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ABSTRACT

In 1988–90, four increasingly intensive reviews were conducted of the Rocketdyne radiological environmental monitoring program and the associated laboratory. Each of these reviews commented on strengths and weaknesses, and offered specific criticisms and recommendations.

This Safety Review Report presents a summary of those reviews, comments on the findings, and provides proposed and accomplished actions in response to the recommendations.

The DOE/San Francisco Operations Office (SAN) asked for a plan of action in response to one of these reviews by ORAU (the Berger Report). An integrated response to the recommendations of all the reports is presented here.

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FORM 734-C REV. 12-84

REV	SUMMARY OF CHANGE	APPROVALS AND DATE
A	Editorial changes and minor technical changes reflecting the generally improved organizational situation since initial preparation of the report and implementation of most of the recommendations.	P. D. Rutherford 4/27/91 R. J. Tuttle 6/24/91

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I. INTRODUCTION

In 1985, the U.S. Department of Energy developed a plan to review environmental conditions at all DOE sites. The purpose of the Environmental Survey was to identify environmental problems and areas of environmental risk at DOE operating facilities for the purpose of prioritizing them for remedial action.

The DOE Environmental Survey of SSFL was performed during May 1988. Included was a brief review of the Rocketdyne radiological environmental monitoring program and laboratory. The Survey found no serious problems with the program and laboratory but made several recommendations. In addition, the report listed ten findings for improvement of the Rocketdyne radiological program: nine were in the lowest-concern category, one was in the next lowest concern category. Applicable excerpts from the preliminary report are attached as Appendix A.

In response to the identification of several locations at SSFL with known or potential low levels of chemical contamination, with the possible involvement of correspondingly low levels of radioactivity, the EPA, Region IX, sent an emergency response unit to collect samples of soil and water for analysis for chemical pollutants. Because they perceived the possibility of exposure to radiation for members of the sampling team, the corporate health physicist of the company supplying those people under contract to EPA (Ecology and Environment, Inc. of San Francisco), requested that EPA provide on-scene radiation safety monitoring.

Gregg D. Dempsey, Chief, Field Studies Branch, EPA Office of Radiation Programs – Las Vegas Facility, was selected to provide that monitoring, in conjunction with making exploratory radiation surveys and collecting samples for analysis for radioactivity. Subsequently, based on the visit to SSFL and review of various documents, a report to the On-Scene Coordinator, EPA Emergency Response Unit was issued, describing the review of the Rocketdyne monitoring program and laboratory (see Appendix B-1). Additionally a later report was issued on the results of the radiometric analyses, directed to the Assistant Director, EPA Toxics and Waste Management Division (Appendix B-2).

A response to the initial EPA report was prepared by Rocketdyne for submittal to the NRC in response to the intervenors' Direct Case, and is attached as Appendix B-3.

Several of the concerns presented in the EPA review report suggested possible deficiencies in the performance of radioanalytical work for projects conducted for the DOE, primarily decontamination and decommissioning (D&D) projects. To investigate this, the DOE-San Francisco Operations Office asked that an independent review, focused on the D&D projects, be performed by the ORAU Environmental Survey and Site Assessment Program. This review was conducted on September 28-29, 1989, and the report is attached here as Appendix C.

One of the observations in the EPA review report was that the Rocketdyne laboratory had not had a thorough peer review, "to assess the direction of the environmental program, identify problems in procedures and protocols, and make recommendations for improvements." Although the program and the laboratory had been under the scrutiny of federal and state regulatory agencies since its inception and through all the succeeding evolutionary changes and current operation, a peer review, by an expert specialist, focused solely on these functions, had not been performed. In response to this concern, a list of six possible reviewers was submitted by Rocketdyne to EPA for approval prior to contracting for performing the review. Of the six, three received EPA approval, with a fourth reviewer listed as optional. Based on EPA's approval, Rocketdyne contracted with Analytics, Inc. whose reviewer was listed first. The report of this review is attached as Appendix D.

Since the peer review report was prepared, Rocketdyne has had discussions with DOE/SAN on plans for implementing appropriate requirements in two draft DOE environmental regulations, namely,

10 CFR 834 "Radiation Protection of the Public and the Environment"

"Regulatory Guide for Effluent Monitoring and Environmental Surveillance for Compliance with DOE 5400 Series Orders"

II. THE REVIEWS

DOE Environmental Survey

As part of a comprehensive DOE-wide environmental survey project initiated in 1985, DOE-sponsored activities at SSFL were reviewed by the Office of Environmental Audit. This survey was conducted May 16 through May 26, 1988, and was the last of the surveys performed in this project. The survey consisted of reviews of documents, tours of SSFL, inspection of historical photographs, and interviews with Rocketdyne employees. No survey measurements or sample analyses were performed.

A preliminary report was prepared, but since previous draft reports in the project had been given broad distribution before being finalized, DOE released this report directly.

EPA Review Report

A general familiarization was presented to the Emergency Response Unit/Technical Assistance Team (T. A. T.) on the morning of July 12, 1989. A brief tour of SSFL Area IV was conducted in the afternoon, and during the closing 2 1/2 hours of the day, operation of the Rocketdyne laboratory was discussed. July 13 was spent in taking samples and performing radiation surveys.

The review report was critical of some aspects of Rocketdyne environmental monitoring; however, the field measurements of radiation and radioactivity made during the course of the sampling provided no indications for concern.

EPA indicated that the Rocketdyne program was inadequate for characterization of the radioactivity in the environment. Rockwell had developed the environmental monitoring program not to characterize the existing (natural) radioactivity, but to watch for detectable consequences of the loss of control and release of radioactivity or radiation from our various facilities. While some isolated instances of environmental contamination had occurred, there were no losses of control of sufficient extent or magnitude to provide widespread releases of radioactivity that could have been detected by environmental monitoring. However, the program had demonstrated its sensitivity by clearly showing the local effects of nuclear weapons tests, the reactor accident at Chernobyl, and several systematic variations in the natural radiation environment. These effects occur at levels that are far below levels of concern for regulatory limits or impact on the environment.

A detailed response to the EPA review report, which was submitted to the NRC as part of the license renewal process, is presented in Appendix B-3.

EPA Results Report

Samples collected on July 13, 1989, by EPA were sent to Controls for Environmental Pollution, Inc. (CEP) for radiometric analyses. The results of these analyses are summarized in Table I. Except for the H–3 results and Cs–137 for the T064 Sideyard Trench, all these values are consistent with naturally occurring background activities, with slightly elevated Cs–137 concentrations.

Most of the soil sampling and analyses are quite straightforward and represent natural background or global fallout in most cases. The analyses for tritium (H–3) in the mud samples from the Sodium Disposal Facility Upper Pond used a special technique, azeotropic distillation, to extract only the free water, not that bound mineralogically in the soil.

For comparison with tritium–in–water analyses, since it is the water in the soil that is being analyzed for tritium, the results of the two tritium–in–soil analyses (Sodium Disposal Facility Upper Pond and Duplicate) were converted to an estimated concentration in water. (The EPA results were reported as per gram of soil, without an indication of whether that was soil as submitted (nearly saturated) or dry, and so, cannot be directly compared with measurements of tritium in water). This soil can contain approximately 0.8 ml H_2O/g soil. Assuming that the water content of the sampled soil was 0.7 ± 0.1 ml/g, the concentration of tritium per liter of water is 843 ± 198 to 1434 ± 303 for the Upper Pond sample and 71 ± 16 to 122 ± 25 for the Duplicate sample. Reasonable estimates based on this interpretation are 1100 ± 300 pCi/L for the Upper Pond sample and 100

Table I. Summary of Results from EPA Survey (July 13, 1989)

Location	Activity (pCi/g) Gamma Spectrometry								
	K40	Cs137	Tl208	Pb212	Pb214	Bi214	Ra226	Ac228	pCi/L H3
Sodium Disposal Facility									
Upper Pond	9.76	0.90	0.81	0.54	0.19	0.28	0.56	0.79	1,110*
Duplicate	10.10	0.94	0.76	0.73	0.42	0.42	0.38	0.77	100
Lower Pond	28.81	0.93	1.55	1.90	1.31	0.87	1.29	1.62	—
RMDF Leach Field**	31.05	1.02	1.58	1.88	1.11	1.41	1.27	2.15	—
T059 French Drain Water	No activity detected								1,890
T064 Sideyard Trench	29.33	331.4	1.67	1.56	1.27	1.49	1.25	1.92	—

*Adjusted from soil analysis on basis that 1 g saturated soil contains 0.8 ml water. See text.
**From a location near but not actually at the Leach Field.

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± 30 pCi/L for the Duplicate sample. Clearly, these results are inconsistent and reflect the considerable difficulty in performing these measurements at such low levels of activity.

The detection of tritium (H–3) in water samples from the T059 French drain water at a concentration of 1890 pCi/L was the first finding of unnatural radioactivity in the groundwater at SSFL. The groundwater had not been tested for tritium previously.

The appropriate regulatory requirements for tritium in water are the NRC regulations, the State of California radiation control regulations, and the DOE Orders. These regulations are summarized here:

- NRC 10CFR20, Section 20.106, "Radioactivity in effluents to unrestricted areas."

Considering the ground and groundwater as an unrestricted area, radioactive material concentrations, averaged over periods of one year, must not exceed the limits specified in Appendix B, Table II. The limit for tritium is 3×10^{-3} μCi/ml, or 3,000,000 pCi/L. Explanatory Appendix B provides that a particular radionuclide may be considered to be not present if its concentration is less than one–tenth of the limit, and if those radionuclides ignored in that manner represent less than one–quarter of the effective limit. Thus, in most cases, tritium may be neglected if its concentration is less than 300,000 pCi/L.

- State of California CCR17, Section 30269, "Concentrations in Effluents to Uncontrolled Areas."

This regulation is essentially identical to 10CFR20.106, and the numerical limits are the same.

- DOE Order 5480.1 Chapter XI (Effective 8/13/81 to 9/3/85)

The numerical limits in this Order were applied directly only to drinking water in controlled areas, and were used as guides in assuring that doses to the public were kept as low as reasonably achievable and below the public dose limits of 500 mrem per year for an individual and 170 mrem per year for a suitable population sample. The numerical limit for tritium concentrations in water was the same as that provided in 10CFR20.106.

- DOE "Radiation Standards for Protection of the Public in the Vicinity of DOE Facilities" (Effective 9/3/85 to 2/8/90).

This eliminated the concentration guides, but kept public dose limits of 500 mrem per year for occasional exposures, and a reduced limit of 100 mrem per year for prolonged exposure.

- DOE Order 5400.5 (Effective 2/8/90 to present).

The requirements of this Order are very similar to the others, except that the explicit provision for ignoring radionuclides with low concentrations is not stated. The numerical limit, which is based on an annual dose of 100 mrem per year (compared to the NRC and State limits of 500 mrem per year) is 2,000,000 pCi/L.

Results for the other radionuclides reported in these analyses appear reasonably consistent, although it appears that the concentration of Tl–208 (a member of the Th–232 decay chain and a direct daughter of Pb–212) has been adjusted for its fractional yield, as is often done to estimate the activity of the chain. Assuming this to be the case, the average Th–232 activity is 1.44 pCi/g, and the average U–238 activity is 1.00 pCi/g. These values are in good agreement with the results from the U. S. Testing analyses done for Groundwater Resource Consultants ("Investigation of Naturally Occurring Radionuclides in Rock, Soils and Groundwater, Santa Susana Field Laboratory, Ventura County, California, June 1, 1990). These analyses showed average values of 1.66 pCi/g for Th–232 and 1.10 pCi/g for U–238.

The EPA report commented on the absence of Co–60 and the presence of tritium (H–3) in the water from the Building T059 french drain, and "although the level encountered is orders of magnitude below what could be described as an environmental concern," recommended further study of tritium, to determine the origin and spread. The only other abnormal radioactivity detected involved Cs–137 at the Building T064 Side Yard, sampled while the area was in the process of being cleaned up.

ORAU Report

This review, conducted by J. D. Berger and C. F. Weaver, benefited from the availability of the EPA Review Report. It was conducted at SSFL on September 28–29, 1989. Analytical equipment was judged to be appropriate, although the lack of a liquid scintillation counter, for tritium, Pm–147, and Ni–63, was considered a shortcoming worth review. Extensive chemistry procedures were not considered to be appropriate or needed. Some lack of comprehensiveness in procedures was found.

