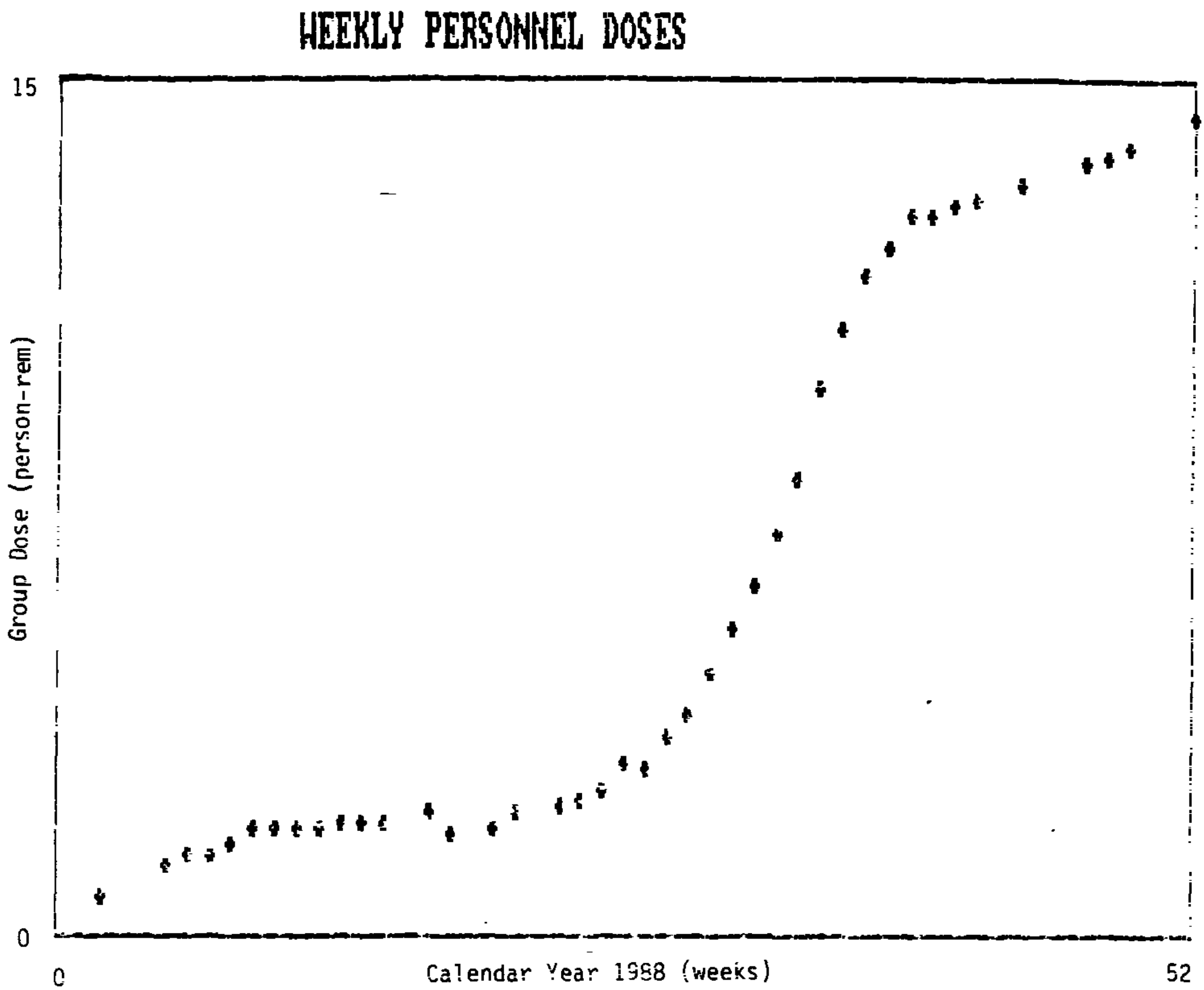

Figure 2. Cumulative Weekly Group Dose for Nuclear Operations

group dose exceeded the predicted value due primarily to the increased personnel and time spent in the Pipe Chase Room (PCR): shoveling sand (we had overestimated the efficiency of sand removal by a vacuum cleaner), difficulty in cutting and separating duct segments due to the presence of closely spaced cooling coils and Thermon, and removal of the heavy wall vertical duct support. The high radiation level within the PCR during planning stages prevented an accurate determination of the sand volume and a close examination of the duct covered by sand.

B. BIOASSAYS

Bioassays normally consist of analysis of urine and occasionally fecal samples. Personnel whose work assignments potentially expose them to 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 1988 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, UR, and UF. The UF analysis is chemically selective for uranium. 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 UR analysis is radiometrically selective for uranium, and is effective for enriched uranium (EU).

Followup results are shown, where available (even into 1989), to indicate the decrease of detected activity to negligible levels. Many of the positive results appear to be the result of laboratory contamination. This appears to be true for three of the highest FP3A results, which were not confirmed by repeat analyses of the same samples.

The excretion rates assumed to be indicative of 1 MPBB for various radionuclides and the minimum detectable activities (MDA) are:

Radionuclides	Standard Excretion Rate	MDA
Sr-90	480 dpm/day	30 dpm/day
U	100 ug/day	0.30 ug/day
EU	220 dpm/day	3.75 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.

Table 1. Summary of Bioassays - 1988

Measurement Type*	Total Tests	Total Positive Results	Total Individuals With Positive Results
UF	238	5	4
UR	238	1	1
PUA	32	0	0
Am-241	4	0	0
FP3A	305	11**	9
FP3B	305	0	0
Total	1122	17	14

*UF = Uranium - Fluorometric
UR = Uranium - Radiometric
PUA = Gross Plutonium-alpha
FP = Fission Products

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

**Plus three positive results that were not confirmed by repeat analysis.

Table 2. Positive Bioassay Result Summary - 1988
(Sheet 1 of 2)

H&S Number	Sample Date	Analysis Type*	Results Per Vol. Anal.	Results Per 1500 ml-day	Assumed Specific Radionuclide	Assumed Critical Nuclide Equivalent MPBB (%)
723	081588	FP3A	4.3838	32.88	Sr-90	6.85
723	101888	FP3A	1.511	-	Sr-90	
3207	042988	FP3A	7.036	52.77	Sr-90	10.99
3207	REPEAT	FP3A	1.257	-	Sr-90	
3207	061988	FP3A	1.327	-	Sr-90	
3207	071388	FP3A	1.1659	-	Sr-90	
3742	080988	FP3A	4.4782	33.54	Sr-90	6.99
3742	091288	FP3A	2.336	-	Sr-90	
3742	101088	FP3A	1.978	-	Sr-90	
3742	120488	FP3A	0.5252	-	Sr-90	
3914	111088	FP3A	6.563	32.81	Sr-90	6.84
3914	011789	FP3A	1.941	-	Sr-90	
3983	081988	UR	0.6428	4.82	EU	2.19
3983	081988	UF	0.0015	2.25	U	2.25
3983	110388	UR	0	-	EU	
3983	110388	UF	0.0002	-	U	
4137	101188	FP3A	4.616	34.62	Sr-90	7.21
4137	110688	FP3A	2.101	-	Sr-90	
4162	041988	FP3A	16.2	121.5	Sr-90	25.31
4162	REPEAT	FP3A	2.328	-	Sr-90	
4162	052688	FP3A	3.296	-	Sr-90	
4162	071188	FP3A	1.209	-	Sr-90	
4162	100888	FP3A	1.85	1.85	Sr-90	
4241	092688	FP3A	5.307	39.8	Sr-90	8.29
4241	111688	FP3A	10.84	54.2	Sr-90	11.29
4241	011689	FP3A	3.441	-	Sr-90	

Table 2. Positive Bioassay Result Summary - 1988
(Sheet 2 of 2)

H&S Number	Sample Date	Analysis Type*	Results Per Vol. Anal.	Results Per 1500 ml-day	Assumed Specific Radionuclide	Assumed Critical Nuclide Equivalent MPBB (%)
4404	080588	UF	0.0004	0.6	U	0.60
4404	080888	UF	0	-	U	
4404	081588	UF	0.0004	0.6	U	0.60
4404	101088	FP3A	4.118	30.89	Sr-90	6.44
4404	110788	FP3A	1.04	-	Sr-90	
4404	110788	UF	0.0004	0.6	U	0.60
4404	011589	FP3A	6.43	32.16	Sr-90	6.70
4530	071088	FP3A	7.436	55.77	Sr-90	11.62
4530	REPEAT	FP3A	1.409	-	Sr-90	
4530	080388	FP3A	0.5022	-	Sr-90	
4530	101488	FP3A	1.54	-	Sr-90	
4883	081588	FP3A	4.52	33.9	Sr-90	7.06
4883	082188	FP3A	1.409	-	Sr-90	
4883	091188	FP3A	1.726	-	Sr-90	
4883	101288	FP3A	2.421	-	Sr-90	
4883	120588	FP3A	4.254	-	Sr-90	
4893	011488	FP3A	4.491	33.68	Sr-90	7.02
4893	031988	FP3A	0.9493	-	Sr-90	
4907	041988	UF	0.0005	0.75	U	0.75
4907	062488	UF	0.0001	-	U	
4907	071188	UF	0	-	U	
4912	011288	UF	0.0004	0.6	U	0.60
4912	031588	UF	0.0001	-	U	
4912	042088	UF	0	-	U	
4912	071188	UF	0	-	U	
4912	080488	UF	0.0001	-	U	
4912	080888	UF	0	-	U	
4912	081788	UF	0.0001	-	U	
4912	120188	UF	0	-	U	
6087	091288	FP3A	4.447	33.35	Sr-90	6.9
6087	110788	FP3A	7.695	38.47	Sr-90	8.0

UF: Fluorometric Uranium
FP: Fission Products
UR: Radiometric Uranium
(FP3A is presumptively Sr-90; FP3B is specifically Cs-137)

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

Comparisons of results from the FP3A and FP3B analyses and the UR and UF analyses are shown in Figures 3 and 4. The laboratory lower limit of detection (LLD, that activity that is considered, with reasonable certainty, to represent true radioactivity) is also indicated for each of the analyses. Results from the individual analyses are also shown as cumulative probability distribution in Figures 5 through 8. These show that very few of the results (the elevated values that appear as outliers at the right side of the figures) depart significantly from the random distribution of results, which closely approximates a Gaussian distribution. (Actually, the distributions are truncated at zero, as is most clearly shown in Figures 6 and 7, where the linear representation of the Gaussian abruptly intersects the baseline, with only zero values being reported for cumulative probabilities less than about 30%.)