ORAU discussed the need for specific guidelines for residual radioactivity in soil and that measurements of gross alpha and beta activities, as done in the past, were no longer adequate to demonstrate compliance with dose-related limits. Our use of the DOE program, RESRAD, in this regard was recognized.

The report stated, based on performance by ORAU of several confirmatory surveys, that the Rocketdyne decommissioning efforts were effective and the survey data were adequate and accurate. Some specific improvements were recommended. The report addressed the concerns over volatilization of radioactivity during ashing by supporting the reduction in the ashing temperature from 500 degrees C to 450 degrees C, while stating that there is probably no problem at the higher temperature. Improvements and

alternatives in gamma spectroscopy were discussed, and development of a soil matrix calibration standard was recommended. Several aspects of quality control were also highlighted as warranting improvement.

ORAU performed gamma surveys at several locations. These identified some previously known areas of elevated radiation, but none of significance.

ORAU reviewed recent surveys performed at SSFL and considered that further investigation of subsurface conditions, relative to discontinued leach fields and other specified areas, should be done.

ORAU concluded that there were no indications of serious radiological problems, but that the review had identified valuable improvements to the monitoring program. A detailed list of specific recommendations was prepared.

Analytics Review Report

This review was arranged as the "peer review" recommended by EPA in the review report. D. M. Montgomery was among six proposed reviewers offered to EPA Region IX for approval. Three individuals were approved with a fourth listed as optional. Analytics was awarded the contract, and the review started on April 16 1990.

The review was performed in two separate one-week onsite visits, and a preliminary report was issued on May 31, 1990. The report included Analytic's comments on the EPA and ORAU reviews. Rocketdyne asked that this report be sent to EPA and ORAU for their review.

This review benefitted from the availability of both prior reviews. After spending two weeks onsite, reviewing a broad range of Rocketdyne reports and various regulations, and considering historical and current operations, Analytics judged that the performance of the program was adequate to meet its requirements, and made several recommendations, with a particular view to the future.

The problems of measuring low-level gross alpha and beta radioactivity in soil was discussed in detail, with the major difficulty being due to loss of radon, which could affect results by roughly a factor of 2, and alternative methods were discussed.

The absence of the previous program administrator was noted as having an undesirable impact on quality control. Additional quality control actions were described.

The environmental monitoring data from 1966 through 1989 were reviewed and commented on extensively, and the impact of various changes discussed.

A major recommendation addressed the value of a final detailed analysis of the environment, including both interpretation of past data and intensive sampling and analysis of various environmental materials.

III. RECOMMENDATIONS AND RESPONSES

Each of these four reviews presented several recommendations, some quite explicitly, others rather implicit. These recommendations are presented here, with direction on finding them in the review reports (provided in Appendices A through D), a discussion of the situation, Rocketdyne action taken or planned in response, and any results achieved. As of the release date of this document, approximately half have been implemented, in whole or in part, and most of the remainder will be implemented in the future when appropriate. After careful review, roughly one-seventh were judged to be inappropriate, in whole or in part. Section IV provides a convenient summary of the resolution status of all 51 recommendations.

1. Meteorological Tower

Summary:

A member of the DOE Environmental Survey team raised a concern that without a meteorological tower providing current wind speed and direction, it would not be possible to accurately predict the area of impact of an unscheduled release. In addition, use of meteorological data from the Burbank Airport may cause calculation of the annual dose due to routine atmospheric effluent to be in error (DOE p. 3-21). This concern was reiterated by EPA (EPA p. 8).

Discussion:

Meteorological data are used for two types of calculations related to atmospheric discharges of radioactive material: annual average doses and doses resulting from accidents ("unscheduled releases"). The data required are the frequency (or fraction of time) that the wind blows in a particular direction, at various speeds, and in several stability classes. For calculation of annual average doses, annual average meteorological data are used. For calculation of doses resulting from significant short-term releases, it is necessary to use current, local data describing meteorological conditions existing at the time of release, to obtain the best estimate. For this purpose, it would be necessary to have onsite meteorological towers.

However, this site (SSFL) has never had facilities whose hazards warranted such detailed accident analyses. The emergency planning zone for most LWR power plants is typically about 10 miles in radius. The highest-powered nuclear facility ever operated at SSFL was the SRE, which operated intermittently at 20 MWth (thermal megawatts), compared to a nominal 3,000 MWth for a typical LWR. This is a ratio of 1:150, which, because of the inverse-square law, translates to a ratio of 1:12 for the range of concern in case of an accident. That is, a distance of 0.8 miles for the SRE was equivalent to a distance of 10 miles for a modern LWR. All other hypothetical accidents, such as an accidental criticality releasing 42 MWsec of energy (equivalent to 14 milliseconds of LWR

operation) involve far smaller potential releases. Thus, real-time local meteorological data are not needed for accident response, and never have been.

For annual average offsite dose estimates we had used, in the early years, atmospheric diffusion calculations with approximate, representative parameter values to generate an envelope of maximum concentration. When AIRDOS-EPA became available in 1980, it was used to calculate concentrations offsite, with detailed meteorological data from the Burbank airport weather station. This data set has continued in use with the newer program, AIRDOS-PC.

While use of the Burbank data could be (and has been) criticized because of its distance (about 20 miles), difference in altitude (about 1,200 ft lower), and location in a valley plain rather than on a hilly plateau, only representative data are needed for estimates of annual doses that are exceedingly far below applicable limits. (This has been explicitly recognized by EPA in concurring with the use of Oakland Airport data for annual dose estimates at Lawrence Berkeley Laboratory.)

Demands for more accurate input data would be justified only if releases approached regulatory limits. While these limits have evolved with time, estimated airborne doses compare very favorably with the current EPA NESHAPs limit of 10 mrem effective dose equivalent, even though that was not in effect until 1989. Estimated maximum doses to a nearby resident ranged from 0.4 mrem/year in 1980 (derived from conservatively calculated concentration values) to 0.0000012 mrem/year for 1990. The apparent reduction is largely, if not entirely, due to progressive improvement in the estimation technique, from using a maximum concentration envelope with the most hazardous radionuclides assumed to constitute the entire release, to using AIRDOS-PC with radionuclide-specific analyses, and excluding the naturally occurring radionuclides from the estimate.

The lack of release of significant amounts of radioactivity from the SSFL facilities has kept offsite exposures so small that improvement in the estimation process is not warranted.

Action:

While installation of a meteorological tower and use of local meteorological data are not useful, the variability in calculated exposures has been investigated by use of the wind data sets included in AIRDOS-PC. The variability in the AIRDOS-PC estimate of dose by the air pathway was studied by using the measured release from the RIHL and RMDF in 1989 and calculated maximum doses at several distances for each of the 27 sets of wind data contained in the AIRDOS-PC program file. These wind-data sets are from locations scattered across the country and provide representation variability in meteorological conditions.

Results:

The results of this investigation are shown in Table II, where the maximum doses at five different directions have been used to sort the wind sets. The wind-data set labeled BUR1051 (the Burbank Airport station) is the set chosen for the calculations for SSFL. At the closest distance, 0.3 km, this set provides the highest estimated dose. At further distances this set approaches the average, but even at 80 km, the dose calculated by use of this wind set is greater than that of 2/3 of the alternate wind sets. The maximum variations produced by choice of wind-data set, up to a factor of 7 from the minimum to the maximum are completely insignificant considering that the estimates are roughly ten million times below the limit of 10 mrem/year. Thus, there is no practical value in using locally correct wind data.

2. Sampling Locations Do Not Reflect Current Operations

Summary:

The thrust of this comment is that the soil sampling program was much more extensive than required by current operations (DOE p. 3-34, 1a).

Discussion:

The sampling locations were selected during the growth of operations at SSFL, with newly installed facilities monitored by soil sample locations. As operations ceased and facilities were decommissioned, the associated sampling locations were not eliminated. This left a soil sampling program that was somewhat excessive by the time of the DOE survey.

Action:

Soil sampling locations were reviewed for pertinence relative to the current operations and conditions at SSFL.

Results:

Routine environmental soil sampling was reduced and, at the end of 1989, eliminated entirely. Soil sampling at contaminated locations for facility surveillance was increased.

3. Sampling Locations Are Not Identified by Markers

Summary:

Lack of clear and permanent location markers for the field sampling locations (particularly soil) could result in samples being taken at other than the designated

Table II. Comparison of Estimated Maximum Air-Pathway Doses (mrem/year) Calculated by AIRDOS-PC for 1989 RIHL and RMDF Releases, Using Different Wind-Data Sets

0.3 km		1.0 km		3.0 km		10 km		80 km	
BUR1051 is the wind-data reference set for SSFL. The NESHAPs limit is 10 mrem/year						MWH0486	0.0000015	MWH0486	0.000000084
						TYS1328	0.0000013	TYS1328	0.000000062
				MWH0486	0.0000054	SUU0316	0.0000012	SUU0316	0.00000006
				TYS1328	0.0000048	ALB0523	0.0000012	ALB0523	0.000000053
				SUU0316	0.0000046	HTS0019	0.0000011	HTS0019	0.000000053
				ALB0523	0.0000045	DEN0618	0.000001	DEN0618	0.000000064
		MWH0486	0.000014	HTS0019	0.0000042	ERI0610	0.00000097	ERI0610	0.000000057
BUR1051	0.000028	BUR1051	0.000013	BUR1051	0.0000039	BUR1051	0.00000091	BUR1051	0.000000048
MWH0486	0.000026	SUU0316	0.000013	ERI0610	0.0000038	BDL1262	0.00000087	BDL1262	0.000000046
TYS1328	0.000023	TYS1328	0.000012	DEN0618	0.0000038	ABQ0282	0.00000086	ABQ0282	0.000000047
SUU0316	0.000021	ALB0523	0.000012	BDL1262	0.0000036	PAH0479	0.00000083	PAH0479	0.000000037
ABQ0282	0.000017	OAK0319	0.000011	CMH0243	0.0000034	OAK0319	0.00000074	OAK0319	0.000000042
ALB0523	0.000017	HTS0019	0.00001	OAK0319	0.0000033	ORD0452	0.00000072	ORD0452	0.000000037
HTS0019	0.000017	BDL1262	0.00001	ABQ0282	0.0000031	CMH0243	0.00000069	CMH0243	0.000000037
BTM0357	0.000016	CMH0243	0.00001	PIH0359	0.0000028	CVE0403	0.00000068	CVE0403	0.000000034
OAK0319	0.000016	ERI0610	0.0000097	PAH0479	0.0000028	PIH0359	0.00000067	PIH0359	0.000000038
PIT1440	0.000014	DEN0618	0.000009	ORD0452	0.0000027	MDW0675	0.00000067	MDW0675	0.00000006
BDL1262	0.000013	PIH0359	0.0000083	CVE0403	0.0000026	PIT1440	0.00000067	PIT1440	0.000000031
DEN0618	0.000013	ABQ0282	0.0000075	MDW0675	0.0000025	ALO0729	0.00000061	ALO0729	0.000000032
UCC1026	0.000013	CVE0403	0.000007	PIT1440	0.0000025	AGS1018	0.00000051	AGS1018	0.00000003
AGS1018	0.000012	MDW0675	0.000007	ALO0729	0.0000024	BTM0357	0.00000045	BTM0357	0.000000021
CMH0243	0.000012	BTM0357	0.0000068	LEA0435	0.000002	DAY1502	0.00000043	DAY1502	0.000000028
PAH0479	0.000012	LEA0435	0.0000068	AGS1018	0.000002	LEA0435	0.00000042	LEA0435	0.000000024
ORD0452	0.000011	ORD0452	0.0000067	BTM0357	0.0000019	AMA0621	0.00000038	AMA0621	0.000000024
CVE0403	0.00001	PIT1440	0.0000065	DAY1502	0.0000018	TPA0662	0.00000037	TPA0662	0.000000025
ERI0610	0.00001	PAH0479	0.0000063	AMA0621	0.0000017	SAF1184	0.00000024	SAF1184	0.000000013
MDW0675	0.00001	ALO0729	0.0000062	TPA0662	0.0000015	UCC1026	0.00000021	UCC1026	0.000000012
PIH0359	0.0000099	AGS1018	0.000006	SAF1184	0.000001				
SAF1184	0.0000095	DAY1502	0.0000054	UCC1026	0.0000093				
ALO0729	0.000009	AMA0621	0.0000053						
LEA0423	0.0000089	TPA0662	0.0000041						
DAY1502	0.0000082	UCC1026	0.0000037						
AMA0621	0.000007	SAF1184	0.0000036						
TPA0662	0.0000047								

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locations. This variability in sampling location could confound evaluation of changes in soil radioactivity (DOE p. 3–34, 1b).

Discussion:

Locations had been identified approximately on a map and by description. Location variability was probably minimized in practice by one person taking nearly all the samples. While the sampling variability would simply reflect the inherent variability in the material sampled, in the absence of any significant release, the recommendation certainly reflects a useful practice.

Action:

Permanent location markers were installed at all soil sample locations.

Results:

No noticeable changes in soil radioactivity were found, compared to prior years. With the elimination of routine soil sampling, this is a moot point.

4. Northwest Rainfall Runoff Should be Monitored

Summary:

Rainfall water that runs off the northwest portion of the site is not periodically sampled and analyzed. This could result in undetected offsite releases of contaminants (DOE p. 3–58).

Discussion:

Approximately 10% of the surface of Area IV slopes to the northwest, away from the general surface drainage toward the retention pond system in the south. Most of this surface is unpaved so that most rainfall soaks into the ground and subsequently evaporates. Heavy rains result in some runoff to the northwest.

Action:

Collection basins were installed in five runoff channels along the northwest boundary of SSFL. These are the Sodium Disposal Facility – west, Sodium Disposal Facility – east, Building T100, RMDF, and SRE. These basins are inspected during each rainstorm and sampled and analyzed if sufficient water is present.

Results:

Rainfall during September 16–19, 1989, failed to produce runoff. Rainfall on November 26, 1989, and January 17, 1990, produced a full set of samples. Water samples were also collected for February 4, February 17, and May 29, 1990. The radiological

results are shown in Table III, as reported by the analytical laboratories. The radioactivity in rainwater varies depending on the natural radioactivity of the air through which the rain falls, and runoff picks up additional natural radioactivity from the soil. Rainwater at SSFL has not been routinely analyzed but the groundwater, surface water, and supply water have been. Samples of groundwater taken in 1990 showed a range of 1.1–9.6 pCi/L for gross alpha and 2.0–7.0 pCi/L for gross beta (GRC 8640M–77); surface water samples taken during 1984–1989 showed 1.2–4.5 pCi/L for gross alpha and 2.9–4.8 pCi/L gross beta (RI/RD90–132); supply water samples during 1984–1989 showed 1.7–6.6 pCi/L for gross alpha and 2.9–4.4 pCi/L for gross beta (RI/RD90–132). The most restrictive limit (10CFR20 or CCR17) for release of radioactivity in water to an uncontrolled area is 30 pCi/L. This limit does not apply to the naturally occurring radioactivity that these results represent.

The higher concentrations of gross beta activity detected in the November samples most likely resulted from the new concrete of the collection basins and disturbance of the drainage channel during installation. Gamma spectrometry was done on several of these samples, and no non–natural radionuclides were detected.

The results of this monitoring are reported in the bimonthly (now quarterly) Environmental Monitoring Reports distributed to the SSFL Work Group and other agencies and to the two public document repositories, the Simi Valley Public Library, and the Urban Collection Library at California State University, Northridge (CSUN).

5. The Procedure for Environmental TLDs Was Not Current

Summary:

The written procedure for calibrating the thermoluminescent dosimeters (TLDs) used for environmental radiation measurements did not list the calibration source that was in use and described an annealing process that was no longer used (DOE p. 4–35).

Discussion:

Minor modifications to the calibration method had been made and these had not been documented in the procedure.

Since operations with significant amounts of radioactive material stopped 3 years ago, the widespread monitoring of ambient radiation has been stopped and only facility monitoring is continuing. This no longer requires the use of the environmental TLDs, but relies on a commercial laboratory for TLD processing.

Table III. Radiological Analyses for Northwest Runoff
(pCi/L ± 2 σ)

	Gross Alpha	Gross Beta	Tritium
Sodium Burn Pit – West			
11/26/89	1 ± 4	39 ± 8	0 ± 1000
01/17/90	1 ± 1	4 ± 2	0 ± 1000
02/05/90	0.862 ± 0.664	7.04 ± 1.54	89.1 ± 108
02/17/90	1.23 ± 0.822	2.55 ± 1.11	15.4 ± 212
Sodium Burn Pit – East			
11/26/89	No water collected		
01/17/90	Insufficient sample		0 ± 1000
02/05/90	No water collected		
02/17/90	0.114 ± 0.335	1.18 ± 0.952	–50.9 ± 208
B100			
11/26/89	0 ± 3	275 ± 10	0 ± 1000
01/17/90	0 ± 2	8 ± 2	0 ± 1000
02/05/90	0.493 ± 0.467	8.27 ± 1.68	50.8 ± 178
02/17/90	0.154 ± 0.391	1.47 ± 0.98	1.92 ± 211
RMDF			
11/26/89	6 ± 2	163 ± 15	0 ± 1000
01/17/90	1 ± 1	40 ± 3	0 ± 1000
02/05/90	0.354 ± 0.485	20.5 ± 2.62	–2.82 ± 175
02/17/90	0.284 ± 0.361	5.49 ± 1.31	–5.76 ± 211
SRE			
11/26/89	0 ± 4	41 ± 8	0 ± 1000
01/17/90 (duplicate)	0 ± 1	6 ± 2	0 ± 1000
01/17/90 (duplicate)	0 ± 1	7 ± 2	0 ± 1000
02/05/90	0.215 ± 0.364	2.45 ± 1.04	–52.7 ± 173
02/17/90	0.945 ± 0.559	1.38 ± 0.941	–95.1 ± 206

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Action:

The procedure (N001OP000013) was revised to maintain a historical record. The use of these TLDs has been discontinued, and therefore, the need to calibrate them no longer exists.

Results:

No further action is required.

6. Details of Dose Calculations Were Not Documented

Summary:

The calculational method and parameters used to calculate boundary-line doses had not been documented (DOE p. 4-35).

Discussion:

The exposure rate, and therefore the hypothetical potential dose at the boundary north of the RMDF, had approached the allowable limit of 500 mrem/year in 1986. Because of the placement of the dosimeters, compliance with this limit was not self-evident in the monitoring data, and it was necessary to evaluate the data in detail to estimate the maximum potential exposure. The method was straightforward and the parameters are readily available in the published literature, but a concise summary of the analysis and results had not been prepared.

Action:

The calculations were documented for 1986 and 1987 in N001SRR140106. Monitoring dosimeters were relocated. Shielding was installed and waste was relocated to reduce site boundary exposure.

Results:

Calculations are fully documented and current dosimeter locations directly demonstrate compliance with limits.

7. Multiple AIRDOS Calculations

Summary:

Estimation of doses from airborne radioactivity required multiple calculations with AIRDOS-EPA, for each release point, and each radionuclide. A complete dose estimate required combining the results from several calculations, with the potential for error (DOE p. 4-35).

Discussion:

AIRDOS-EPA is a computer program for calculating the radiation dose due to the air pathway. At the time of the survey, it was the only EPA-approved code mandated by NESHAPs that was workable.

Action:

EPA has developed a PC-based program (AIRDOS-PC) that provides for combined calculations, works easily, and is approved under NESHAPs. This program was obtained as soon as it was available, and is in use.

Results:

Dose calculations are done simply and directly by use of AIRDOS-PC.

8. Use of Spiked Samples

Summary:

Analytical laboratory quality control is provided by a broad variety of methods, including the use of "spiked" samples. (Samples to which a known amount of the material being analyzed has been added.) The DOE Environmental Survey report commented that this method was not generally being used, and was not used frequently enough (DOE p. 4-37, 4-39; EPA p. 4).

Discussion:

Spiked samples have been used here to establish standards for instrument calibration. The use of spiked field samples to monitor the performance of the analytical methods has not been used. Rather, the repetitive counting of standards of known and highly repeatable activity has been used instead. Since no chemical processing is performed on the samples, the use of field spikes is not necessary (see Analytics p. 11).

Action:

Additional, more representative samples will be prepared and used for calibration of the radiation instruments (see Recommendations 35, 49, and 50). The routine use of spiked field samples is not an important addition to the quality control program.

Results:

More accurate analyses will be performed than at present, by the use of better calibration standards, based on spiked samples of environmental materials.

9. Lack of Overcheck of Calculations

Summary:

In view of the somewhat involved calculations needed to convert the measured radiological data into the appropriate results, it was recommended that a procedure be developed for independently checking data entry and the calculations (DOE p. 4–37, 4–39).

Discussion:

Important calculations are reviewed by an independent person, and the "Radiological Environmental Monitoring Program Quality Assurance," N001DWP000009, requires semiannual overchecks of computations.

Action:

This is being done.

Results:

Significant results are protected from error.

10. Peer Review

Summary:

A peer review of the environmental monitoring laboratory should be done to assess the direction of the environmental program, identify problems in procedures and protocols, and make recommendations for improvement (EPA p. 3).

Discussion:

While a peer review of the laboratory (and program) as described had never been done, the environmental monitoring had always been subject to the inspection and concurrence of the regulatory agencies involved in nuclear and radioactive material operations (AEC/ERDA/DOE, DHS–RHB, NRC) which considered the performance of the program for adequacy in assuring compliance with regulations and protection of the workers and the public. The program was not, nor was it ever intended to be, a state–of–the–art program, characterizing the radiation environment. It was intended to detect failures in operational controls that would result in noncompliance with the regulations or threaten workers or the public. Those levels are far above environmental levels and do not require the extensive analytical capabilities necessary to investigate all occurrences of (mostly naturally occurring) radioactivity.

Action:

A list of proposed peer reviewers was submitted to EPA for approval, three approved reviewers were asked to bid on the job, one was available and accepted. (EPA states that this review should have been done by a group; we expected a single reviewer. These differing ideas did not surface until after completion of the review.)

Results:

A peer review was performed in April–May 1990 by D. Montgomery of Analytics, Inc., and a report was issued October 1, 1990.

11. Analysis of Soil for Gross Alpha and Beta Activity

Summary:

Gross alpha and beta analysis is not a good method for assessing environmental radioactivity, nor is it a reliable and accurate quantitative technique for radiological analysis of soil (EPA p. 3, ORAU p. 16 #5, Analytics p. 18 #7).

Discussion:

Natural soil, uncontaminated with other than negligible amounts of global fallout, contains varying amounts of naturally occurring radionuclides such as H–3, Be–7, C–14, K–40, and the uranium and thorium chains. Most of these are readily detected in a gross alpha/beta analysis (special analyses are needed for H–3 and C–14). A complication in this method is that the uranium and thorium chains include radon as an intermediate radionuclide in the transitions from the parent atom to lead. Radon, as an inert ("noble") gas, diffuses out of the soil sample and so significant, but variable, fractions of both the alpha activity and the beta activity are lost. Consistent procedures in the preparation of the soil samples will largely reduce the variability introduced by the loss of radon and its daughters but will not eliminate the loss.

A detailed analysis of SSFL rock and soil for natural radioactivity conducted by Groundwater Resources Consultants, Inc., showed the following significant activities in soil:

K–40	22.2 pCi/g
U–238	1.10 pCi/g
Th–232	1.66 pCi/g

Samples were taken from areas unaffected by any nuclear work. No unnatural gamma–emitters other than Cs–137 at normal environmental levels (0.02–0.2 pCi/g) were reported, and the U–234 and U–238 and daughter activities were equal, confirming that it is natural uranium. This was also true for the thorium chain.

At the low concentrations of alpha and beta radioactivity naturally present in soil, differences from the expected activity on the order of ±40% are observed. These differences from the expected values reflect biases in the counter calibration, for alpha and beta activity at very low levels, not variations in the soil activity, or contamination. At concentrations approaching the guidelines for allowable radioactivity in soil, these differences become less significant.

While these gross alpha and beta measurements do not "characterize" the natural environmental (soil) radioactivity with high accuracy (because of these biases) nor with specificity, they do provide an effective means for screening samples for contamination. While there are no regulatory limits for residual radioactivity in soil, guidelines for the radionuclides used at SSFL range from about 25 pCi/g to several thousand pCi/g, and therefore, this analytical method is adequate for demonstrating compliance with guidelines. To do so requires assumption of a "mix" of radionuclides in the detected activity, and this generally leads to conservative overestimates and loss of accuracy. As an example, in the late 1970s, we adopted as a working limit for soil areas contaminated with old mixed fission products, an activity concentration of 100 pCi/g gross detectable beta activity, including background. This low level of radioactivity can be detected by use of field survey instruments. Since "old mixed fission products" consist of approximately equal activities of Cs–137, Sr–90, and Y–90 (in equilibrium with its parent Sr–90), this working limit resulted in concentrations on the order of 25 pCi/g each for natural radioactivity, Cs–137, Sr–90, and Y–90. Residual concentrations of 25 pCi/g Cs–137 and Sr–90 are consistent with current guidelines developed using RESRAD. NRC has used acceptance limits of 25 to 35 pCi/g for plutonium, enriched uranium, and depleted uranium.