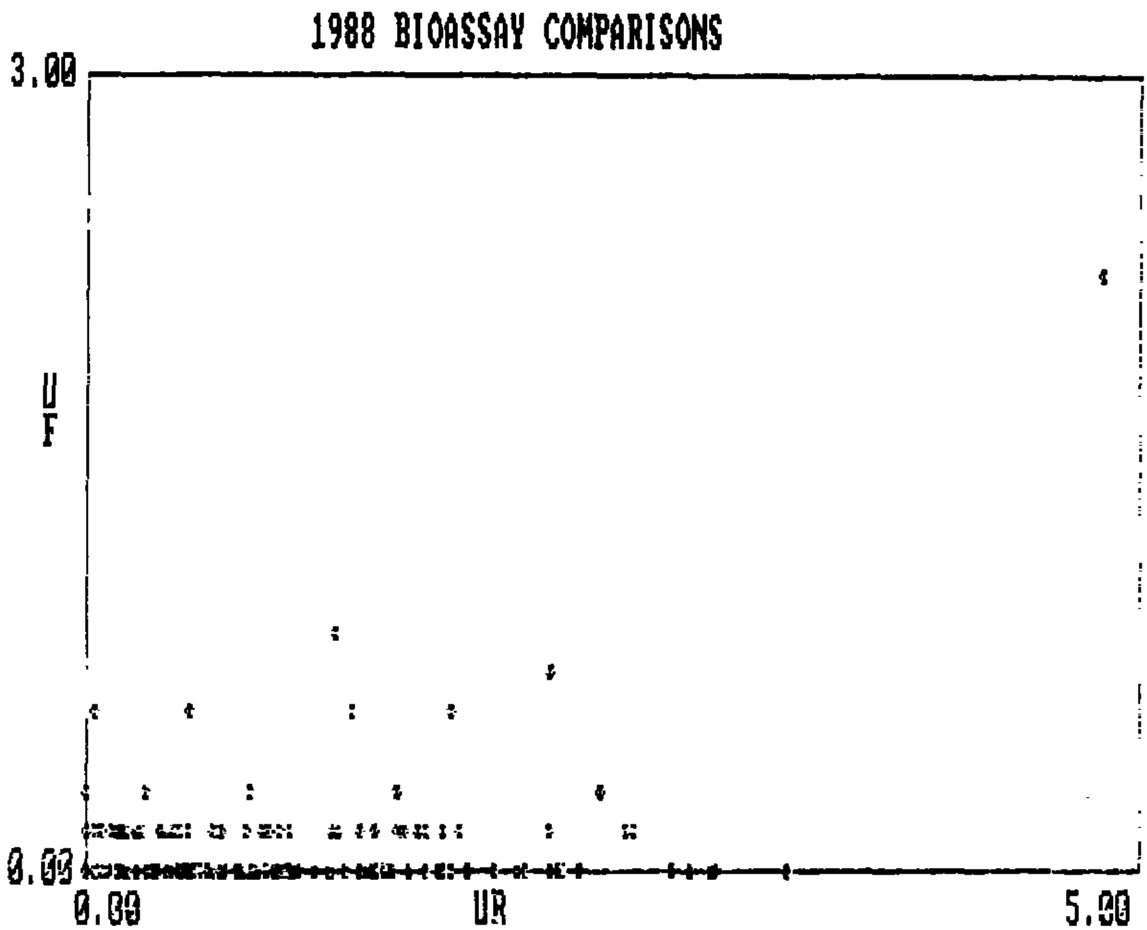

Figure 3. 1988 Bioassay Comparisons, UF vs. UR
(Standardized Excretion Rates, Microgram Per Day
for UF, dpm Per Day for UR)

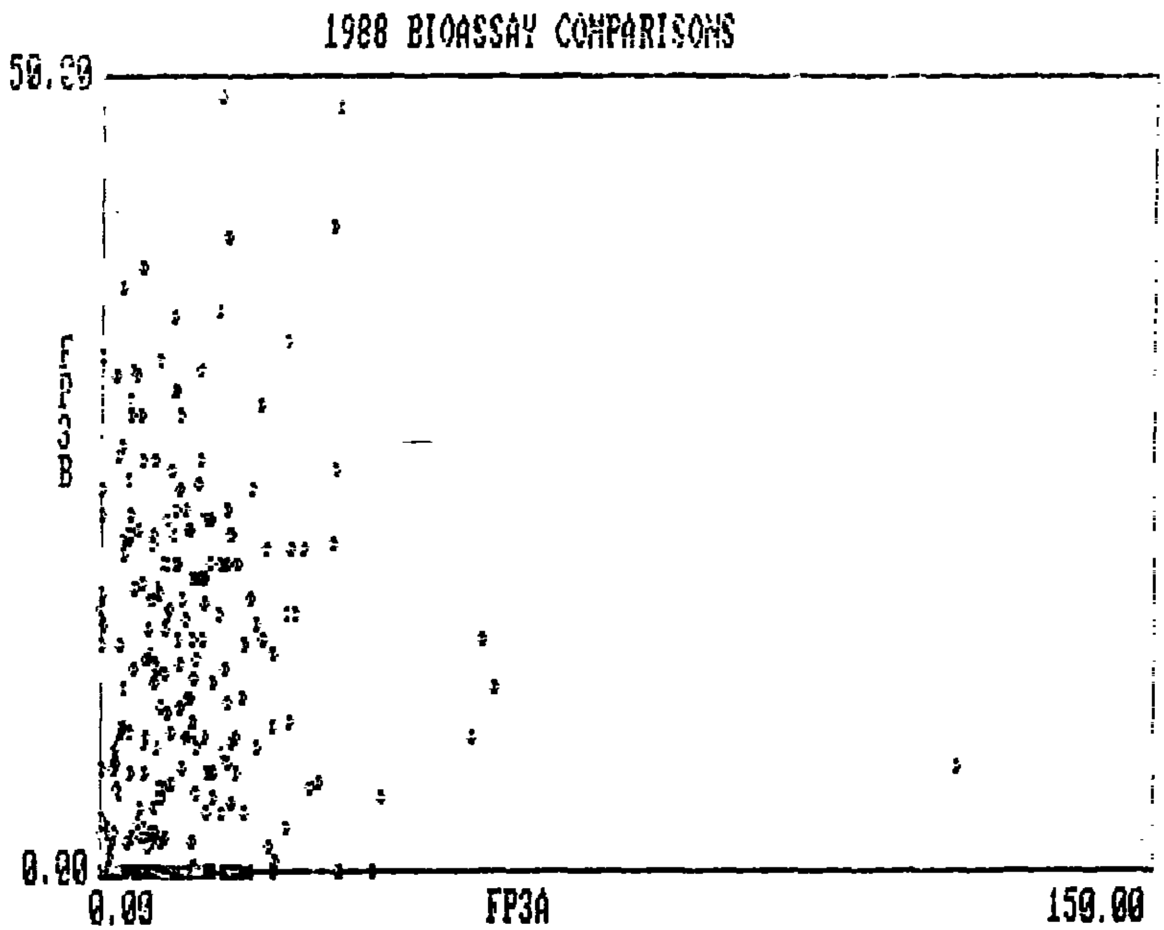

Figure 4. 1988 Bioassay Comparisons, FP3B vs. FP3A
(Standardized Excretion Rates, dpm/Day)

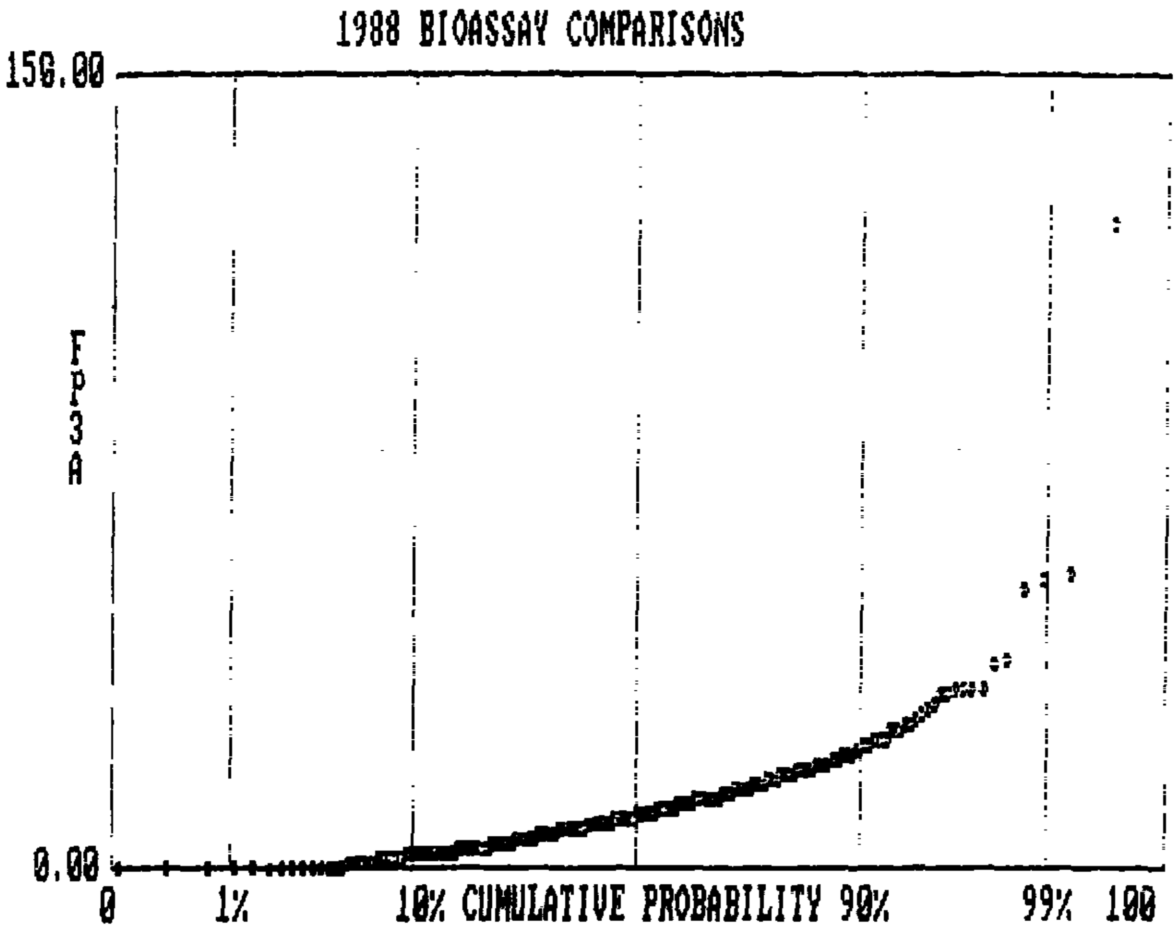

Figure 5. Cumulative Probability Plot of FP3A Results

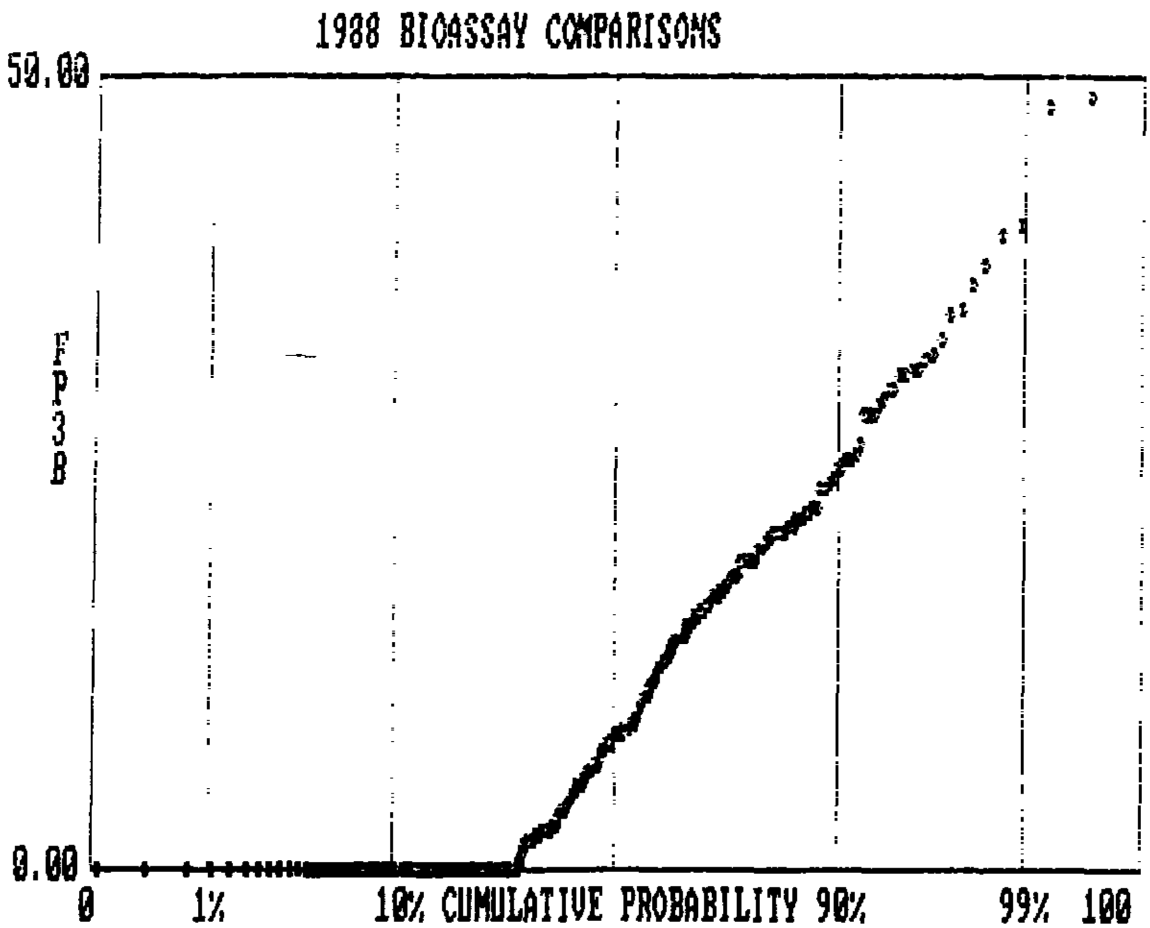

Figure 6. Cumulative Probability Plot of FP3B Results

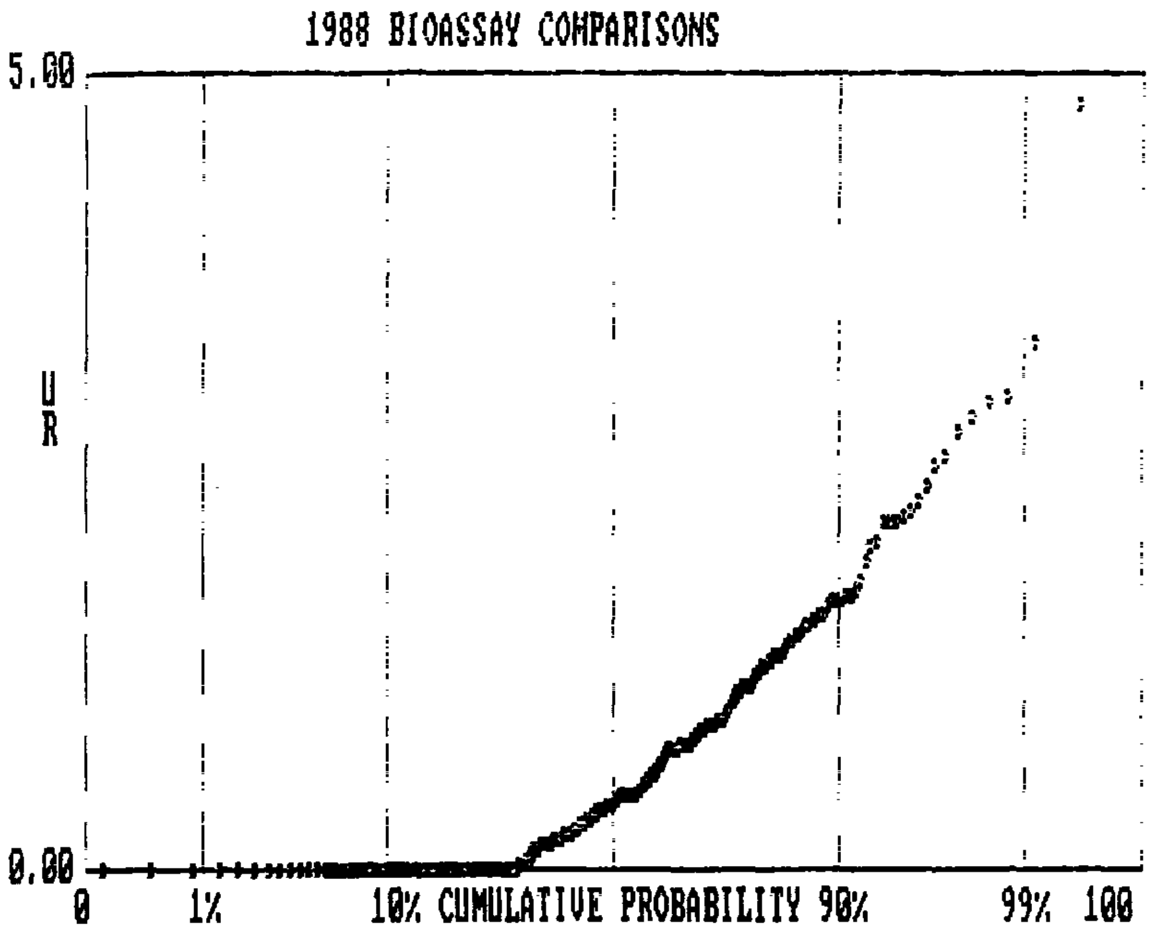

Figure 7. Cumulative Probability Plot of UR Results

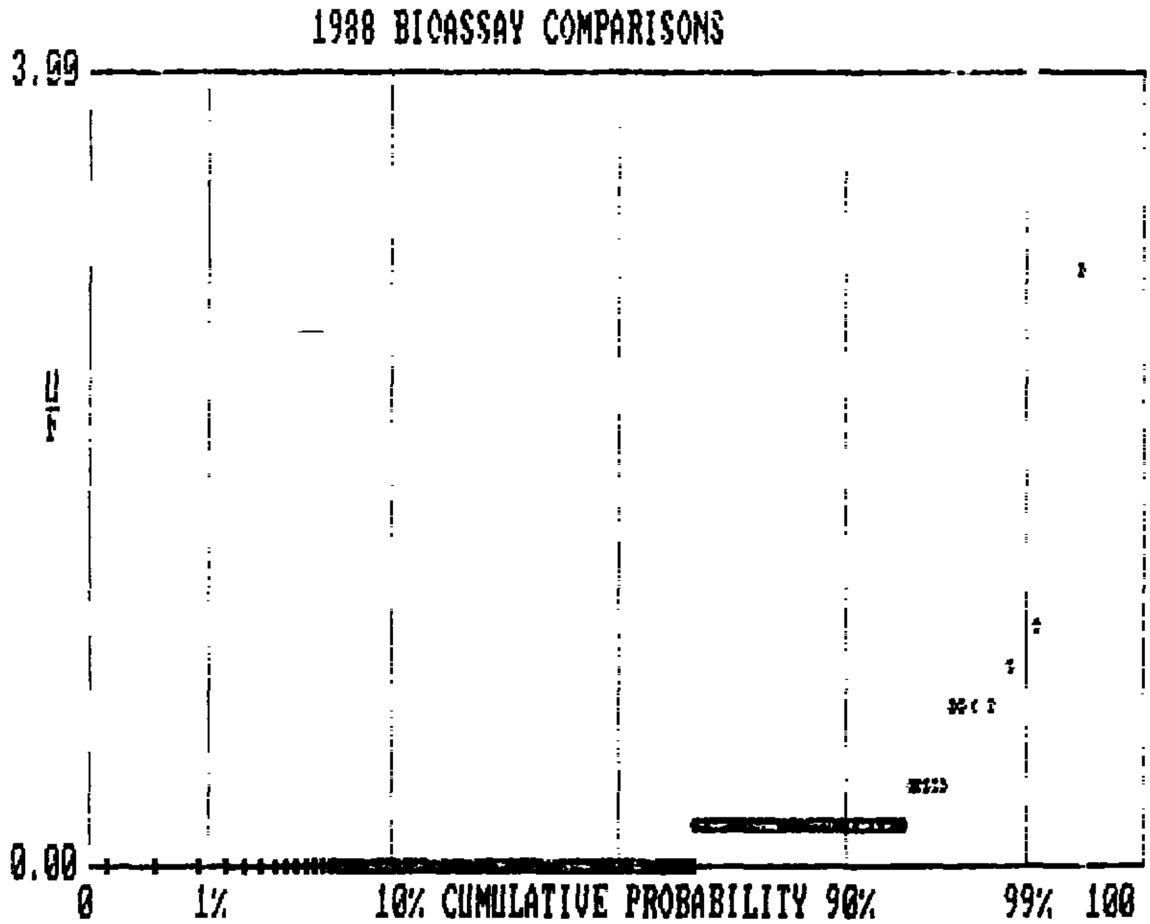

Figure 8. Cumulative Probability Plot of UF Results

II. RADIATION/RADIOACTIVITY MEASUREMENTS

The measurements and surveillance performed to determine local radiation levels in the working areas where radioactive materials are used 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.

The maximum exposure rates for the RIHL are associated with the radioactive water holdup tank, in an area that is rarely occupied. At the RMDF, the highest exposure rates are at the evaporator. The maximum rates at the GIF are due to storage of mass spectrometer samples in a shielded location along the east wall. The sandblaster sand catcher in Room 4130-75 is the source for the maximum exposure rates in the ANT laboratories. The X-ray exposures at T172 are very variable from quarter to quarter and cannot be localized. The highest exposure in the Instrument Laboratory is associated with the high-range calibrator, which contains 37 Ci of Cs-137.

Other location badges, such as those at the Canoga and De Soto X-ray booths, showed no exposure, except for a badge located near the entry to the darkroom for the medical radiology facility at Canoga which showed 60 mR for the year.

Building T024 contains two below-grade reactor test cells with residual radioactivity resulting from neutron activation of the concrete and re-bar. Since 1984, location film badges have been placed in the test cells. Analysis of the exposures recorded by those badges, with the assumption that the only

Table 3. Location Badge Radiation Exposure - 1988

Facility	Q1	Q2	Q3	Q4
	Calendar Quarter			
	Average Exposure Rate (mR/h) / Maximum Exposure Rate (mR/h)			
RIHL	0.09 / 0.62	0.06 / 0.42	0.07 / 0.60	0.09 / 0.89
Fenceline	0.003 / 0.02	0.002 / 0.014	0.016 / 0.027	0.011 / 0.023
RMDF	0.86 / 2.65	0.51 / 1.62	0.37* / 1.19	0.74 / 2.88
Fenceline	0.040 / 0.13	0.024 / 0.088	0.025 / 0.082	0.020 / 0.096
GIF	0.018 / 0.064	0.013 / 0.046	0.010 / 0.041	0.023 / 0.092
ANTL	0.15 / 1.71	0.14 / 0.71	0.20 / 0.73	0.12 / 0.63
T172 (X-ray)	0.039 / 0.192	0.001 / 0.005	0.007 / 0.018	0.005 / 0.027
Instrument Laboratory	0.030 / 0.078	0.026 / 0.064	0.027 / 0.064	0.026 / 0.060

*Two badges were damaged by heat, estimated values

significant sources of radiation are the induced activities of Co-60 and Eu-152, yields the following formula for exposure rate:

$$X(t) = (0.62\ e^{-0.1315\ t} + 0.22\ e^{-0.0525\ t})\ \mathrm{mR/hr}$$

for t in years after January 1, 1980. The first term represents Co-60 activity; the second term represents Eu-152. As further data are obtained, this analysis will be followed to improve the estimate.

As a corollary to this analysis, the standard deviation of individual film badge measurements is estimated to be about ±20%.

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 1988 is given in Table 4.

Table 4. Interior Air Sample Summary 1988

Area	Sample		Q1	Q2	Q3	Q4	MPC
			Average Airborne Activity Concentration (MPC)				
			Calendar Quarter				
RIHI	Unposted	alpha	0.000006	0.000003	0.000008	0.000001	2×10^{-12}
		beta	0.000002	0.000001	0.000001	0.000001	1×10^{-9}
	Posted	alpha	0.000002	0.000007	*	*	2×10^{-12}
		beta	0.000001	0.000001	*	*	1×10^{-9}
	Maximum	alpha	0.000033	0.000063	0.000241	0.000040	2×10^{-12}
		beta	0.000010	0.000007	0.000010	0.000002	1×10^{-9}
RMDF	Facility	Average	0.000058	0.000064	0.000083	0.000028	3.6×10^{-8}
	Facility	Maximum	0.000086	0.000104	0.000114	0.000036	3.6×10^{-8}

*Posted areas were eliminated at the direction of an NRC Region V inspector.

5131Y/lab

III. EFFLUENT MONITORING

Effluents which may contain radioactive material are generated at certain Rocketdyne 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 facility identified with the NRC license is Building 020 at the SSFL at Santa Susana.

An annual report of effluent releases, prepared by Radiation & Nuclear Safety in the Health, Safety, and Environment Department, describes in detail the monitoring program at Rocketdyne for gaseous effluents from the Rocketdyne facilities. The data reported in the 1988 edition of that report[17] 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.)

Sanitary facilities at the buildings in SSFL Area IV drain to a sewage treatment plant (Building 600) where the effluent is digested, filtered, and chlorinated before the liquid stream is discharged to surface drainage for collection in Pond R2A. The sludge is periodically removed for disposal at an off-site commercial sewage sludge disposal facility. Starting in June 1988, samples of the sludge have been analyzed by gamma spectroscopy each time the sludge has been removed. Eight samples were analyzed and no unnatural radioactivity was found.

The liquid stream is monitored for radioactivity by a submerged detector prior to release to surface drainage. If the alarm setpoint on this detector is exceeded, the effluent is diverted to a holding pond for sampling and analysis. This diversion occurred once in 1988, on August 3, as a result of a malfunction of the detection instrument. No activity was found in the water sample, and the diverted effluent was released to surface drainage.