While, for the sake of accuracy and correctness, it is certainly desirable to use radionuclide–specific analyses rather than gross alpha and beta counting, some practical considerations should be recognized. The gross alpha/beta counting requires 2–g samples, while gamma–spectrometry uses 100– to 600–g samples. This results in handling, storage, and disposal problems if gamma–spectrometry is performed on more than a few samples. Soil samples are easily and automatically counted for gross activity in automatic sample counters so that a throughput of 100 samples a day is easily achieved. Gamma–spectrometry is labor intensive and 20 samples per day is difficult to achieve. Thus, for the same effort, a survey based on gross analysis can be far more comprehensive than one based on gamma spectrometry, and a great deal more effort must be expended on a gamma–spectrometry survey to produce information that is more "correct" but of not much more value. In addition to gamma–spectrometry, a chemical analysis is required to determine the Sr–90 activity, or assumptions of the same sort as apply to gross beta counting must be made. This analysis introduces a turnaround time of several weeks to months. While not specifically identifiable by gross beta counting, the Sr–90 activity is easily detected by this method.

Action:

Concurrent with the availability of high-efficiency/high-resolution gamma-ray spectrometers (germanium detectors), more radionuclide-specific analyses have been performed. Gross alpha and beta counting continues to have value for environmental screening purposes and will continue to be done.

Results:

Recent soil decontamination projects (Old Conservation Yard, T064 Side Yard) have utilized gamma-spectrometry to specifically identify and quantify gamma-emitting radionuclides. Since Sr-90 is not detectable by gamma-spectrometry, interpretation of these results still relies on an assumption that Sr-90 is present in concentrations equal to Cs-137.

12. Reduce Temperature for Baking Soil

Summary:

Baking soil at 500°C would volatilize most man-made radionuclides of concern, including cesium-137 and strontium-90 (EPA p. 3). ORAU disagreed with this concern but recommended reduction of the temperature to be consistent with other laboratories (ORAU p. 8, p. 17 #9). A similar concern was expressed regarding ashing vegetation samples at 500°C (EPA p. 4).

Discussion:

Surface soil samples taken in the field generally contain small to large fractions of organic material (roots, twigs, leaves, bugs, humus) and moisture. To produce a true "soil" sample, these extraneous materials must be eliminated. This reduces variability in the results. Moisture is easily eliminated by baking the sample at a relatively low temperature near 100°C. The organic material must be fully oxidized to eliminate most of its mass. The procedure put into use at Atomics International in the 1950s was to bake the sample for 8 hours at 500°C, in an air atmosphere. While this temperature is consistent with some EPA and DOE procedures for analysis of specific radionuclides, there is no "approved" procedure for preparing soil samples for gross alpha and beta counting. Some related procedures caution about loss of cesium above 450°C. The same discussion applies to ashing of vegetation.

Action:

In response to this concern, some soil known to be contaminated with Cs-137 (by gamma-spectrometry) was analyzed by gross alpha and beta counting before and after baking at 500°C for 8 hours. Both the gross alpha activity and the gross beta activity concentrations increased after baking (due to the loss of mass), by essentially the same

amount, approximately 7%, thus indicating that there was no loss of the Cs–137. Measurements of Cs–137 in wood ash from home fireplace burning of various woods, analyzed by several different laboratories, and reported partially in the HPS Newsletter for April 1990, showed high concentrations, suggesting little loss by volatilization. The author (Stewart Farber) discusses this lack of loss of Cs–137 for temperatures ranging from 650°C to 1100°C and the fact that it is contrary to accepted expert opinion.

Nonetheless, the procedures have been changed to use a temperature of 450°C, since doing so eliminates this item as a source of disagreement and has essentially no effect on the results of the analyses.

Results:

The soil baking and vegetation ashing temperature is now in agreement with current recommendations.

13. Soil is Sieved Rather Than Milled

Summary:

The soil is sieved to obtain a uniform particle size by eliminating sand, clay, and pebbles. Uniform particle size is better obtained by grinding (EPA p. 3).

Discussion:

Natural soil contains mineral grains, such as quartz and feldspar, that are impervious to contamination by radioactivity. Inclusion of large grains in a sample counted for gross alpha and beta activity would result in a somewhat reduced observed activity for two reasons: (1) the uncontaminated material serves as a diluent since it has less radioactivity per unit mass than do small particles and (2) it acts to block radiation from reaching the detector, particularly alpha radiation, violating an assumption of uniformity in calculation of the absorption correction factors. While the second effect would be eliminated by milling (grinding), the first effect would still exist, diminishing the observed radioactivity concentration by inclusion of inert material.

For situations where analysis of the entire sample is important, such as neutron–activated soil, we have used a ball mill to grind the soil to powder before analysis. This is time–consuming and requires additional effort, and results in somewhat more material for ultimate disposal.

For screening purposes, the intent of gross alpha and beta measurements, the current practice is appropriate. For gamma–spectrometry and chemical extractions, it is unnecessary.

Action:

No change in procedures.

Results:

Soil processing will continue to produce consistent, appropriate results for screening purposes.

14. Washing Vegetation Removes Fallout Contamination

Summary:

Airborne contamination that has settled on the surface of vegetation would be washed off before counting (EPA p. 4).

Discussion:

At the start of the monitoring program, the potentially most significant pathways for environmental contamination were considered to be global fallout from nuclear weapons testing, exhaust effluent from nuclear facilities onsite, and release of radioactive liquids to the ground. This led to establishment of a program concentrating on sampling and analysis of surface soil and ambient air, facility exhaust effluent, and vegetation. Airborne radioactivity was well monitored by the first three methods (as is evident from a review of historical data). Analysis of vegetation can be an effective means of detecting subsurface soil contamination, through the uptake of radioactivity into the plants by the roots. For this purpose, it is necessary to wash the plant samples before analysis. At SSFL, there is a considerable amount of windblown dust that can accumulate on the plants, and due to little rain and long dry spells, it does not get washed off naturally, as happens in some parts of the country. While it has been claimed that this accumulation of airborne material can serve to monitor for airborne releases, it is more direct to monitor effluent and ambient air. Washing before analysis removes the extraneous material, which could either increase or decrease the observed radioactivity concentration, and results in a value that is more truly representative of the plant radioactivity.

Action:

No change in procedure. Washing will continue to be used when the purpose is to monitor for plant uptake. Plants will not be washed when a measure of radioactivity of the plant as an "object" is required.

Results:

Vegetation analyses will continue to represent the intrinsic radioactivity of the plants.

15. Collect and Analyze Wild Animals and Roadkill

Summary:

While hunting is not permitted at SSFL, eating wildlife could be a pathway of exposure to man, and wild animals should be collected for analysis, either directly or by picking up roadkills (EPA p. 5).

Discussion:

SSFL has a variety of native wildlife, as a result of the generally protected wilderness condition of the site, assisted by artificial ponds, which makes water available where it normally would be parched dry, and by the somewhat enhanced food supply resulting from workers' meals and deliberate feeding of the animals. There are no sources of radioactively contaminated water, and only small areas of contaminated soil that do not supply significant forage for the animals. Thus, there is little, if any, chance that wildlife would be contaminated. Further, since the wildlife are not a part of the local human food chain, they would not provide a pathway for exposure to the public. While analysis of wild animals might be an interesting adjunct to the SSFL monitoring program (as it well might be a major component at some other sites with different circumstances), it is not an important contribution to monitoring for radioactivity or for calculating hypothetical public doses.

Action:

Some dead animals have been collected and analyzed.

Results:

The results of animal analyses performed in the last year are shown below:

Wildlife Analysis

Dead Deer

A hind leg and the liver removed from a dead deer that was found on November 27, 1989, were sent to U.S. Testing for several types of radiometric analyses. The results were received January 9, 1990, and are shown below:

Material	Radionuclide	Activity Concentration pCi/g ± 2 sigma
Bone	Pu-239/240	Not detected
Bone	Pu-238	Not detected
Bone	Sr-90	0.375 ± 0.071
Bone	Cs-137	Not detected
Bone	Gamma spectrometry showed no other significant activity	
Muscle water	H-3	0.286 ± 0.164
Liver water	H-3	0.101 ± 0.154
Liver tissue	K-40	1.56 ± 0.31
Liver tissue	Cs-137	0.002 ± 0.006
Liver tissue	Gamma spectrometry showed no other significant activity	

Roadkill Rabbit - 01/09/90

A squashed rabbit was picked up from near the intersection of 12th and G Streets (somewhat between RMDF and the T064 vault) on January 9. Gamma spectrometry was done at T100 and at the RIHL. The average results are:

U-238	0.075 pCi/g
Th-232	0.146 pCi/g
K-40	1.36 pCi/g

No unnatural radionuclides (specifically Co-60 and Cs-137) were found. (In these analyses, the U-238 and Th-232 activities are deduced from the activities observed for daughters in the decay chains.)

Roadkill Rabbit - 02/07/90

Another dead rabbit was collected on February 7, on the main access road, about 500 ft east of the Protective Services Control Center. Gamma spectrometry was done at T100. The results are:

U-238	0.112 pCi/g
Th-232	0.387 pCi/g
K-40	1.348 pCi/g

No unnatural radionuclides were found.

Roadkill Squirrel – 06/22/90

A dead squirrel was found on the road at G Street near the Coal Yard. Gamma spectrometry done at T100 showed:

U–238	Not detected
Th–232	Not detected
K–40	1.339 pCi/g

Roadkill Squirrel – 06/28/90

A dead squirrel was found on G Street midway between 11th and 12th Streets. Gamma spectrometry done at T100 showed:

U–238	0.038 pCi/g
Th–232	0.254 pCi/g
K–40	1.367 pCi/g

Trapped mice have been tried, but their masses (about 10 to 20 g) are too small to provide adequate radioactivity for detection.

These analyses have not shown any indication of radioactive contamination other than naturally occurring radioisotopes.

An interesting comparison may be made with the K–40 results. Potassium is an essential element in living organisms and should be present in mammals at the same concentration. Therefore, K–40 results for different animals analyzed at different laboratories may be compared to determine the performance of the gamma spectrometry performed at the different laboratories:

U.S. Testing (1 deer liver)	1.56 pCi/g
SSFL (2 rabbits, 2 squirrels)	1.36 pCi/g

All results are within the expected variation, and the SSFL results compare well with the other measurements.

16. Count Air Samples (Gamma Spectrometry) According to Procedure

Summary:

Composited air filters were counted (gamma–spectrometry) for 10,000 seconds instead of the required "at least 36,000 sec" and were loose in a bag rather than in a Marinelli beaker. (EPA p.5)

Discussion:

The gamma spectrometers are frequently used to do "casual" scans of samples to determine if it is worth doing a precise scan and to give some early indication as to what interpretation or further processing might be required. This can be done by simply setting the sample, in whatever container, in the detector shield, and punching a button—the count will proceed for whatever default time is set in the analyzer, or until it is stopped. It requires no other effort and can be done at any convenient time the analyzer is not in use.

These were the circumstances for the situation in question: the composited air samples are normally accumulated in a plastic bag. This bag was set in the detector shield and the analyzer started while the analyst went off to do some other things. The default time interval (10,000 sec) passed, the analyzer automatically printed out, and the printout was given (in original form, without copying) to the reviewer as an example of the output of this particular gamma–spectrometry system. Upon review of the procedure, it was determined that the "36,000 sec or longer" was a typographical error and should have read "3,600 sec or longer."

Action:

The procedure was corrected to state "3,600 sec or longer." The annual collection of air filters was sent to U.S. Testing for detailed analysis.

Results:

The procedure shows current practice.

17. Do Not Normalize TLD Results for Elevation

Summary:

The annual radiation exposure for 32 locations are adjusted for elevation. Two experts considered this to be meaningless. (EPA p.5)

Discussion:

Natural ambient radiation varies between locations predominantly due to three effects: elevation, geomagnetic latitude, and geology. While the geomagnetic latitude differences are trivial for the locations monitored, elevation and, to a lesser extent, geology provide noticeable differences. Since the SSFL, De Soto, and offsite locations are grouped at three different elevations, an effort was made to reduce the variation due to elevation in order to make the true differences resulting from nuclear operations more clearly apparent. The adjustment was based on a compilation of annual exposures for

cities throughout the U.S.A. While this includes the confounding effect of geology and, somewhat, the geomagnetic latitude, it provides a reasonable adjustment.