Table 5. Atmospheric Emissions to Unrestricted Areas - 1988

	De Soto 104 Research	SSFL 020 RIHL	SSFL 022 RMDF
Approximate effluent volume cubic meters	167,100,000	408,700,000	240,900,000
Approximate lower limit of detection (LLD)			
Gross alpha fCi/m^3	0.30	0.30	0.30
Gross beta fCi/m^3	0.31	0.31	0.31
Approximate air volume sampled-cubic meters	21,400	30,300	34,200
Annual average concentration in effluent			
Gross alpha fCi/m^3	1.39	0.38	0.29
Gross beta fCi/m^3	5.61	9.31	17.20
Sampling period maximum observed concentration			
Gross alpha fCi/m^3	8.12	1.01	2.93
Gross beta fCi/m^3	32.6	35.1	258.0
Total activity released-microcuries/year			
Gross alpha	0.23	0.16	0.07
Gross beta	0.94	3.80	4.10

	Release µCi/ Year	LLD µCi/ Year	Concen tration fCi/m^3	%MPCa	Release µCi/ Year	LLD µCi/ Year	Concen-tration fCi/m^3	%MPCa	Release µCi/ Year	LLD µCi/ Year	Concen-tration fCi/m^3	%MPCa
Estimate of activity released by nuclide												
Beryllium-7*	0	0.59	0		2.85	1.02	6.98		0	0.54	0	
Potassium-40*	0.37	1.41	2.22		0.44	2.43	1.08		0.64	1.27	2.66	
Cobalt-60	0	0.09	0	0	0	0.15	0	0	1.64	0.08	6.82	0.002
Strontium/Yttrium-90	0.03	0.05	0.18	0.0006	0.10	0.08	0.24	0.0008	0.21	0.04	0.87	0.003
Cesium-137	0.03	0.08	0.22	0.00004	0.12	0.13	0.28	0.00006	1.53	0.07	6.37	0.001
Polonium-210*	0.94	0.002	0.56		0.16	0.003	0.39		0.06	0.001	0.24	
Uranium-234	0.13	0.0008	0.77	0.0192	0.0002	0.001	0.0004	0.00001	0.002	0.0007	0.01	0.0003
Uranium-235	0.005	0.0008	0.03	0.0008	0	0.001	0	0	0	0.0007	0	0
Uranium-238	0.002	0.0008	0.01	0.0005	0.0007	0.001	0.002	0.00006	0.002	0.0007	0.008	0.0003
Plutonium-238	0	0.002	0	0	0	0.003	0	0	0.0001	0.001	0.0004	0.0006
Plutonium 239/40	0.0001	0.002	0.0007	0.0011	0.00003	0.003	0.00008	0.00001	0.008	0.001	0.03	0.052

*Naturally occurring, not included in dose estimates.

Note: Concentrations are shown as femtocuries per cubic meter for clarity of presentation in this table. To convert to microcuries per milliliter, multiply the values by 1×10^{-15}.

Surface runoff from the RMDF, as a result of rainfall, is collected in a small retention pond and automatically pumped to surface drainage for collection in Pond R2A. A floating radiation detector is used to monitor for radioactivity in the water in this pond. Water samples are taken and analyzed by gamma spectroscopy and gross alpha and beta counting, frequently during the rainy season, less often the rest of the year. In two samples, gamma spectrometry showed measurable amounts of Cs-137, at about 6×10^{-8} µCi/ml. The maximum permissible concentration (MPC) for Cs-137 in water released to an unrestricted area is 2×10^{-5} µCi/ml. All other samples showed no detectable activity or only naturally occurring radionuclides. The gross alpha and gross beta results are shown in Figure 9. The scales (30 pCi/L for alpha and 300 pCi/L for beta) correspond to the MPCs for the most restrictive radionuclides that have been present at the RMDF. The observed activity includes natural radionuclides such as Be-7, K-40, and U and Th daughters. The observed results have beer .ell below the limits.

For 1988, the stack sampler filters were accumulated for each of the three stacks with a potential for release of radioactive materials. The three sets were sent to U.S. Testing (Richland, WA) for a detailed analyses. These analyses showed significant amounts of the naturally occurring radionuclides Be-7, K-40, and Po-210. At the RIHL, these enter the effluent in the bypass air. At De Soto (EF-405), they entered through a hole in the flexible coupling connecting the filter plenum to the exhaust blower. This hole was repaired early in the year, so all Be-7 (half-life 52 days) had decayed before analysis.

Effluent releases are extremely low as a result of a combination of factors. Much of the radioactive material processed is in relatively undispersible form, many of the operations are conducted in glove boxes and sealed hot cells, and the effluent is filtered by pre-filters and HEPA filters. The HEPA-filter systems are tested annually by use of a polydisperse DOS aerosol. The

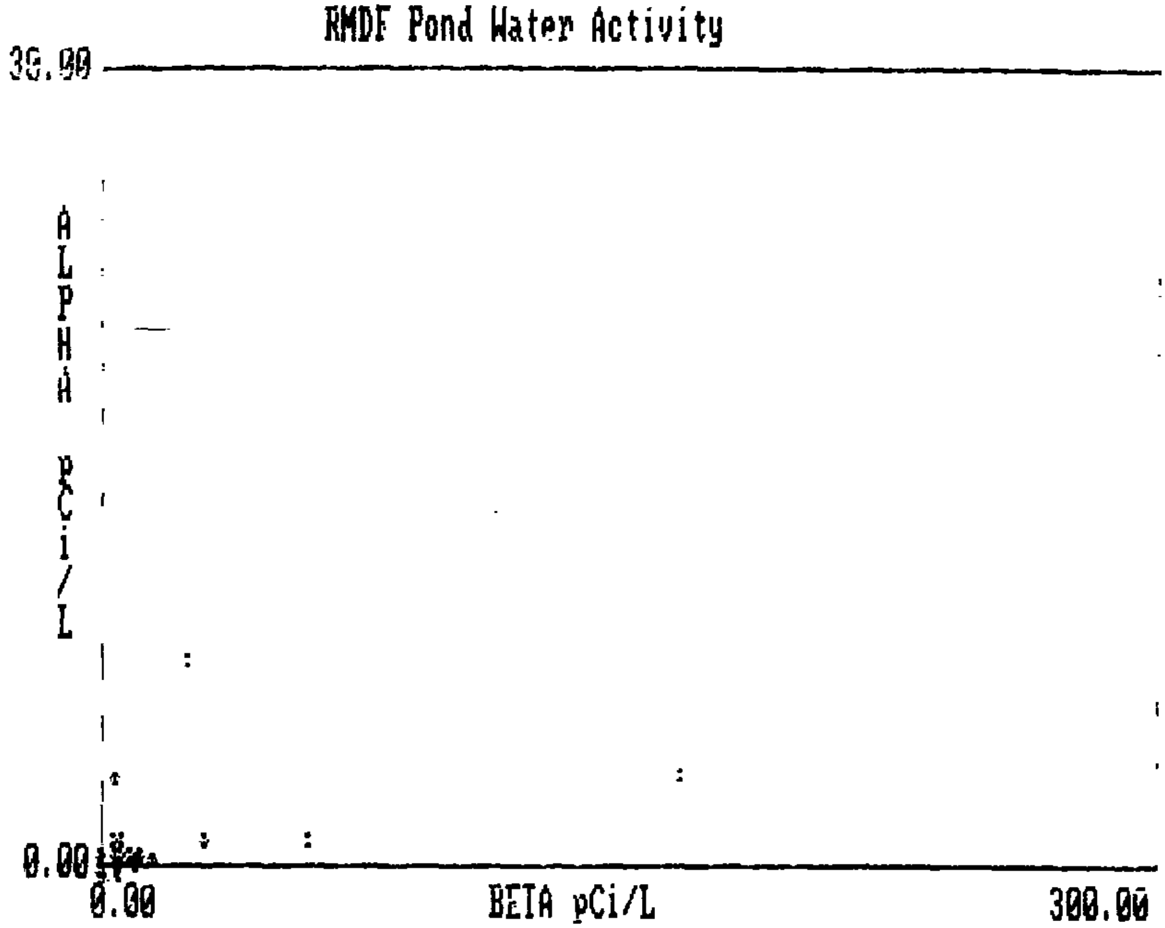

Figure 9. RMDF Pond Water Activity

test dates and filtration efficiencies for several exhaust systems, and the required efficiencies, are shown below:

		Measured	Required
RMDF (Vault 14884)	05/12/88	99.99%	99%
RMDF (Vault 14885)	05/12/88	99.99%	99%
RMDF (Decon 14886)	05/12/88	99.99%	99%
RMDF (Decon 14887)	04/06/88	99.99%	99%
RIHL	11/17/88	99.99%	99.95%
ANT (EF-405)	06/09/88	98.0%	99%
GIF	06/09/88	99.99%	99%

The EF-405 filter system did not satisfy its requirement. Operations were allowed to continue after review of the material involved and determination that there was no significant risk of release of radioactivity.

IV. ENVIRONMENTAL MONITORING PROGRAM

The basic policy for control of radiological and toxicological hazards at Rocketdyne 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 Rocketdyne 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&E Department, describes in detail the Rocketdyne environmental monitoring program.

Some of the data reported in the 1988 edition of that report(17) 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 naturally occurring radioactive materials, and residual activity from the Chernobyl reactor accident and nuclear weapon testing.

These data are:

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

Table 6. Soil Radioactivity Data - 1988

Area	Activity	Number of Samples	Gross Radioactivity (pCi/g) Annual Average Value and Dispersion	Maximum Observed Value* and Month Observed
On-site (quarterly)	Alpha	48	29.1 ± 6.2	53.6 (October)
	Beta	48	26.0 ± 2.8	31.4 (October)
Off-site (quarterly)	Alpha	48	25.6 ± 6.2	39.6 (October)
	Beta	48	24.4 ± 2.7	29.6 (April)
Pond R-2A mud No. 55	Alpha	4	28.7 ± 3.6	33.6 (January)
	Beta	4	24.7 ± 0.8	25.4 (January)
Bell Creek upper stream bed soil No. 62	Alpha	4	22.0 ± 7.5	33.2 (October)
	Beta	4	23.9 ± 1.5	25.1 (December)

*Maximum value observed for single sample.

Table 7. Soil Plutonium Radioactivity Data - 1988

Sample Location	29 June 1988 Survey Results: ^{238}Pu (pCi/g)	29 June 1988 Survey Results: $^{239}Pu + ^{240}Pu$ (pCi/g)	1 December 1988 Survey Results: ^{238}Pu (pCi/g)	1 December 1988 Survey Results: $^{239}Pu + ^{240}Pu$ (pCi/g)
S-56	0.0004 ± 0.0002	0.0008 ± 0.0002	0 ± 0.0001	0.0012 ± 0.0002
S-57	0 ± 0.0001	0.0039 ± 0.0005	0 ± 0.0001	0.0032 ± 0.0005
S-58	0.0004 ± 0.0001	0.0022 ± 0.0003	0 ± 0.0001	0.0033 ± 0.0004
S-59	0.0001 ± 0.0001	0.0031 ± 0.0004	0.0002 ± 0.0001	0.0069 ± 0.0008
S-60	0.0001 ± 0.0001	0.0029 ± 0.0004	0 ± 0.0001	0.0032 ± 0.0004
S-61*	0.0004 ± 0.0002	0.0003 ± 0.0002	0 ± 0.0001	0.0001 ± 0.0001

*Off-site location

Table 8. Supply Water Radioactivity Data - 1988

Area	Activity	Number of Samples	Gross Radioactivity (10^{-9} μCi/ml) Average Value and Dispersion	Maximum Value* and Month Observed
De Soto (monthly)	Alpha	12	3.80 ± 1.42	6.57 (April)
	Beta	12	4.10 ± 0.43	5.16 (March)
SSFL (monthly)	Alpha	24	5.40 ± 3.34	13.81 (June)
	Beta	24	3.93 ± 0.84	5.80 (June)

*Maximum value observed for single sample.

Further investigation was made into the problem of self-dosing of the TLD bulb-type dosimeter. This will continue.

During the third quarter, the TLD reader behaved erratically, due to what was finally determined to be an intermittently stuck shutter in front of the photomultiplier tube. This shutter must open fully for reading, which it apparently did, but must close when the read-head is removed, to prevent the PM tube from being "light-struck." The shutter was not always closing fully, resulting in some erroneously high readings. This was corrected in October 1988.

Table 9. SSFL Site Retention Pond, Site Runoff, and Well Water Radioactivity Data - 1988
(Sheet 1 of 4)

			Gross Radioactivity Concentration ($\times 10^{-9}$ µCi/ml)		
Area	Activity	Number of Samples	Annual Average Value and Dispersion	Maximum Value[a] and Month Observed	Percent of Samples with Activity <LLD[b]
Pond No. 6 (Monthly)	Alpha	12	2.04 ± 1.63	4.48 (September)	100
	Beta	12	4.18 ± 0.70	5.56 (October)	0
Pond No. 12 (R-2A) (Monthly)	Alpha	12	4.47 ± 2.11	8.47 (September)	92
	Beta	12	4.51 ± 0.91	6.49 (September)	0
Upper Bell Creek No. 17 (Seasonal)	Alpha	8	3.67 ± 2.36	8.92 (December)	75
	Beta	8	4.31 ± 0.85	5.59 (December)	0
Well WS-4A (Seasonal)	Alpha	3	5.54 ± 2.33	6.89 (March)	100
	Beta	3	4.35 ± 0.12	4.48 (June)	0
Well WS-5 (Seasonal)	Alpha	12	3.47 ± 3.07	8.95 (August)	83
	Beta	12	4.27 ± 0.93	6.21 (August)	0
Well WS-6 (Seasonal)	Alpha	3	6.78 ± 1.48	7.83 (March)	50
	Beta	3	5.02 ± 0.56	5.63 (December)	0
Well WS-7 (Seasonal)	Alpha	2	9.16 ± 6.84	14.00 (June)	50
	Beta	2	5.75 ± 1.15	6.56 (June)	0

Table 9. SSFL Site Retention Pond, Site Runoff, and Well Water Radioactivity Data - 1988
(Sheet 2 of 4)

Area	Activity	Number of Samples	Gross Radioactivity Concentration ($\times 10^{-9}$ µCi/ml): Annual Average Value and Dispersion	Maximum Value[a] and Month Observed	Percent of Samples With Activity <LLD[b]
Well WS-8 (Seasonal)	Alpha	4	7.95 ± 2.66	10.60 (March)	25
	Beta	4	3.68 ± 1.65	5.10 (December)	0
Well WS-9 (Seasonal)	Alpha	3	9.67 ± 1.56	10.82 (June)	0
	Beta	3	4.60 ± 0.22	4.76 (December)	0
Well WS-9A (Seasonal)	Alpha	1	4.40	4.40 (December)	100
	Beta	1	3.37	3.37 (December)	0
Well WS-11 (Seasonal)	Alpha	Well out of service			
	Beta				
Well WS-12 (Seasonal)	Alpha	2	6.38 ± 5.62	10.35 (June)	50
	Beta	2	5.42 ± 0.19	5.53 (June)	0
Well WS-13 (Seasonal)	Alpha	12	4.62 ± 3.21	8.54 (October)	83
	Beta	12	4.09 ± 0.75	5.78 (June)	0

Table 9. SSFL Site Retention Pond, Site Runoff, and Well Water Radioactivity Data - 1988
(Sheet 3 of 4)

Area	Activity	Number of Samples	Gross Radioactivity Concentration ($\times 10^{-9}$ μCi/ml) Annual Average Value and Dispersion	Maximum Value[a] and Month Observed	Percent of Samples with Activity <LLD[b]
Well WS-14 (Seasonal)	Alpha	2	10.44 ± 0.01	10.45 (December)	0
	Beta	2	4.61 ± 0.30	4.82 (December)	0
Well OS-1 (Seasonal)	Alpha	3	5.50 ± 3.23	7.77 (March)	33
	Beta	3	4.20 ± 0.95	5.19 (September)	0
Well OS-2 (Seasonal)	Alpha	3	6.40 ± 2.29	9.01 (December)	66
	Beta	3	2.96 ± 1.23	4.23 (September)	0
Well OS-5 (Seasonal)	Alpha	3	7.53 ± 7.39	15.11 (September)	66
	Beta	3	4.20 ± 0.41	4.46 (September)	0
Well OS-8 (Seasonal)	Alpha	2	3.52 ± 3.31	5.86 (December)	100
	Beta	2	3.60 ± 1.39	4.59 (December)	0
Well OS-10 (Seasonal)	Alpha	1	4.87	4.87 (December)	100
	Beta	1	1.55	1.55 (December)	0

Table 9. SSFL Site Retention Pond, Site Runoff, and Well Water Radioactivity Data - 1988
(Sheet 4 of 4)

Area	Activity	Number of Samples	Gross Radioactivity Concentration ($\times 10^{-9}$ µCi/ml): Annual Average Value and Dispersion	Maximum Value[a] and Month Observed	Percent of Samples with Activity <LLD[b]
Well OS-13 (Seasonal)	Alpha	Dry well--not sampled			
	Beta				
Well OS-15 (Seasonal)	Alpha	1	11.87	11.87 (December)	100
	Beta	1	6.63	6.63 (December)	0
Well OS-16 (Seasonal)	Alpha	2	11.06 ± 7.18	16.13 (June)	50
	Beta	2	4.90 ± 0.88	5.52 (March)	0
Well RS-20 (Seasonal)	Alpha	1	2.29	2.29 (December)	100
	Beta	1	0.50	0.50 (December)	100
Well RS-21 (Seasonal)	Alpha	1	14.60	14.60 (March)	0
	Beta	1	1.75	1.75 (March)	0
Well RS-22 (Seasonal)	Alpha	2	11.56 ± 8.32	17.45 (March)	50
	Beta	2	2.01 ± 0.53	2.38 (September)	0

[a]Maximum value observed for single sample.
[b]Lower limit of detection: Approximately 0.4 x 10^{-9} µCi/ml alpha; 1.10 x 10^{-9} µCi/ml beta for water.

Table 10. Ambient Air Radioactivity Data - 1988

Area	Activity	Number of Samples	Gross Radioactivity Concentrations--Femtocuries per m^3 (10^{-15} µCi/ml) Annual Average Value and Dispersion	Maximum Value[a] and Date Observed	Percent of Guide[b]	Percent Less Than LLD[c]
De Soto (2 locations)	Alpha Beta	680	2.4 ± 2.6 34.1 ± 21.8	15.0 (04/03) 108.6 (10/24)	0.08 0.01	96 48
SSFL Area IV (5 locations)	Alpha Beta	1696	1.9 ± 2.7 31.0 ± 20.4	17.3 (08/10) 134.4 (01/04)	3.2 0.10	98 55
SSFL sewage treatment plant	Alpha Beta	355	2.2 ± 2.7 31.5 ± 19.0	11.2 (09/07) 94.6 (12/14)	3.7 0.11	99 50
SSFL control center	Alpha Beta	346	1.9 ± 2.7 31.1 ± 19.3	10.9 (09/07) 99.8 (10/16)	3.2 0.10	98 56
All locations	Alpha Beta	3077	2.1 ± 2.7 31.7 ± 20.4	-	-	-

[a]Maximum value observed for single sample.

[b]Guide De Soto site: 3×10^{-12} µCi/ml alpha, 3×10^{-10} µCi/ml beta; 10 CFR 20 Appendix B, CAC 17. 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]LLD = 9.1×10^{-15} µCi/ml alpha; 3.8×10^{-14} µCi/ml beta.

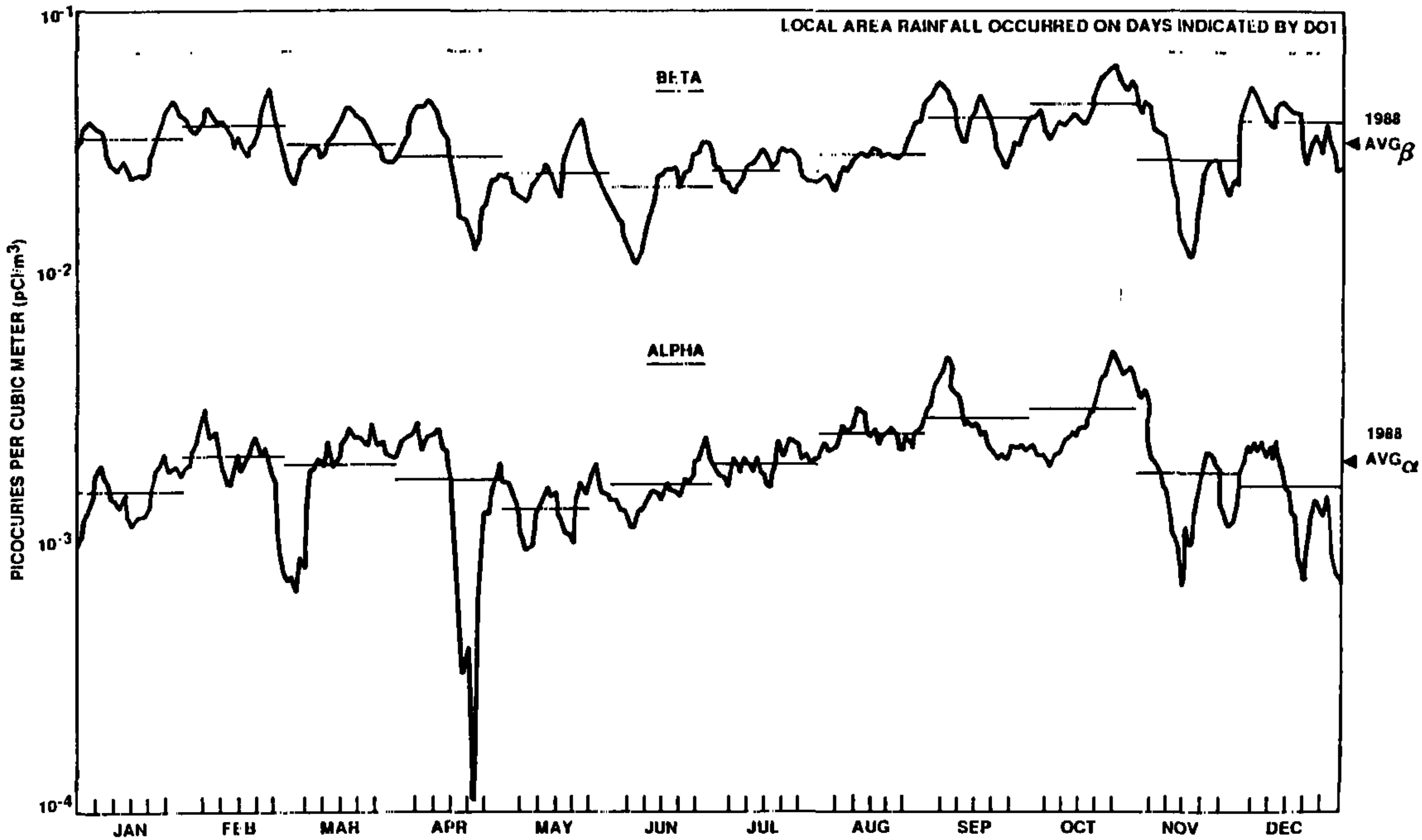

Figure 10. Average Long-Lived Airborne Radioactivity at the De Soto and Santa Susana Field Laboratories Sites 1988

Table 11. De Soto, SSFL, and Canoga Sites - Ambient Radiation Dosimetry Data - 1988

TLD Location		Quarterly Exposure (mR)				Annual Exposure (mR)	Equivalent Exposure at 1000-ft ASL	
		Q-1	Q-2	Q-3	Q-4		(mR)	(μR/h)
De Soto	DS-1	20	23	27	20	90	91	10
	DS-2	21	21	22	16	80	82	9
	DS-3	20	23	27	17	87	90	10
	DS-4	19	18	27	20	84	85	10
	DS-5	20	15	20	15	70	71	8
	DS-6	23	16	33	15	87	88	10
	DS-7	23	16	37	19	95	96	11
	DS-8	19	10	31	15	75	78	9
Mean value		21	18	28	17	84	85	10
SSFL	SS-1	21	22	31	20	94	82	9
	SS-2	26	22	30	23	101	89	10
	SS-3	21	20	27	18	86	74	8
	SS-4	18	29	29	22	98	85	10
	SS-5	21	21	29	27	98	84	10
	SS-6	25	19	29	21	94	82	9
	SS-7	27	14	31	14	86	73	8
	SS-8	26	12	41	18	97	84	10
	SS-9	29	20	32	21	102	90	10
	SS-10	24	18	31	20	93	81	9
	SS-11	33	26	39	39	137	126	14
	SS-12	32	25	41	31	129	118	13
	SS-13	25	19	32	29	105	94	11
Mean value		25	21	32	23	102	89	10
Canoga	CA-1	22	11	24	12	69	72	8
	CA-2	19	13	31	13	76	78	9
	CA-3	23	14	24	13	74	75	9
	CA-4	24	13	25	15	77	79	9
	CA-5	19	7	43	8	77	79	9
	CA-6	17	14	34	13	78	79	9
Mean value		21	12	30	12	75	77	9
Off-site	OS-1	29	18	25	13	85	88	10
	OS-2	18	12	21	13	64	62	7
	OS-3	18	21	25	18	82	84	10
	OS-4	21	16	25	13	75	73	8
	OS-5	22	16	27	16	81	81	9
Mean value		22	17	25	15	77	78	9

V. UNUSUAL EVENTS

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

A. REPORTABLE INCIDENTS

On March 11, 1988, during return of an empty fuel shipping cask, used for transporting disassembled Fermi fuel from the RMDF to INEL, the trailer tipped onto its side while rounding the last turn at the approach to the RMDF. The trailer was severely damaged, the ISO shipboard container enclosing the cask was moderately damaged, and the cask impact limiters were damaged. The cask was not damaged and there was no release of radioactive contamination. The incident was investigated and the results reported in SAN 88-1.[19]

The conclusion of the investigation was that the trailer was unstable and structurally inadequate for the service it had seen and progressive cracking of the front side beams had weakened the structure so that it could not withstand the cornering forces encountered at moderate speed.