The unadjusted exposures are also clearly included in the reported results, and these values are used in determining the hypothetical doses, above background, to the public due to operations at the various locations.

The adjustment appears to have added unnecessary confusion so it was decided to eliminate it.

Action:

Adjustments for elevation are no longer made.

Results:

This adjustment will no longer be made.

18. Do Not Withhold Comparisons of TLD Data with State and DOE Results

Summary:

Results of the State TLD monitoring and the DOE intercomparison were indicated as "not available," but should have been included in the following annual report. (EPA p. 5)

Discussion:

For many years, the State DHS has included TLDs at several of the locations where we measure radiation exposure. The State results were included for direct comparison in our annual report. For 1987, and again for 1988, the State asked us not to include their results in our report, even though the data had been made available to us. The DOE intercomparison was a special study investigating the effect of using different calibration sources. While we expected to use the results, the study was not released.

A comparison of our TLD results and those of the State are shown in Table IV.

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

Action:

Permission for inclusion of the State data in the 1989 report was requested and was received.

Table IV. Comparison of State (CA) and Rockwell (RI) TLDs

		mR/Quarter							
		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

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Results:

Comparison with the State TLD results is included in the 1989 report. This is shown in Table V.

19. Conduct a Complete Systematic Survey of SSFL and Compare Results with Allowable Guidelines

Summary:

Systematically characterize the radiological condition of the site, including buildings, and surface and subsurface sail. Develop general and site-specific guidelines for residual radioactivity. (EPA p.9, ORAU p. 17 #16)

Table V. De Soto, SSFL, and Canoga Sites—Ambient Radiation Dosimetry Data—1989

TLD Location		Quarterly Exposure (mR)				Annual Exposure (mR)	Annual Average Exposure Rate (μR/hr)	
		Q-1	Q-2	Q-3	Q-4		Rocketdyne	State DHS
De Soto	DS-1	23	17	22	15	77	8.8	
	DS-2	15	16	19	126	66	7.5	9.0
	DS-3	24	17	33	15	89	10.2	
	DS-4	24	17	21	16	78	8.9	
	DS-5	19	15	23	18	75	8.6	
	DS-6	26	14	31	19	90	10.3	10.0
	DS-7	28	16	21	19	84	9.6	
	DS-8	30	12	43	10	95	10.8	9.1
Mean value		24	16	27	16	82	9.4	
SSFL	SS-1	25	17	26	17	85	9.7	
	SS-2	26	26	28	20	100	11.4	
	SS-3	23	21	48	20	112	12.8	10.8
	SS-4	25	24	22	25	96	11.0	
	SS-5	25	18	24	27	94	10.7	11.3
	SS-6	23	23	42	20	108	12.3	
	SS-7	28	15	35	18	91	10.4	10.4
	SS-8	32	16	27	14	89	10.2	
	SS-9	31	19	28	18	96	11.0	
	SS-10	27	22	29	17	95	10.8	
	SS-11	31	28	46	26	131	15.0	17.2
	SS-12	35	28	53	21	137	15.6	
	SS-13	27	20	35	27	109	12.4	
Mean value		28	21	34	20	103	11.8	
Canoga	CA-1	22	14	25	14	75	8.6	
	CA-2	25	13	30	11	79	9.0	
	CA-3	21	15	25	12	73	8.3	
	CA-4	24	27	24	12	87	9.9	
	CA-5	22	12	17	10	61	7.0	
	CA-6	27	13	33	16	89	10.2	
Mean value		24	16	26	13	77	8.8	
Off-site	OS-1	26	17	25	15	85	9.7	10.5
	OS-1	23	(21)[a]	33	19	96[b]	11.0	
	OS-3	21	13	22	11	82	9.4	
	OS-4	23	15	32	13	75	8.6	
	OS-5	20	20	15	8	81	9.2	
Mean value		23	16	25	13	84	9.6	

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[a]Missing dosimeter. Assumed value in ( ).

[b]Adjusted to full year to compensate for missing dosimeter.

Discussion:

A significant fraction of Area IV has been thoroughly surveyed with no indication of contamination. This survey addressed all those areas suspected of possibly being contaminated. A broader scope survey is needed to address the concern of completeness by investigating those areas not suspected of possibly being contaminated.

Action:

A complete survey is in planning. This will include buildings, surface soil, and subsurface soil associated with discontinued leach fields. Site-specific guidelines for radioactivity in soil will be developed by use of RESRAD.

Results:

Several methods for performing this survey have been identified. Guidelines for Cs-137 and Sr-90 activity in soil have been calculated by use of RESRAD.

20. Have an EG&G/ARMS Aerial Survey of SSFL Performed

Summary:

EG&G operates an Aerial Radiological Monitoring System service, available to DOE and NRC, for the purpose of detecting radioactive material. A helicopter is used for aerial surveys with several large radiation detectors sensitive to small amounts of gamma-emitters. Use of this service to look for unknown spill areas or to demonstrate the final cleanup was recommended. (EPA p. 9, Analytics p. 15)

Discussion:

A survey of this sort was performed in 1978, but because of significant radioactive material in process at RIHL, RMDF, and SRE during the survey, most of the sensors had to be turned off. This resulted in a much diminished sensitivity and no radioactive material was detected in the natural environment. This survey is best done when all known radioactivity has been removed and the full sensitivity can be used to detect any residual radioactivity.

Action:

An aerial survey is planned to be conducted after radiological contamination has been completed.

Results:

Artificial radioactivity will have been removed by that time, permitting an effective survey to be performed.

21. Further Study of Tritium in Water

Summary:

Tritium was found at a concentration greater than natural in one groundwater sample by EPA, and further study was recommended to determine the origin and spread of tritium at SSFL. (EPA Results p. 6 and 7)

Discussion:

Tritium is a radioactive isotope of hydrogen and is produced naturally by cosmic rays in the atmosphere. It is produced in small amounts in many nuclear reactors, and in very large amounts in some. During atmospheric testing of H-bombs, large amounts were released to the environment. It is used in glow-in-the-dark watch dials and emergency exit signs that require no electrical power. It is normally present in the environment as a component of water and is much more mobile than most radionuclides.

None of the reactors at SSFL were used to produce tritium, and there were no major uses of tritium. However, tritium was expected to be produced in small amounts in the concrete shielding of some reactors at SSFL. This occurs as a result of the presence in the aggregate used in the concrete (granite rocks) of minerals containing lithium. Lithium naturally consists of two isotopes, lithium-6 and -7, and the lithium-6 nuclide readily absorbs a neutron, producing an atom of helium and an atom of tritium. Neutrons released by fissions in the reactors in Building T059 produced tritium in the surrounding concrete, along with iron-55, cobalt-60, and europium-152. The latter two radionuclides are very easily detected by gamma-spectroscopy and are the controlling radionuclides in terms of regulatory limits. (Iron-55 emits very low-energy X-rays.) For these reasons, it was decided not to analyze for tritium, since special equipment is needed for that, and the other radionuclides serve as much more sensitive tracers.

Action:

Over 200 water samples have been analyzed for tritium, with approximately 40 of these analyzed by an extra-sensitive enrichment process that permits measurement of tritium at concentrations generally encountered in the environment. A detailed analysis and interpretation of these tritium measurements has been performed by Rocketdyne. As additional groundwater wells are constructed in Area IV, the water will be sampled and analyzed for tritium. A continuous tritium monitoring program will not be conducted, since it is not warranted by the current levels.

Results:

Tritium-in-water has been confirmed at greater than background levels in wells associated with Building T059 and a well near the T886 Sodium Disposal Facility. These

levels are generally in the range of about 100 to 1,000 pCi/L and are far below the regulatory limits of 3,000,000 pCi/L (NRC and California) and 2,000,000 pCi/L (DOE), and below the level requiring analysis (300,000 pCi/L).

22. Analyze for Sr-90

Summary:

A representative group of samples should be analyzed for Sr-90. (EPA Results p. 7)

Discussion:

Sr-90 occurs in conjunction with Cs-137 in "old mixed fission products (MFP)" since these are the only significant radionuclides left after a few years of decay. A reasonable approximation is that the Sr-90 and Cs-137 activities are equal, and this assumption is usually made. Cs-137 can easily be identified and quantified at levels of concern for environmental contamination by gamma-spectrometry. Sr-90 cannot be detected by gamma-spectrometry, can be detected by gross beta counting, but is best determined by means of a time-consuming chemical separation.

Except for use scenarios in which a large amount of food is grown in contaminated soil, the allowable limit for Sr-90 in soil far exceeds that for Cs-137, so the Cs-137 concentration, which is easily measured by gamma-spectrometry, controls the cleanup. For example, limits calculated by RESRAD (a DOE pathways analysis code) for Sr-90 and Cs-137 in the residential scenario at SSFL are 409 and 70.8 pCi/g, respectively.

Action:

To confirm that no unusual separation has occurred, some soil samples with residual radioactivity will be analyzed for Sr-90, as well as other radionuclides, as appropriate.

Results:

None as yet.

23. Analyze Vegetation and Animals

Summary:

Vegetation and wildlife should be sampled and analyzed. (EPA p. 5, EPA Results p. 7)

Discussion:

During the development of the environmental monitoring program, vegetation was included as a major sample type, along with soil, water, and air. After approximately 25

years of analysis, and after the termination of most nuclear projects, the resulting data were reviewed to determine the need for continuation of vegetation sampling. It was decided that, considering the facility exhaust effluent monitoring, ambient air sampling, and surface soil sampling, the vegetation sampling offered little value and routine sampling was stopped.

Action:

Vegetation has been sampled and analyzed at two locations with soil contamination. Animal carcasses (predominantly "roadkill") have been analyzed. The results of these analyses have shown no evidence of radioactive contamination and, therefore, routine sampling and analysis of vegetation and animals will not be done.

Results:

The results of gross alpha and beta counting of 20 plant samples taken in August 1989 from the T886 Sodium Disposal Facility ("Old Sodium Burn Pit") and the RMDF are shown in Table VI.

These samples were analyzed for the purpose of determining total radioactivity, not just uptake, and so were not washed. While there is considerable variation in the results, there is no indication of radioactive contamination due to man-made radioisotopes, external or internal, of the plants.

Leaves from cat-tails growing in a depression adjacent to T024 and watered entirely by the discharge of the T024 french drain sump pump were sampled and analyzed by gamma-spectrometry.

The cat-tail leaves were reduced in volume by charring, with minor ashing, in an oven. While this study was primarily directed to detection of uptake, the leaves were fresh, clean, and free of dust, and therefore we decided not to wash them prior to analysis. The charred leaves were packed into a Marinelli (re-entrant) beaker and counted for 64,632 seconds (18 hours) with the Environmental Laboratory ER-HPGe gamma spectrometer. (The unusually long time, overnight, was used to improve sensitivity.) The MCA computer program was used to identify and quantify radionuclides, and the spectrum was also searched manually for Co-60, Cs-137, and Eu-152, which had not been detected by the automatic search.

The results of this analysis and comparisons with activity found in wood-ash from a variety of locations across the counter are shown in Table VII.

(The wood ash results are derived from data collected by Steward Farber and published [partially] in the HPS Newsletter April 1990. Further data were sent to the

Table VI. Results of Gross Alpha and Beta Counting of 20 Plant Samples (Based on Dry Weight of Sample)

	Alpha (pCi/g)	Beta (pCi/g)
North of T/022 on north slope plateau - Acacia	40.6	30.32
North of northeast corner fence post on plateau near leach field - Mulefat	23.6	16.99
North of RMDF northeast fence post near leach field - Green and Furry	32.9	20.36
Northwest shoulder of plateau north of T/022 - California Laurel Sumac	14.4	14.97
North of T/022 near north edge of plateau north slope - Wire Bush	8.4	7.03
North of T/022 on plateau north slope - Little Green Lace	21.2	15.40
North edge of 883 burn pit - Agave	19.5	2.73
Green weed from middle of lower pond burn pit - Salvia	24.3	36.47
North of northeast post on plateau RMDF - Wire Bush	6.7	11.45
North of northeast fence post on plateau RMDF - creosote	16.8	15.19
Near west shoulder with northeast containment RMDF - Toyon	27.4	22.39
Northwest corner of lower pond burn pit - Salvia	20.4	28.47
North edge of T/883 burn pit - Telegraph Weed	20.4	14.81
East side of upper pond burn pit - Salvia	13.9	24.15
Within lower pond burn pit - wild oats	14.9	10.45
Northeast of lower pond burn pit - wild oats	6.0	6.33
West side of upper pond burn pit - Salvia	1.4	6.25
Southeast corner of lower pond burn pit - Salvia	14.9	29.34
Lower pond burn pit - Mustard	4.8	7.42
Northeast of lower pond - Wild Mustard (dry)	5.3	5.72

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participants in his survey. These results were for wood-ash and were converted to fresh weight for this comparison based on an assumption of fresh weight to ash weight of 10:1.)