B. NONREPORTABLE INCIDENTS

The Radiation and Nuclear Safety group provides radiological monitoring and safety guidance for operations with radioactive material (including Special Nuclear Material) and radiation-producing devices. As part of this function, "Radiological Safety Incident Reports" are written and distributed. The purpose of these reports is to record incidents that are not significant enough to require formal reporting to any regulatory agency (NRC, DOE, State of California), assure communication among the R&NS personnel, and enhance hazard awareness within the operations groups.

To promote the purpose of these reports, the reporting criteria have been deliberately left vague and general. Generally, a report is written for any injury occurring in a radioactively contaminated area, abnormal release of contamination, fire involving radioactive material, or exposure of personnel to radiation or abnormal radioactive contamination. These criteria are well below the regulatory agency reporting requirements. Judgment is required in determining when to write a report, and the goal has been both to inform workers and management and to record those events that might be questioned in the future but because of lack of consequence would not be otherwise recorded.

The reports are distributed to all members of Radiation and Nuclear Safety and generally to the individuals personally involved, their managers, and any related management. Each incident is reviewed at the time of reporting, and case-by-case corrective actions are implemented as appropriate.

1. January 26, 1988 — When exiting the Building T059 Pipe Chase Room, a photographer was found to have contamination on one pants leg. This contamination was successfully removed. Proper safety procedures had not been followed. The photographer was not trained for entry into a confined space, he did not have a film badge and pocket dosimeter, as required for a High Radiation Area, and a Controlled Work Permit was not prepared. Protective staffing was inadequate. Responsible management was reminded of these requirements.

2. February 25, 1988 — During transfer of Fermi fuel canister No. OP4 from Vault 1 to Vault 3 at the RMDF, the canister was dropped about 12 ft to the bottom of Vault 1. This apparently resulted from incomplete engagement of the lifting grapple hook with the canister bale, and the canister being dislodged when the cask bottom plate was put in place. Visual inspection showed some deformation on the bottom of the canister. A hot-water bubble leak test confirmed that no damage had been done to the canister.

3. August 12, 1988 — Two mechanics were found to have skin and hair contamination (10000-20000 dpm/100 cm2) on exiting the Pipe Chase Room at Building T059 after doing some torch cutting of the vacuum duct. All activity was removed by showering and wet wiping at the RIHL. Estimated dose to the skin was less than 1 mrem. Some radioactivity was detected in nasal wipes. Bioassay results were less than the laboratory minimum detectable activity.

4. August 13, 1988 — A glass jar containing activated sand from T059 broke while it was being centrifuged in the Chemistry Laboratory at Building S300. The sand was cleaned up and the centrifuge was decontaminated. No personnel were exposed.

5. August 15, 1988 — Two 55-gal waste disposal drums containing activated sand from T059 were punctured by a lift truck forks while being prepared for shipment. Approximately 40 grams of sand leaked out. The sand was cleaned up and the holes in the drums were sealed with tape. The sand in the drums was then transferred to new drums for disposal.

6. August 19, 1988 — While working in the Pipe Chase Room at T059, a mechanic felt his airline respirator filter cartridge pod disconnect from his face piece. After an attempt at reconnecting it, he exited the room to a clean area. He had apparently loosened the pod while untangling his airline hose on entering the room. Other airline users were notified of this problem. Bioassay results were less than the laboratory minimum detectable activity.

7. September 30, 1988 — On exiting Cell 1 at the RIHL, a mechanic found his right knee was contaminated to about 3500 dpm. He was successfully decontaminated by use of dry and wet wipes. The contamination may have been caused by some hydraulic fluid on some material that he had picked up. No significant exposure resulted from this incident.

8. October 10, 1988 — A mechanic found contamination on his left knee, right forearm, and left forearm after working in Cell 1 at the RIHL. The maximum contamination was 10,000 dpm on his left forearm. He was successfully decontaminated by use of wet and dry wipes. The contamination apparently worked through his protective clothing while he handled a heavy piece of contaminated metal. No significant exposure resulted from this contamination.

9. November 14,1988 — A mechanic cut his left index finger on some wire mesh while working in the Hot Storage Room at the RIHL. No contamination of the wound was found and no activity was detected in a blood smear. He was sent to the nurse for further treatment.

The number of incidents, 9, is a considerable reduction from prior years. They are categorized as:

Personal contamination (4 incidents)

1, 3, 7, 8

Release of contamination (2 incidents)

4, 5

Potential exposure/contamination (2 incidents)

6, 9

Potential equipment damage (1 incident)

2

It is indicative of the low level of problems experienced during this year that the last two categories refer simply to "potential" problems.

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)										Group		
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	>5.0	Total Exposed Persons	Dose (Person rems)	Average Dose (rems)
1988	129	19	9	4	3	3					167	18	0.111
1987	130	22	15	8	2	1				1	179	27	0.153**
1986	134	20	11	7	5	3					180	23	0.126
1985	134	10	4	9	12	25					194	58	0.301
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
**Includes presumptive exposure of 7.36 rem to industrial radiographer. Omitting this exposure yields a group dose of 20 person-rem and an average dose of 0.112.

Data shown for 1980 and prior years include visitors. Visitor exposures rarely exceed 0.25 rem. Data for 1981 through 1985 represent occupationally exposed Rocketdyne employees excluding certain workers in Rocketdyne operations predating the merger, while all occupational exposures are shown after 1985. The group dose was calculated exactly for the last eight 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 1988 showed a slight reduction in group dose and average dose from prior years. This reflects both the continuing effectiveness of the ALARA program and a reduction in radioactive work load.

Additional aspects of the external dose control program have been reviewed. For those programs included in the external dosimetry program in 1988, their accumulated ("lifetime") doses have been plotted against age for comparison with the guideline for an accumulated dose to not exceed 5 X (N-18) rem, where N is the age in years. This comparison is shown in Figure 11. It is clear that all doses are far below the guideline. This was further reviewed by calculating the average annual dose rate for these individuals. This is shown as a log-normal probability plot in Figure 12. Only six individuals (out of 427 on the program in 1988) exceed an average rate of 1 rem/year, with the highest at about 2 rem/year. These findings are particularly significant, in that no active control has been placed on lifetime doses, and many of the individuals have worked for many years under regulations that would permit up to 5 rem per year, and up to 12 rem per year with prior review (not to exceed 5 X (N-18)).

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.

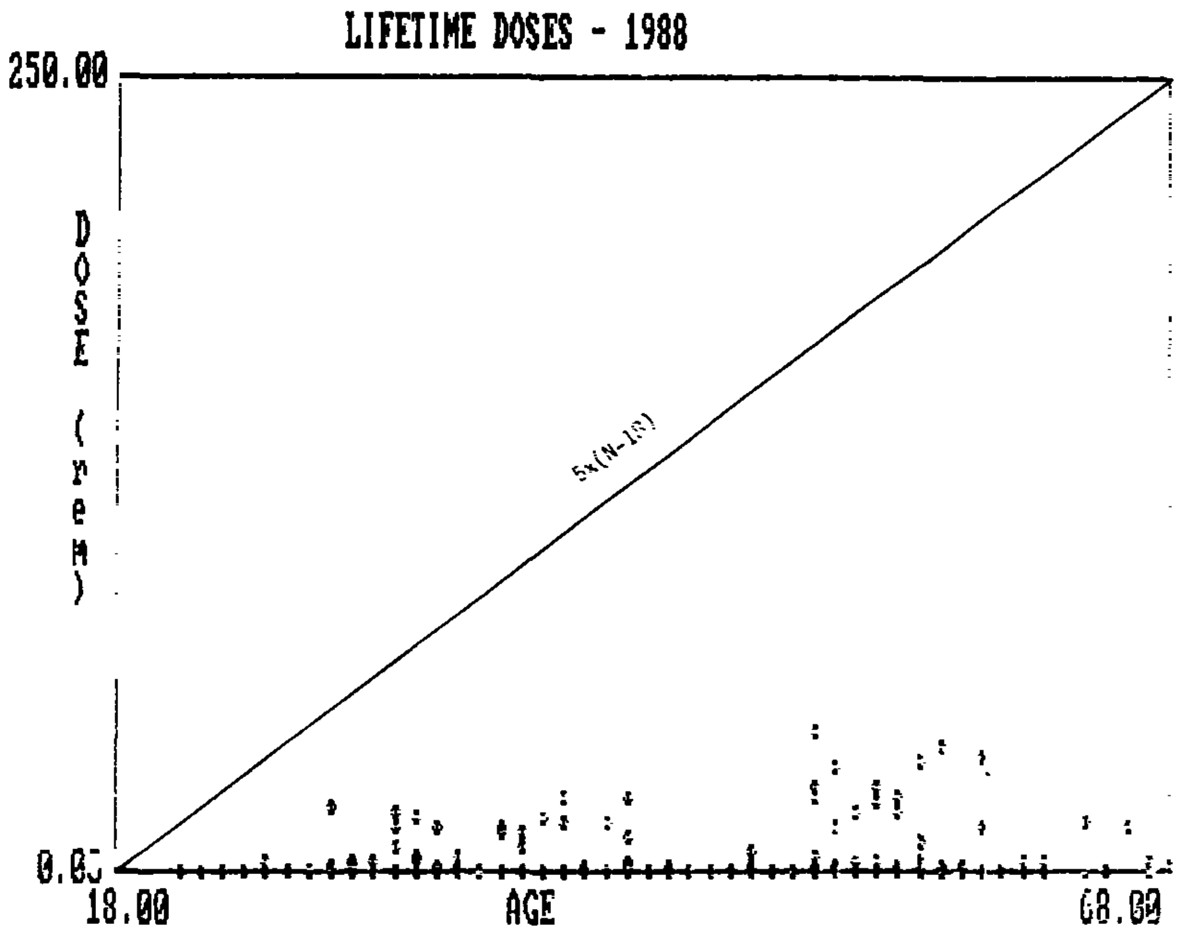

Figure 11. Lifetime Accumulated Doses - 1988

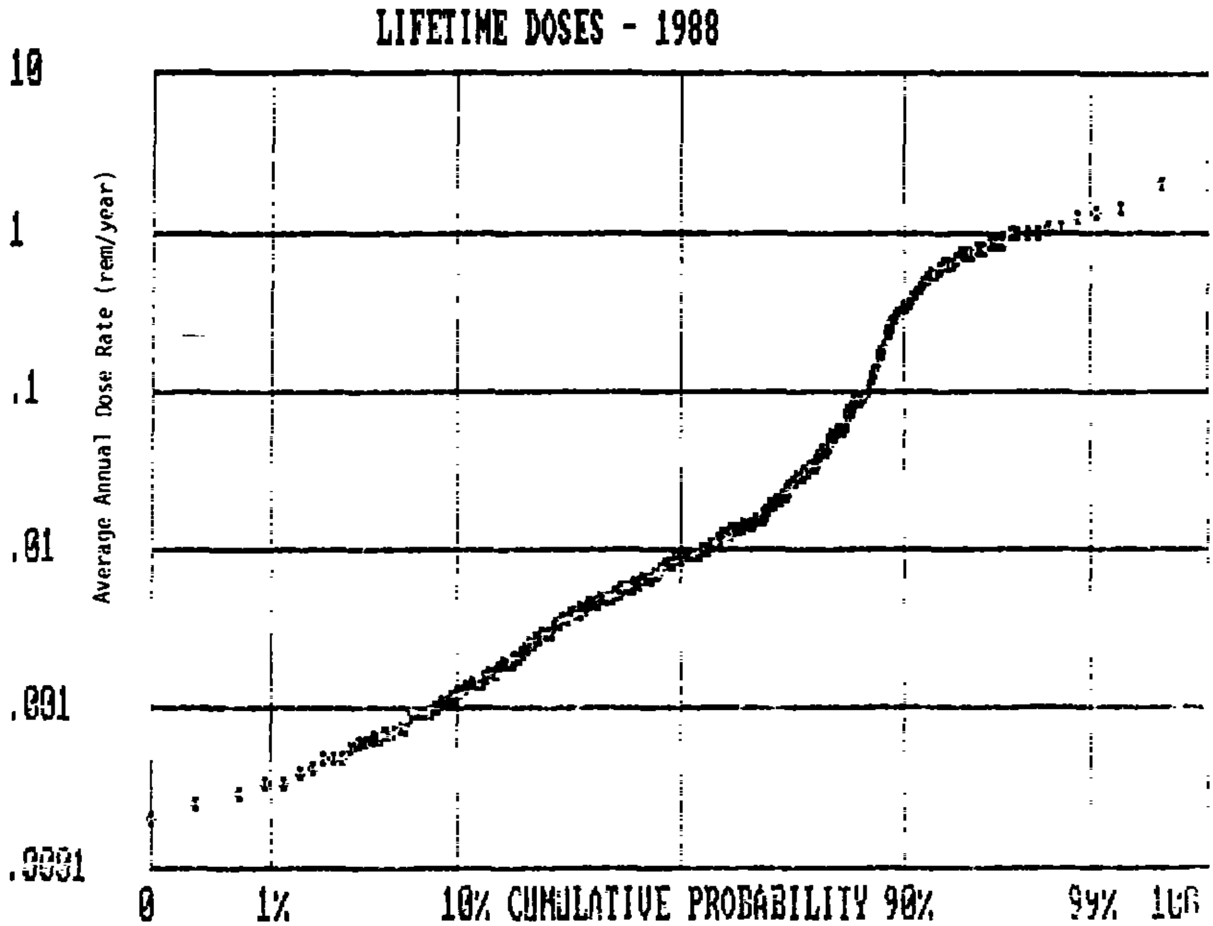

Figure 12. Lifetime Annual Dose Rates - 1988

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
1988	1086	15	1.4
1987	869	14	1.6
1986	663	39	5.9
1985	644	69	10.7
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	7.2
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 14 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. Tests were increased after 1984 to provide more detailed information for the purpose of future dose evaluations. The reduction in percentage of positive results for 1986 appears to be significant compared to immediately prior years. Following tables show the distribution for the two major radionuclides tested during this time period: Cs-173 (FP3B) and Sr-90 (FP3A). While the FP3A analysis is not specifically selective for Sr-90, that is the most restrictive radionuclide likely to be present and detected.

Cs-137 (Assumed Nuclide)

Year	Number of FP3B Tests	Number with Positive Results	Fraction of Positive Results with less than 0.01% MPBB	Maximum % MPBB
1988	287	0	all	0
1987	227	0	all	0
1986	255	8	0.250	0.02
1985	256	49	0.082	0.03
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	all	0.01

Sr-90 (Assumed Nuclide)

Year	Number of FP3A Tests	Number with Positive Results	Fraction of Positive Results with less than 10% MPBB	Maximum % MPBB
1988	287	9	0.89	11.3
1987	222	5	0.80	14.0
1986	255	25	0.720	20.8
1985	256	19	0.842	14.5
1984	136	15	0.800	45.0
1983	74	0	all	
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

B. WORK PLACE RADIATION AND RADIOACTIVITY

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

	Facility Average Exposure Rate (mR/h) / Maximum Exposure Rate (mR/h)			
Year	GIF	RIHL	ANTL	RMDF
1988	0.016 / 0.061	0.078 / 0.61	0.15 / 0.70	0.62 / 2.08
1987	0.023 / 0.11	0.07 / 1.43	0.18 / 1.47	1.27 / 5.65
1986	0.08 / 0.22	0.06 / 0.57	0.23 / 1.06	2.92 / 11.3
1985	0.16 / 0.23	0.13 / 0.87	0.97 / 4.00	2.74 / 29.42
1984	0.49 / 0.80	0.13 / 1.15		1.72 / 7.06
1983	0.001 / 0.004	0.47 / 6.42		0.82 / 4.15
1982	0.02 / 0.06	0.10 / 0.21		4.24 / 42.4

Variations reflect changes in workload, with a significant problem at the RMDF in 1985, due to processing of radioactive water and the accumulation of the resultant sludge, showing continuing improvement in subsequent years.

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

Year	Percent of MPC	
	RIHL	RMDF
1988	0.0006	0.0006
1987	0.4	15.7
1986	0.2	6.3
1985	0.5	4.4
1984	0.5	-
1983	0.5	-
1982	0.06	-
1981	0.05	-
1980	0.20	-

Major improvements in reducing airborne radioactivity at the RMDF were achieved this year.

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 from natural sources, 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. During the early part of 1988, considerable outside (unfiltered) air was also exhausted (and sampled) through the ventilation system of De Soto 104 due to a torn flexible coupling between the filter plenum and the exhaust blower.

Considerable natural activity (Be-7, K-90, Po-210) was also found in the effluent for the RIHL, where unfiltered bypass air is used to limit the suction provided by the exhaust blower. Inclusion of this natural radioactivity in the gross alpha and beta activities discharged to the atmosphere results in a significant overestimate of the releases of regulated radioactivity.

RADIOACTIVITY DISCHARGED TO ATMOSPHERE
(microcuries)

	De Soto		Santa Susana		
	101	104	RIHL	RMDF	NMDF
1988					
Alpha	-	0.23	0.16	0.07	-
Beta	-	0.94	3.86	4.100	-
1987					
Alpha	-	0.29	0.18	0.25	-
Beta	-	0.67	3.7	12.0	-
1986					
Alpha	-	0.08	0.13	0.05	0.04
Beta	-	0.78	22.0	13.0	4.0
1985					
Alpha	-	0.15	0.45	0.04	0.05
Beta	-	0.45	9.0	9.0	1.5
1984					
Alpha	-	0.44	0.10	0.074	0.04
Beta	-	0.59	4.5	3.7	0.98
1983					
Alpha	52.0	1.1	0.024	0.047	0.08
Beta	19.0	1.1	1.3	1.1	1.1
1982					
Alpha	1.2	0.24	0.03	0.024	0.023
Beta	0.94	1.1	14.0	0.61	1.0
1981					
Alpha	2.8	0.39	0.069	0.087	0.059
Beta	2.7	4.1	14.0	4.0	2.0
1980					
Alpha	5.3	1.0	0.17	0.061	0.082
Beta	4.3	4.9	17.0	1.7	1.1
1979					
Alpha	2.1	1.1	0.18	0.085	0.053
Beta	5.8	5.7	44.0	2.7	0.21
1978					
Alpha	16.0	0.65	0.13	0.1	0.081
Beta	5.0	4.3	59.0	11.0	-
1977					
Alpha	10.0	0.88	0.1	0.11	0.15
Beta	4.1	7.5	13.0	3.0	-
1976					
Alpha	64.0	8.1	0.15	0.23	0.15
Beta	17.0	8.9	5.8	1.1	-
1975					
Alpha	3.7	5.4	0.15	0.45	0.19
Beta	2.6	12.0	6700.0*	10.0	-

*Released from burned fuel slug.

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	
1988	22.7	17.6	29.7	18.3	88.3
1987	27.2	40.9	43.3	31.5	142.9
1986	21.8	28.7	30.9	28.7	110.1
1985	21.8	32.2	26.6	29.0	109.6
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
1975	21.3	24.6	26.2	25.4	97.6

The quarterly doses are plotted as a histogram in Figure 13. 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. The data for 1985 and 1986 suggest a leveling off of this decline. 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.

Results from the State of California monitoring program are compared in the table below:

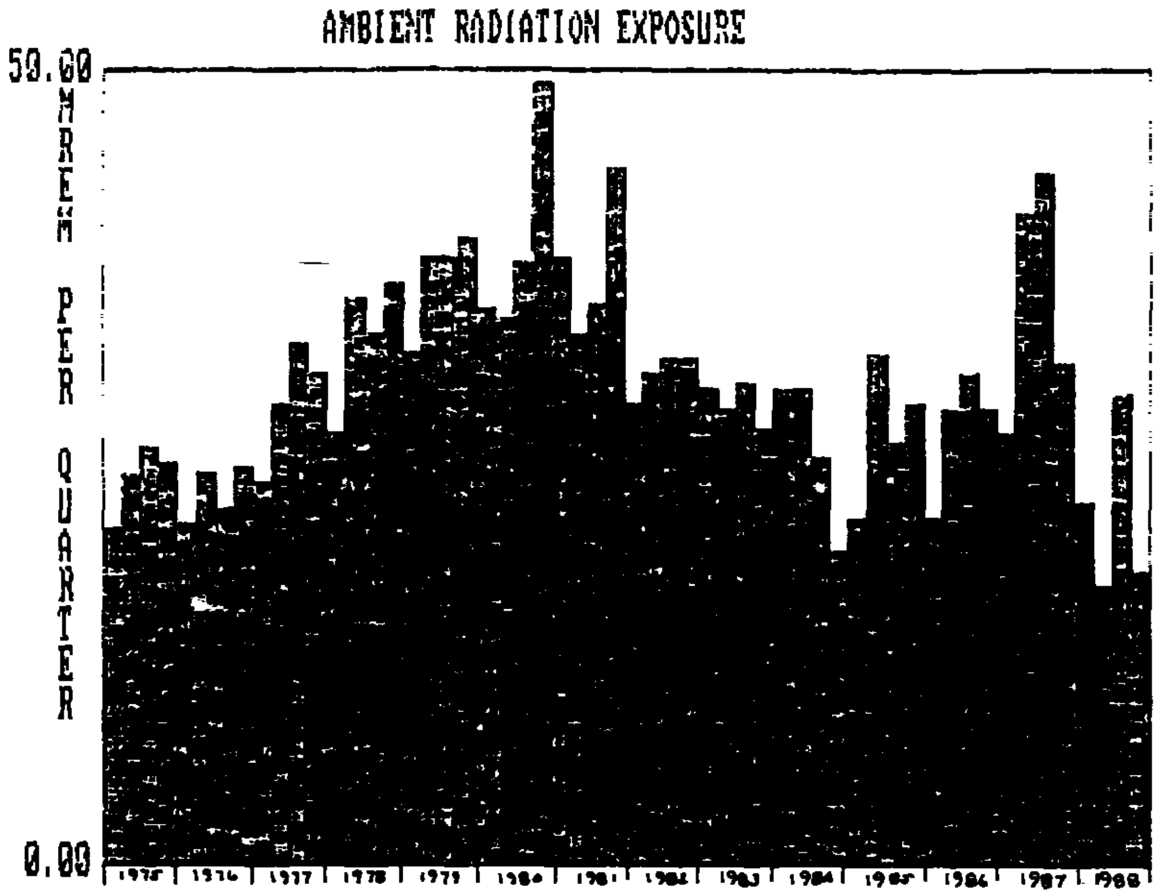

Figure 13. Averaged Quarterly Dose Recorded
by Environmental TLDs

Comparison of State and Rockwell TLDs

		mR/Q							
		1987				1988			
		1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
DS-6	CA	28.2	25.5	23.4	21.7	22.2	22.1	22.2	23.0
	RI	28	32	55	30	23	16	33	15
DS-2	CA	20.1	21.1	21.7	23.7	20.4	19.3	18.8	19.1
	RI	27	29	47	26	21	21	22	16
SS-3	CA	28.5	25.5	26.8	25.4	23.9	23.2	22.2	23.8
	RI	29	51	47	40	21	20	27	18
SS-6	CA	25.6	30.5	25.7	27.6	25.4	24.8	24.7	25.7
	RI	30	54	38	32	25	19	29	21
OS-1	CA	27.0	18.6	20.0	20.2	18.7	18.3	16.3	19.5
	RI	23	24	34	24	29	18	25	13
OS-5	CA	25.9	28.6	24.0	25.7	24.1	24.7	21.8	24.9
	RI	29	42	44	33	22	16	27	16
DS-8	CA	20.9	17.8	20.4	21.9	20.0	19.0	18.8	21.0
	RI	25	28	28	27	19	10	31	15
SS-7	CA	23.6	23.6	24.9	25.0	22.9	22.2	21.5	24.2
	RI	22	41	58	30	27	14	31	14
SS-11	CA				36.0	37.9	41.3	----	37.9
	RI					33	26	39	39

While the results are generally similar, the Rockwell measurements show considerably greater variability.