The major activity is K-40, a naturally occurring radionuclide present in all living things. No Cs-137 or Eu-152 could be found in the manual search, and the trace amount of Co-60 indicated is uncertainly present.

A dead deer, some rabbits, and some squirrels have been analyzed. These results were presented with Recommendation No. 15.

24. Reference Survey Locations to State or USGS Grid System

Summary:

Survey locations should be referenced to the State or USGS geodetic grid to assure possible identification of these areas after building demolition and renovation. (ORAU p. 7, 16 #6)

Table VII. Gamma-emitters in Cat-tails

	Cat-tails pCi/g ± 1σ for Fresh Material	Wood-ash Range pCi/g Adjusted to Fresh Material
Be-7	0.095 ± 0.019	0.04 - 0.15
K-40	5.24 ± 0.09	0.9 - 15.4
Co-60	Trace (0.007 ± 0.006)	None detected
Cs-137	None detected (less than 0.005)	0.0008 - 2.11
Eu-152	None detected (less than 0.005)	None detected
Pb-212	0.086 ± 0.004*	None reported
Pb-214	0.011 ± 0.008*	None reported
Ra-226	0.126 ± 0.020**	None reported
U-235	0.006 ± 0.001**	None reported
U-238	0.126 ± 0.020**	None reported

*Presumably diminished by loss of radon gas from the sample before analysis.

**Activities based on analysis of 186-keV photopeak and assumption of equilibrium between U and Ra.

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Discussion:

Past identification of decontamination projects has been largely based on naming the building involved in the survey reports. This location could then be found be reference to Rockwell site maps. It is considered preferable to identify these locations by reference to an independent geodetic grid.

Action:

Current reports include the Township, Range, and Section designation for each location. However, since this provides an area of one square mile for the location, a reproduction of a portion of the USGS topographic map is included in the report with the location marked.

Results:

Improved location identification is provided.

25. Reevaluate Gamma Exposure Rate Surveys for Contaminated Soil Areas

Summary:

Close-to-the-ground surveying for gamma hot spots is recommended. (ORAU p. 7, 16 #7)

Discussion:

Micro-R meters (gamma-sensitive, exposure-rate meters) are used to locate soil areas contaminated with gamma-emitting radionuclides. This is done with the detector essentially at ground level. After removal of all areas with significant contamination, a final survey is performed with the detector 1 meter above the surface to conform with DOE and NRC guidance. The survey and sampling of soil assures that levels are below applicable limits, and these residual levels are sought to be as low as is reasonably achievable.

Action:

Continue to emphasize ALARA in cleanup operations.

Results:

Decontaminated areas will be well below allowable limits.

26. Detection Capabilities for Survey Instruments

Summary:

A comprehensive listing of detection capabilities for the various field survey equipment and survey techniques should be developed (ORAU p. 8, p. 16 #8)

Discussion:

For instruments that provide clearly defined digital data, the parameter "lower limit of detection" (LLD) can be calculated. This is essentially a "figure-of-merit" for an instrument or technique. It is the activity that will be detected with a specified confidence level (usually 95%) as being above a specified fraction of the background activity distribution (usually 95%). Estimation of LLDs for analog instruments is more subjective.

Action:

Values for LLD that are readily calculated for instruments will be included in a procedure currently being prepared that describes survey methods. Estimates will be made for field survey instruments also.

Results:

A procedure has been prepared describing the detection capabilities of survey instruments and presenting representation values of LLD.

27. Evaluate Staffing Requirements

Summary:

Several retirements and resignations in the last 2 years have significantly reduced the radiation protection staff. Additional demands for environmental monitoring protection data require additional staff. (ORAU p. 4, 16 #1; Analytics p. 18, #5)

Discussion:

Considering that Rocketdyne was withdrawing from work with radioactive materials as a business area, the Radiation and Nuclear Safety staff had been allowed to decline. This was complicated by the ongoing controversy regarding operations and environmental conditions at SSFL creating greater-than-normal demands for monitoring and analysis, interpretation of present data, and retrieval and explanation of historical data.

Action:

Two permanent employees have been hired to support the environmental monitoring program and the dosimetry/ALARA programs. Three retirees from the group have been brought back on intermittent or part-time basis, two other retirees are being used to help with procedures and historical data. Three contract H.P. technicians have been hired. The group has been reorganized and was reassigned to another functional organization in anticipation of the retirement of the previous manager. Further reorganization has reassigned the group to the newly established Vice President—Environment, Health, Safety and Facilities.

Results:

The additional staff has improved the productivity of the group.

28. Cross-Train Staff

Summary:

A few individuals have major responsibilities for environmental monitoring without adequately trained backups. (ORAU, p. 4, 16 #1)

Discussion:

When the staff was larger, there was more flexibility in assignments and more interaction, promoting familiarity with various aspects of the program. This infrastructure has been lost as a result of the reduced staff.

Action:

Cross-training has been provided to several staff members on operation of the gamma-spectrometer, the alpha/beta counter, and the computer.

Results:

Some improvement in capabilities has been achieved.

29. Evaluate Need for Liquid Scintillation Counter

Summary:

Review the need for onsite capability to analyze low-energy emitters such as H-3, Ni-63, and Pm-147, by use of a liquid-scintillation counter. (ORAU p. 5, 16 #2)

Discussion:

Some radionuclides that were produced or used at SSFL are very low-energy beta emitters or, in the case of Fe-55, low-energy X-ray emitters, and cannot be detected in the small quantities present by the existing instrumentation. The low-energy emitters are also very low-hazard radionuclides, and in most cases, are associated with other easily detected radionuclides, such as Co-60 and Eu-152, that provide adequate indication at levels far below applicable limits. The low-energy emitters are also very low-hazard radionuclides. While a liquid-scintillation counter is effective in measuring the low-energy emitters, extensive preprocessing of the sample materials (chemical separation, isotopic enrichment) is required. Accurate analysis of widely varying samples depends on a skilled and dedicated operator with intensive practice. When needed, these analyses are best done at an established commercial laboratory.

Action:

Do not obtain a liquid-scintillation counter.

Results:

Quantification of low-energy emitters will rely on ratios to easily detected indicators and use of outside laboratories.

30. Prepare Procedure for Radiological Surveys and Measurements

Summary:

While procedures exist for performing environmental monitoring and for final surveys of decontaminated facilities, there are no procedures for routine operational surveys of surface contamination or exposure rate. (ORAU p. 5, 16 #3)

Discussion:

Routine operational surveys are considered part of the "craft" of health physics, but as instruments improve or change, measurements recorded in the past may not have exactly the same meaning as those recorded now or in the future. It is unfortunate that a detailed history of survey instruments and methods was not kept from the beginning.

Action:

Procedures for performing routine operational surveys, including descriptions and capabilities of the instruments, are being prepared. These procedures provide for historical records.

Results:

A present-day description of survey instruments and methods will be available.

31. Revise Procedures and Establish Schedule for Review

Summary:

Procedures should be revised to accurately reflect current practices. (ORAU p. 6, 16 #3; Analytics p. 18 #8)

Discussion:

Procedures provide a documented description of the way work is performed.

Action:

Procedures are in the process of being revised. An appropriate review schedule will be established.

Results:

When action is complete procedures will be up to date.

32. Develop Guidelines for Residual Radioactivity

Summary:

Site-specific guidelines for residual radioactivity in soil should be developed. (ORAU p. 6, 16 #4)

Discussion:

While universal limits for surface contamination have been generally accepted for many years, the hazard associated with residual soil contamination is considered to be so sensitive to local conditions and reasonable use as to require site-specific determination. To facilitate this determination, DOE has developed a dose-estimation program called RESRAD.

Action:

The RESRAD program and manual have been obtained, two staff members attended DOE training classes, two other Rocketdyne scientists have been trained in its use, and calculations have been performed for Cs-137 and Sr-90 in soil.

Results:

The allowable limits for residual soil contamination for Cs-137 and Sr-90 are shown in Table VIII.

Table VIII. RESRAD-Calculated Soil Activity Limits for Future SSFL Land Use Scenarios

Land Use Scenario	Allowed Single Radionuclide Concentration (pCi/g)[a]	
	^{137}Cs	^{90}Sr
1. Industrial	239	33,020
2. Residential	70.8	409
3. Wilderness	3,830	9,240,000
4. Family farm	31.7	37.2

[a]Single radionuclide soil activity limits from RESRAD for 100 mrem/year dose, and assuming an effectively infinite contamination extent.

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33. Develop Radionuclide-Specific Analyses for Soil

Summary:

Radionuclide-specific analyses should be performed for contaminated soil, rather than gross alpha and beta analyses. Gamma spectrometry for soil should use a soil-matrix standard for gamma spectrometer calibration. (ORAU p6, 16 #5; Analytics p2, 17 #2)

Discussion:

The environmental monitoring program had always relied on gross alpha and beta counting of soil samples as an effective method of screening samples for significant contamination. This method was also used until recently to analyze soil from decontaminated areas, in conjunction with conservative assumptions regarding the radionuclide composition. Gamma-emitters can be readily detected by use of high-resolution gamma spectrometry. Other radionuclides require considerable chemistry to perform specific analyses. With proper control, gross alpha and beta analyses can be effective at the allowable levels for residual contamination.

The gamma ray standard used for calibrations is composed of an epoxy resin with a density of approximately 1.0 g/cm^3, matching water in attenuation very closely. Soil provides somewhat more attenuation and so use of this standard for soil analyses underestimates the activity by a small amount.

Action:

Gamma-spectrometry will be used for specific analyses for gamma-emitters such as Co-60, Cs-137, Eu-152, and Am-241. Others, such as Sr-90, U-238, and Pu will be sent out for radiochemistry as required. Gross alpha and beta analyses, because of their considerable practical advantages, will continue to be used for screening and guidance in decontamination.

Standard solutions have been obtained and will be used to formulate soil-matrix standards for calibration of the gamma spectrometer for soil samples. A comparison between the epoxy standard and the soil standard will determine the magnitude of the previous bias.

Results:

Radionuclide-specific data will be available for use in RESRAD calculations, and for direct comparison with other limits. Soil analyses by gamma-spectrometry will have improved accuracy.

34. Evaluate Alternate Photopeaks for Gamma Spectrometry

Summary:

The gamma-ray photopeaks used in the routine analyses of soil are not the most appropriate for certain radionuclides. Alternate photopeaks should be used. (ORAU p8, p17 #10)

Discussion:

Natural soil contains a large number of naturally occurring radionuclides (approximately 44) that provide a wide variety of gamma-ray photopeaks. Some of these, most notably at 186 keV from Ra-226 (186.0 keV) and U-235 (185.7 keV), interfere (are not resolvable) and must either be ignored, or adjusted analytically. This line is one of the best for estimating natural uranium (consisting of uranium in its natural isotopic composition and in nominal equilibrium with all its daughters).

Since both Ra-226 and U-235 are present in natural uranium, we adjust the results analytically. Comparison of the U-235 activity calculated from the U-238 activity derived from its daughters' activities, with that derived from the adjustment of the 186-keV photopeak activity provides a test for the presence of chemically processed uranium that has lost its daughters. The natural uranium present in soil contains approximately 0.7% U-235, which contributes about 4.6% as much alpha activity as does U-238. The Ra-226 activity is roughly 20 times as great as the U-235 activity, but because of a lesser yield of gamma-rays, contributes about the same as U-235 to the 186-keV photopeak. At the allowable contamination limit for depleted uranium (principally U-238) the U-235 activity (for uranium depleted to 0.2% U-235) is roughly 10 times that naturally present in natural soil and therefore would dominate the Ra-226 contribution and be easily detectable, even at lower concentrations. At higher enrichments, this effect would be even more noticeable. The allowable limit established by NRC for enriched uranium is only slightly lower than for depleted uranium (30 pCi/g compared to 35 pCi/g). For normal and enriched uranium, other (alternate) photopeaks that do not suffer from interference become detectable. These are at 144 keV and 205 keV, and are included in the multi-channel analyzer library. Detection of observable amounts of U-235 by these methods would lead to subsequent, more detailed analyses, utilizing a commercial laboratory, for isotopic determination of the uranium activity.

Because of the long turnaround time for routine analyses at commercial laboratories (30 working days) this is clearly practical only for final surveys and not for guiding decontamination work in progress. In spite of its shortcomings, gross alpha and beta analysis is far more practical for decontamination guidance. Natural soil (at SSFL) has roughly 25 pCi/g alpha activity and 25 pCi/g beta activity. If it were contaminated with depleted uranium at the allowable limit of 35 pCi U/g soil, this soil would have 60 pCi/g alpha and

95 pCi/g beta (two beta decays are associated with each U–238 alpha decay). Even a severe loss of radon and daughters would not obscure this increase, especially considering the statistical analyses that are performed on survey data. Highly enriched uranium, at its allowable limit of 30 pCi/g, would roughly double the observed alpha activity to 55 pCi/g with no noticeable change in the beta activity. This would also be easily detected.

Direct detection of U–238 in soil by gamma–spectroscopy is extremely difficult. At allowable levels of contamination, the 1.001 MeV gamma–ray from Pa–231m is not detectable, and the 93–keV doublet from Th–234 is not interpreted accurately by our analyzers. If there were a need for this method of analysis, it could be developed. Little work has been done at SSFL with unirradiated depleted uranium.

Many difficulties with environmental analyses disappear at concentrations that are acceptable for decommissioning.

Action:

As needed, more detailed analyses are performed for guidance and confirmation of soil decontamination operations (see Recommendation 33).

Results:

It is expected that decontamination projects will continue to produce results that are clearly acceptable to confirmatory surveys and the regulatory agencies.

35. Use Simulated Soil Matrix for Gamma Spectrometer Calibration

Summary:

Soil analysis would be more accurate if a soil–matrix calibration standard were used to eliminate a 5–10% bias. (ORAU p9, p17 #11; Analytics p10, p17 #2)

Discussion:

Commercial mixed–radionuclide gamma–ray sources in an epoxy matrix contained in standard Marinelli (re–entrant) beakers are used to calibrate the gamma–ray spectrometers in terms of gamma–ray energy and efficiency. Because soil attenuates gamma rays more than the epoxy does, radioactivity determined in this manner is underestimated slightly.

Action:

Several standard solutions have been obtained and will be used to prepare gamma–ray calibration standards with a soil matrix.

Results:

Gamma spectrometry of soil will be more accurate.

36. Develop Chain-of-Custody for Samples

Summary:

A chain-of-custody procedure for radiological analyses of samples does not exist and should be implemented. (ORAU p9, p17 #2)

Discussion:

In this recommendation, the chain-of-custody procedure is a tracer log to permit tracking where samples are and assuring that results are properly received.

Action:

A tracking procedure has been developed.

Results:

Location of samples and analytical results are being documented.

37. Initiate Auditable Program of Training and Qualification for Monitoring Personnel

Summary:

Records showing the training and qualification of personnel performing radiological monitoring should be developed. (ORAU p9, 17 #13; Analytics p17 #1f)

Discussion:

The training and qualifications of the present staff consist of a combination of experience, formal training, and on-the-job training. Some of this is documented, much is not.

Action:

A training plan has been developed for RP + HPS staff. A descriptive summary listing the training and experience of personnel performing radiological monitoring will be developed.

Result:

Training and qualifications will be auditable.

38. Establish Periodic Comprehensive Audits

Summary:

An independent comprehensive audit program for radiological monitoring should be developed. (ORAU p9, 17 #14)

Discussion:

Independent audits are an additional source of guidance in the performance of a monitoring program such as this, supplementing licensing reviews and regulatory inspection.

Action:

An independent QA audit was conducted in August 1990. A schedule for future audits has been developed. Expansion of this and application of other audits will be investigated.

Results:

Four findings and three observations were produced by this audit. Comprehensive audits will be performed periodically.

39. Use Quality Control Samples to Evaluate Rocketdyne and Contract Laboratory Performance

Summary:

Spiked samples, blank samples, and duplicate samples should be included in samples analyzed by the Rocketdyne laboratory and the contract laboratory as a quality control measure. (ORAU p10, 17 #15; Analytics p2 #5, 17 #1d)

Discussion:

Analyses of spikes, blanks, and duplicates serve as measures of the performance of a laboratory. The analytical results for a spike should match the known amount put in, a blank should show essentially zero, and a duplicate should match its mate, within the quoted uncertainties. Quality control samples are most effective if they are sufficiently numerous or if they form satisfactory statistical sets. Since Rocketdyne's analytical requirements are relatively small, we have relied on the commercial laboratory's own quality control and the overchecks performed by its major customers. Spikes, blanks, and duplicates are analyzed by the Rocketdyne laboratory, but not in a structured quality control manner. One of our reviewers has suggested an extension of the DOE/EML Quality Assurance Program samples for use as spikes in gross alpha and beta counting. Preparation of QC samples can be a major effort in itself. Adequate review of the results also

requires additional effort. The contract laboratory participates in the DOE/EML Quality Assurance Program, and results of this program are provided to us.

Action:

The use of and interpretation of the DOE/EML–QAP samples in the laboratory QC program will be expanded.

Results:

QAP–XXXII was recently completed, and the samples are now available for QC use.

40. Conduct Additional Investigations of T064 Contaminated Area

Summary:

Small areas in the T064 Side Yard showed radiation well above background on contact and may indicate excessive subsurface contamination. An unidentified clay pipe was observed. The exposure rate was greater in a hole dug in the contaminated soil. (ORAU p11, 17 #17; EPA p8)

Discussion:

The observations discussed occurred during the decontamination of the Side Yard and all significant radioactivity was subsequently removed. The major concern in decontaminating an area such as this is that average conditions must be acceptable and "as low as reasonably achievable." DOE guidance provides for averaging soil contamination over areas of 100 square meters. "Hot spots" with activity that does not exceed 30 times the allowable limit are acceptable so long as the average concentration limit for the 100–square–meter area is satisfied. NRC guidance provides for determining the exposure rate at 1 meter from the surface which, with most detectors, provides an average over an area of roughly 3 square meters. The NRC guidance severely limits the possible size and activity of an acceptable "hot spot."

The unidentified clay pipe was the sewer drain line from T064. It was sampled and analysis showed no detectable activity.

The gamma–radiation exposure rate measured in a hole dug in contaminated soil will always be greater (by a factor of 2–3) than a surface reading because the detector is nearly surrounded by the radiation source.

Action:

Decontamination of the Side Yard was completed and the area was surveyed and sampled. Calculations using RESRAD were performed to determine the allowable

residual soil contamination (60 pCi/g for an assumed equal-activity mixture of Sr-90 and Cs-137) and reasonable maximum potential dose (36 mrem/year before contamination and 5 mrem/year after decontamination).

Results:

The T064 Side Yard has been decontaminated beyond requirements and this is documented in N704SRR990031.

41. Perform Final Environmental Survey Using Radionuclide-Specific Analyses

Summary:

Since work with nuclear and radioactive materials has ended and a determination has been made that it will not resume, a comprehensive final survey of the SSFL environment should be done. This should include analyses of all appropriate sample types for the radionuclides used during nuclear operations at SSFL.

Discussion:

While the environmental and effluent monitoring have shown that no significant releases of radioactivity have occurred, there is continuing concern expressed by the media and the public over exactly what constitutes the radioactivity in the environment. Some sampling has been done at various locations, with radionuclide-specific analyses, and a study was recently done on the natural radionuclides in rock, soil, and water. Now, it is appropriate to do a structured, comprehensive survey to close-out the previous environmental monitoring. Radionuclide-specific analyses will be done by use of gamma-spectrometry at Rocketdyne, and by gamma-spectrometry and chemically-selective methods and other procedures by outside contract analytical laboratories.

Action:

A site-wide survey is in the conceptual planning stage.

Results:

Several methods for performing this survey are under consideration.

42. Evaluate Historical Data in Detail to Improve Sensitivity and Information Content

Summary:

The final environmental assessment should include detailed review of the environmental data accumulated in the past, that had previously been reported as statistical summaries. (Analytics p2, #2, 13)

Discussion:

An environmental monitoring program has been in operation at SSFL since approximately 1956. Most of the data on individual sample analysis is available. While individual results were reviewed at the time, annual reports summarized these in terms of the mean, the dispersion (standard deviation), and the maximum. In view of the absence of significant environmental contamination, this was reasonable for routine reporting. However, as a recapitulation of the program, the entire set of results should be reviewed. This can be done using statistical techniques that clearly show deviations from the inherent variability in the naturally occurring radioactivity. This can be done on a time basis for each sampling location and type and on a location basis for each type and time. This should be done prior to the detailed planning or performance of the final survey discussed in Recommendation No. 41, to provide indication of any particular location that deserves special attention.

Action:

This should be considered as a prelude to the final site survey.

Results:

None as yet.

43. Revise Alpha/Beta Calibrations and Use Representative Standards

Summary:

Variations in the loss of radon from soil samples make the current alpha calibration for soil uncertain. (Analytics p2 #4, 10, 13)

Discussion:

Spiked samples should, as calibration standards, be as free of variability as practical. For alpha activity in soil, this can be done by spiking to a high concentration, so that variation of a few picocuries per gram is negligible, or by use of sea sand (which is essentially free of radioactivity) as a sample material.

Action:

Fabrication and use of representative (spiked) environmental samples for calibration standards will be reviewed and used as necessary.

Results:

Water samples spiked with Co–60, Sr–90, and Cs–137 have been prepared and put into use.

44. Develop and Implement Detailed Procedures for Counting Instruments

Summary:

Procedures containing detailed instructions on setup, calibration, and operation of all counting instruments should be developed and implemented. (Analytics p17 #1a)

Discussion:

Three types of counting instruments are used at present: an internal gas–flow proportional counter, a thin–window gas–flow proportional counter, and a high–resolution gamma–ray spectrometer. These procedures should also include QC provisions, and data interpretation.

Action:

A procedure for use of the internal proportional counter for source calibration has been written. A procedure on quality control has been written for the thin–window proportional counter. Quality control and operating instructions are included in a procedure written for the gamma spectrometers.

Results:

All of the needed procedures have been completed.

45. Perform Quality Control Tests for the Gamma Spectrometer

Summary:

Quality control tests on energy calibration, efficiency, and resolution should be performed for the gamma spectrometer. (Analytics p17 #16)

Discussion:

The Marinelli beaker gamma–ray standard that is used to provide energy and efficiency calibration can be used to track the performance of the spectrometer. These measurements (energy deviation for selected photopeaks, efficiency and resolution at several energies) should be made as a pre–use or daily qualification test. Control charts should be kept and satisfactory criteria established.

Action:

These QC measurements are included in a new procedure for use of the gamma spectrometer.

Results:

The new procedure has been implemented.

46. Routinely Review QC On Instruments

Summary:

Management and laboratory personnel should be reviewing QC data on the instruments. (Analytics p11, 17 #1c)

Discussion:

Individual QC measurements provide a simple good/bad test of the instrument at the time. Continuing review provides early warning by considering trends and offsets. Management review assures that QC is perceived as important and is performed.

Action:

QC data will be reviewed in an ongoing manner to assure early detection of developing problems.

Results:

Control charts for instruments are reviewed.

47. Analyze DOE and EPA Samples for Gross Alpha and Gross Beta

Summary:

Samples in the DOE/EML-QAP, and EPA laboratory QC samples, can serve as well-qualified blind spikes and QC samples for gross alpha and gross beta as well as gamma spectrometry. (Analytics p11, 17 #1e)

Discussion:

The DOE/EML-QAP samples are primarily intended to test gamma spectrometry and radiochemistry and are not qualified in terms of gross alpha and beta activity. However, these activities can be closely estimated for the mixture and activities of the specific radionuclides included, and therefore can be used as QC samples for the gross alpha and beta counter. This is particularly true for the water samples. The alpha activity in these samples may be too low to be useful.

Action:

Use of DOE/EML-QAP samples and EPA samples, will be included in the laboratory QC as practical.

Results:

QAP-XXXIII samples are now available and will be analyzed for gross alpha and gross beta.