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

	De Soto		SSFL		Canoga		Off-site	
Year	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
1988	84	95	102	137	75	78	77	85
1987	126	145	158	172			138	152
1986	99	113	120	143			105	116
1985	100	107	124	152			105	112
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 shows 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 the off-site locations due to the significantly greater elevation of the SSFL site, and possibly also due to the greater out-cropping of uranium-mineral-bearing sandstone. There is no indication of significant exposure resulting from operations with radioactive material.

Average and maximum values for soil radioactivity are shown in Table 12. This table shows the change in reported alpha activity resulting from adoption of a calibration factor for thick soil samples. Prior to 1984, only relative

Table 12. Soil Radioactivity Summary
1975-1988
(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
	1988	29.1 ± 6.2	53.6	26.0 ± 2.8	31.4	25.6 ± 6.2	39.6	24.9 ± 2.7	29.6
	1987	27.1 ± 7.7	40.1	25.4 ± 2.1	30.9	25.7 ± 7.7	55.1	23.9 ± 3.5	29.1
	1986	26.7 ± 6.6	40.1	26.1 ± 2.2	32.2	28.1 ± 5.9	39.0	24.2 ± 1.3	30.4
	1985	25.2 ± 7.3	48.4	24.2 ± 1.9	32.7	26.3 ± 7.8	46.0	23.9 ± 3.3	30.2
	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 as equal to the MDL. For 1981 and later, actual measured values were used.

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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 on-site (out of 1728 samples): those are 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 the 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 13 and 14. The on-site averages are generally higher than off-site but not greatly so. This may represent differences between the set of five on-site locations and the single off-site 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 on-site values shows no systematic variation with location relative to the NMDF and the RIHL.

As reported at the July 1988 annual meeting of the Health Physics Society, plutonium in soil, sampled in areas distant from the Hanford (Washington) site and determined to not be from Hanford operations by the isotopic ratios observed, showed values in the range of 3 to 16 fCi/g. This is essentially what is observed for the SSFL measurements.

Table 13. Plutonium in Soil Summary
1978-1988
(Pu-239 + Pu-240, fCi/g)

	On-site		Off-site
Year	Average ± Dispersion	Maximum Value	Average ± Dispersion
1988	3.1 ± 1.7	6.9	0.2 ± 0.2
1987	2.7 ± 1.8	7.1	0.1 ± 0.1
1986	1.8 ± 1.3	3.8	1.2 ± 1.0
1985	2.6 ± 1.5	5.1	0.4 ± 0.2
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
Grand Average	4.2 ± 4.3	11.2	1.7 ± 2.6

Table 14. Summary of Plutonium in Soil
(Pu-239 + Pu-240, fCi/g)

	Location	Average ± Dispersion	Maximum Value	Date
S-56	1100 ft NW NMDF	3.5 ± 4.3	14.4	December 1983
S-57	900 ft SE NMDF	3.5 ± 2.2	9.5	June 1980
S-58	500 ft SE NMDF	4.9 ± 4.1	18.9	December 1979
S-59	900 ft ESE NMDF	4.5 ± 3.7	18.6	December 1979
S-60	2000 ft SE NMDF	4.7 ± 2.6	29.5	December 1980
S-61	2.7 mi. NE NMDF	1.7 ± 2.6	7.1	June 1983

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In 1986, after review of the results of vegetation sampling conducted over the prior 28 years, it was determined that this sample class did not provide significantly useful data. Fallout is more accurately assessed by measurement of airborne radioactivity and soil radioactivity. Therefore, the vegetation sampling was discontinued.

Alpha and beta radioactivity in the supply water at the De Soto and SSFL sites are shown in Table 15. 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 on-site 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 since 1983.

Alpha and beta radioactivity in environmental waters is shown in Tables 16A and 16B. 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, while Pond 6 receives runoff and effluent from the other facilities. The Bell Creek sample, from the location sampled prior to 1986, appears to be mostly seepage from the Bell Canyon community. After 1985, water was automatically sampled at the head of Bell Creek.) The results for the pond water are very nearly the same as the supply water for 1986. No radionuclides that are present at the nuclear facilities have been found.

Tables 17A and 17B 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 off-site samples are essentially identical. (The "off-site" samples are located at SSFL but at a considerable distance from the nuclear facilities.)

Table 15. Supply Water Radioactivity Summary, 1975-1988

		De Soto				SSFL			
		Alpha		Beta		Alpha		Beta	
	Year	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value
	1988	3.80 ± 1.42	6.57	4.10 ± 0.43	5.16	5.40 ± 3.34	13.81	3.93± 0.84	5.80
	1987	5.14 ± 6.62	25.12	3.40 ± 0.72	4.52	5.10 ± 3.81	14.98	3.59 ± 1.03	6.04
	1986	4.41 ± 2.53	8.70	3.75 ± 0.62	4.69	6.55 ± 9.09	45.77	3.58 ± 0.95	6.75
	1985	2.76 ± 1.82	5.73	3.17 ± 0.78	4.6	2.45 ± 2.61	8.6	2.80 ± 0.52	3.95
	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. Subsequent 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.

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Units for Table 15 are pCi/ℓ.

Table 16A. Environmental Water Radioactivity Summary
1975-1988
(Alpha, pCi/L)

	Year	Pond R-2A		Pond 6		Bell Creek	
		Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value
	1988	4.47 ± 2.11	8.47	2.04 ± 1.63	4.48	3.67 ± 2.36	8.92
	1987	2.78 ± 1.98	5.35	1.75 ± 1.65	3.87	2.03 ± 0.69	2.76
c	1986	4.18 ± 2.70	8.70	2.51 ± 2.88	9.51	2.02 ± 2.08	5.90
	1985	3.07 ± 1.94	6.61	1.06 ± 4.44	13.6	1.38 ± 7.09	19.7
	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. Subsequent 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.

[c] Prior to 1986, Bell Creek was sampled at the eastern boundary of the residential community of Bell Canyon. In 1986, an automatic water sampler was installed that collects water only when water is present in the upper part of Bell Creek, immediately downstream from the discharge of Pond R-2A.

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Table 16B. Environmental Water Radioactivity Summary
1975-1988
(Beta, pCi/L)

	Year	Pond R-2A		Pond 6		Bell Creek	
		Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value
	1988	4.51 ± 0.91	6.49	4.18 ± 0.70	5.56	4.31 ± 0.85	5.59
	1987	4.38 ± 0.61	5.67	4.66 ± 0.98	5.76	3.28 ± 0.93	3.85
b	1986	3.58 ± 1.14	8.93	2.92 ± 0.94	4.57	2.60 ± 0.52	3.66
	1985	3.49 ± 0.79	5.56	3.58 ± 0.96	4.92	2.49 ± 0.75	3.79
	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.
[b]Prior to 1986, Bell Creek was sampled at the eastern boundary of the residential community of Bell Canyon. In 1986, an automatic water sampler was installed that collects water only when water is present in the upper part of Bell Creek, immediately downstream from the discharge of Pond R-2A.

Table 17A. Ambient Air Radioactivity Summary
1975-1988
(Alpha, fCi/m^3)

	De Soto		SSFL		Off-site	
Year	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value
1988	2.4 ± 2.6	15	1.9 ± 2.7	17	2.0 ± 2.7	11
1987	1.9 ± 2.6	15	1.9 ± 2.4	36	1.9 ± 2.1	9
1986	2.9 ± 3.4	22	2.8 ± 3.3	37	2.9 ± 3.3	33
1985	2.7 ± 2.2	38	2.0 ± 1.6	44	2.0 ± 1.9	25
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.

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Table 17B. Ambient Air Radioactivity Summary
1975-1988
(Beta, fCi/m^3)

	De Soto		SSFL		Off-site	
Year	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value	Average ± Dispersion	Maximum Value
1988	34 ± 22	109	31 ± 20	134	31 ± 19	100
1987	27 ± 20	112	27 ± 18	107	28 ± 20	104
1986	58 ± 103	1236	60 ± 94	1579	60 ± 90	1233
1985	44 ± 14	180	40 ± 13	170	40 ± 14	240
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.

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VII. ANTICIPATED ACTIVITIES DURING NEXT REPORTING PERIOD (1989)

Building 104 (GIF and ANT)

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

Building 020 (RIHL)

Continue cleanup of cells as part of the decontamination project.

Buildings 021/022 (RMDF)

Shipment of disassembled Fermi fuel, and support of on-site D&D projects.

REFERENCES

1. U.S. Nuclear Regulatory Commission - Special Nuclear Materials License No. SNM-21, USNRC (June 28, 1984)

2. "Annual Review of Radiological Controls - 1975," R. S. Hart, Atomics International, Rockwell International, N001TI990002, July 2, 1979

3. "Annual Review of Radiological Controls - 1976," R. S. Hart, Energy Systems Group, Rockwell International, N001TI990003, April 2, 1980

4. "Annual Review of Radiological Controls - 1977," R. S. Hart, Energy Systems Group, Rockwell International, N001TI990098, May 27, 1980

5. "Annual Review of Radiological Controls - 1978," R. S. Hart, Energy Systems Group, Rockwell International, N001TI990104, August 6, 1980

6. "Annual Review of Radiological Controls - 1979," R. S. Hart, Energy Systems Group, Rockwell International, N001TI990113, September 15, 1980

7. "Annual Review of Radiological Controls - 1980," R. R. Eggleston, Energy Systems Group, Rockwell International, N001TI990144, July 14, 1981

8. "Annual Review of Radiological Controls - 1981," R. R. Eggleston, Energy Systems Group, Rockwell International, N001TI990176, January 21, 1983

9. "Annual Review of Radiological Controls - 1982," R. J. Tuttle, Rocketdyne Division, Rockwell International, N001TI000238, January 29, 1985

10. "Annual Review of Radiological Controls - 1983," R. J. Tuttle, Rocketdyne Division, Rockwell International, N001TI000256, January 27, 1986

11. "Annual Review of Radiological Controls - 1984," R. J. Tuttle, Rocketdyne Division, Rockwell International, N001TI000257, March 30, 1986

12. "Annual Review of Radiological Controls - 1985," R. J. Tuttle, Rocketdyne Division, Rockwell International, N001TI000260, July 4, 1986

13. "Annual Review of Radiological Controls 1986," R. J. Tuttle, Rocketdyne Division, Rockwell International, N001TI00285, July 1987.

14. "Annual Review of Radiological Controls - 1987," R. J. Tuttle, Rocketdyne Division, Rockwell International, N001TI000287, July 28, 1988.

15. "Occupational Radiation Exposure (1982 and 1983)," NUREG-0714, Vols. 4 and 5, B. Brooks, S. McDonald, E. Richardson, Division of Radiation Programs and Earth Sciences, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, October 1985

16. "Sixteenth Annual Report - Radiation Exposures for DOE and DOE Contractor Employees - 1983," DOE/PE-0072, October 1984

17. "Rocketdyne Environmental Monitoring and Facility Effluent Annual Report - 1988," J. D. Moore, Rockwell International, Rocketdyne Division, RI/RD89-139, March 1988

18. "Report of Committee II on Permissible Dose for Internal Radiation (1959)," ICRP Publication 2

19. "Report of the Committee Investigating the Fuel-Cask-Trailer Accident at the Rocketdyne Santa Susana Field Laboratory, March 11, 1988." May 13, 1988 (USDOE San Francisco Operations Office, Oakland, CA).

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