48. Calibrate Gamma Spectrometers for Single Air Samples and Smears

Summary:

High activity on air sample filters and smears should be checked by gamma spectrometry. Calibration of the gamma spectrometers for these sample types is recommended. (Analytics p17 #3)

Discussion:

Air samples and smears rarely have sufficient activity to be detected by gamma spectrometry, but when one does, it would be useful to have an identification of the radionuclides present. This identification can be done without recalibration for this geometry (as opposed to the Marinelli beaker) but is not done as often as might be desirable. The efficiency factor for these samples is known to be roughly a factor of 2 less than for the Marinelli beaker (the detector is roughly twice as sensitive for the flat samples as for the bulk sample). Higher accuracy and determination over the full energy range would be useful.

Action:

A determination of relative efficiencies for air samples and smears will be done. Gamma spectrometry will be done on these samples more often.

Results:

More accurate and more complete information on contamination conditions will be obtained.

49. Expedite Receipt of Radionuclide Standards

Summary:

Radionuclide standards that were needed for preparation of instrument calibration standards should be expeditiously sent to SSFL. (Analytics p18 #4)

Discussion:

Several standard sources and solutions had been ordered to permit preparation of calibration standards. These had been delivered to the DeSoto Receiving Dock. Transferral to SSFL had been blocked waiting revision of the site-to-site shipping procedure.

Action:

The sources were transferred to SSFL in September 1990.

Results:

Standard sources and solutions are available for use at SSFL.

50. Hire a Qualified Person to Operate the Laboratory

Summary:

A qualified person should be hired to replace the retired former laboratory operator. Part-time help should be used to supplement the current staff. (Analytics p18 #5)

Discussion:

The former lab operator retired after a significant reduction in the scope of the environmental monitoring program (but not due to this reduction). At present there is no one assigned to use and maintain the lab on a full-time basis.

Action:

Part-time assistance by the former lab operator has been arranged. Additional training of other members of RP&HPS has been conducted to expand laboratory capability.

Results:

Analysis of environmental and facility radiological samples has been speeded up.

51. Use EPA Procedure for Gross Alpha and Beta Analysis of Water

Summary:

The EPA drinking water analysis procedure or other standard methods should be used for gross alpha and beta analysis of water. (Analytics p18 #6)

Discussion:

Standard methods for gross alpha and beta analysis of water are available from EPA (Method No. 900.0) and the American Public Health Association (Method No. 703).

Action:

The EPA procedures will be adapted for use, as needed.

Results:

Water analysis will be performed by use of a government–approved procedure.

IV. SUMMARY

The actions taken in response to the 51 recommendations extracted from the 4 reviews are briefly summarized here:

Recommendation	Response
1. Meteorological tower	Not needed, not to be installed
2. Sampling locations do not reflect current operations	Sampling locations were reviewed and reduced to reflect current operations. Not in use any more.
3. Sampling locations are not identified by markers	Durable markers were installed.
4. Northwest rainfall runoff should be monitored	Five gully basins have been installed and sampled and analyzed after rainfall.
5. The procedure for environmental TLDs was not current	The procedure was revised to show the practice at the time of termination.
6. Details of dose calculations were not documented	The dose calculations were specifically documented.
7. Multiple AIRDOS calculations	Use of the current program, AIRDOS-PC, eliminates the need for multiple calculations.
8. Use of spiked samples	Spiked samples will be used for improved calibrations. Spiked field samples will not be used.
9. Lack of overcheck for calculations	Additional overchecking of calculations will be done.
10. Peer review	A peer review was performed.
11. Analysis of soil for gross alpha and beta activity	Gross alpha and beta analysis of soil continues to have practical value. More radionuclide-specific analyses will be performed.
12. Reduce temperature for baking soil	The temperature for baking soil (and for ashing vegetation) has been reduced to the generally accepted 450°C.
13. Soil is sieved rather than milled	Sieving is appropriate for the analyses where it is used.
14. Washing vegetation removes fallout contamination	Washing insures accurate determination of the intrinsic radioactivity of the plant and is appropriate for these analyses.

Recommendation	Response
15. Collect and analyze wild animals and roadkill	Some wildlife has been collected and analyzed.
16. Count air samples (gamma spectrometry) according to procedure	This recommendation was based on a misconception by the reviewers. The procedure has been revised to show the correct count time.
17. Do not normalize TLD results for evaluation	The TLD results are no longer normalized for evaluation.
18. Do not withhold comparisons of TLD data with State and DOE results	The State results were included in the next annual report. The DOE results were never released.
19. Conduct a complete systematic survey of SSFL and compare results with allowable guidelines	A complete survey of building, surface and subsurface soil, and leach fields is being planned.
20. Have an EG&G/ARMS aerial survey of SSFL performed	An aerial survey is currently planned for Summer 1992.
21. Further study of tritium in water	An extensive study of tritium in water has been completed.
22. Analyze for Sr-90	Selected samples of radioactively contaminated soil will be analyzed for Sr-90.
23. Analyze vegetation and animals	Some vegetation and wildlife have been analyzed for radioactivity.
24. Reference survey locations to State or USGS grid system	Survey locations are referenced to the USGS grid system by inclusion of a section of the appropriate USGS topographic map in the survey report.
25. Reevaluate gamma exposure rate surveys for contaminated soil areas	Small areas of contaminated soil left in cleanup projects will be minimized by application of the ALARA principle.
26. Detection capabilities of survey instruments	Discussion of the detection capabilities of survey instruments is included in a recently completed survey procedure.
27. Evaluate staffing requirements	Additional staff members are at work.
28. Cross-train staff	Cross-training has been provided to several staff members.

Recommendation	Response
29. Evaluate need for liquid scintillation counter	Liquid scintillation counter analyses are best performed by a commercial laboratory.
30. Prepare procedure for radiological surveys and measurements	This procedure is being prepared.
31. Revise procedures and establish schedule for review	The procedures are being revised and will include a specification of the review schedule.
32. Develop guidelines for residual radioactivity	Guidelines for residual radioactivity have been developed by use of the DOE program, RESRAD.
33. Develop radionuclide-specific analyses for soil	Gamma-spectrometry and radiochemistry will be used as appropriate to identify radionuclides in soil.
34. Evaluate alternate photopeaks for gamma spectrometry	Useful alternate photopeaks become effective naturally at contamination levels approaching allowable limits.
35. Use simulated soil matrix for gamma spectrometer calibration	A soil-matrix calibration will be prepared.
36. Develop chain-of-custody for samples.	A tracking log will be implemented.
37. Initiate auditable program of training and qualification for monitoring	A summary of training and qualification will be prepared.
38. Establish periodic comprehensive audits	A schedule for audits has been prepared.
39. Use quality control samples to evaluate Rocketdyne and contract laboratory performance	Samples from the DOE/EML-QAP will be used to test laboratory performance.
40. Conduct additional investigations of T064 contaminated area	Decontamination of the T064 Side Yard was completed.
41. Perform final environmental survey using radionuclide-specific analyses	This is planned to be done.
42. Evaluate historical data in detail to improve sensitivity and information content	This is planned to be done.
43. Revise alpha/beta calibrations and use representative standards	Some spiked water samples have been prepared.

Recommendation	Response
44. Develop and implement detailed procedures for counting instruments	This has been done.
45. Perform quality control tests for gamma spectrometer	QC tests have been included in the procedure for use of the gamma spectrometer.
46. Routinely review QC on instruments	Control charts are being reviewed.
47. Analyze DOE and EPA samples for gross alpha and gross beta	DOE/EML-QAP samples will be analyzed for gross alpha and gross beta.
48. Calibrate gamma spectrometers for single air samples and smears	This is planned to be done.
49. Expedite receipt of radionuclide standards	The standards have been received.
50. Hire a qualified person to operate the laboratory	Consultation by the former operator and training of others has resolved this problem.
51. Use EPA procedure for gross alpha and beta analysis of water	This procedure will be adapted as needed.

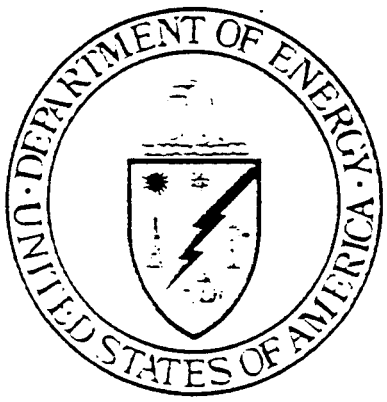
D641-0004

Appendix A

Excerpts from DOE Environmental Survey Preliminary Report

U.S. Department of Energy

Environment, Safety and Health
Office of Environmental Audit



Environmental Survey
Preliminary Report

DOE Activities at
Santa Susana Field Laboratories
Ventura County, California

February 1989

Although the burn facility has not been used since April 1987, it is available for use in the future.

Utilization of chlorinated solvents and freons is small. During a 1987 survey (Remley, 1987), annual use of methyl chloroform was estimated to be about 630 pounds per year. This survey also estimated annual use of freons (mostly freon-12 and freon-22 in air conditioning) to be about 1,450 pounds per year.

3.1.3 Environmental Monitoring Program

Ambient Air Monitoring

SSFL operates a network of eight ambient air samplers (see Figure 3-1), which collect particulate samples continuously. Seven samplers (A-3 to A-9) are located near major sources or downwind. These collect a sample every 24 hours on a 37 mm diameter filter at a flow rate of 25 cubic meters per day. A somewhat unique arrangement of hardware allows air flow to be switched to a fresh filter each midnight. Seven samples are collected each week, one sample representative of each of the preceding 7 days. An eighth sample (A-10) is collected adjacent to the sampler near Building 100 (A-3). This sample is collected over a 7-day period. Thus, in total, about 2,500 samples are collected each year. Samples are counted for alpha and beta radiation following a 120-hour delay to allow for decay of radon and thoron daughters.

Many of the daily samples are near or below the method detection limits (MDL). For example, in 1987, 99 percent of the alpha measurements and 64 percent of the beta measurements were below MDL. Although the 7-day sampler provides information which serves many purposes, it provides an excellent quality control check on the daily sampler. In recent years there has been excellent agreement between the daily and 7-day samples. For example, in 1987, the daily samples showed an average (see Table 3-4) of 0.0019×10^{-12} uCi/ml for alpha radioactivity and 0.027×10^{-12} uCi/ml for beta. During 1987, the average of 7-day samples showed 0.0015×10^{-12} uCi/ml for alpha and 0.0289×10^{-12} uCi/ml for beta. Typically, 68 percent of the alpha measurements and 0 percent of the beta measurements are below MDL for the 7-day samples.

Stack Sampling

All stacks known to contain any significant quantity of radionuclides are continuously monitored at SSFL. During 1987, this included only Building 020 and the stack serving Buildings 021 and 022. Prior to July 1986, Building 055 was also monitored. During 1988 (including the on-site portion of the

Environmental Survey), Building 020 was essentially inactive. This presented the opportunity to perform maintenance on the sampling and analytical equipment employed at Building 020.

Sampling at Buildings 021–022 consists of continuously collecting a sample of gas withdrawn from the stack. A flow rate of 62 liters per minute provides sampling that is approximately isokinetic. A filter with 5 micron porosity is changed weekly. A detector mounted nearby would alarm at any rapid build-up of radioactive material on the filter. Additional precautions to prevent large discharges from the stack come as a result of frequent monitoring of the pressure drop across the HEPA filters and monitoring (primarily for employee health purposes) conducted within the two buildings.

Emissions from the RMDF complex have been low for many years. Recent results are summarized in Table 3-7. Better precision results, because fewer measurements are close to detection limits than with ambient air measurements. In 1987, 31 percent of the alpha measurements and none of the beta measurements were below MDLs.

The annual monitoring report usually contains a statement such as: "The effectiveness of the air cleaning systems is evident from the fact that the atmospheric effluents are less radioactive than is the ambient air" (Moore, 1988b). In 1987, this was correct for the emissions from Building 020 and for the DeSoto buildings. Table 3-7 shows, however, that emissions from Buildings 021–022 were higher than the equivalent ambient air. Nevertheless, controls are effective and the total radioactivity release is low. In 1987, the total released was less than 1 percent (0.17 percent alpha, 0.17 percent beta) of the appropriate DOE guideline.

Modeling by AIRDOS-EPA is used to estimate doses to the general population. Doses are not substantially different from zero. For example, the average individual dose to a person living within an 80-km radius was 9.6×10^{-7} mrem in 1987. The total dose from all sources, including natural background, is about 180 mrem. Total dose from SSFL, including direct radiation, will be discussed more fully in Section 4.3.

TABLE 3-7

RMDF ATMOSPHERIC EMISSIONS
SSFL - VENTURA COUNTY, CALIFORNIA

Year	Total Radioactivity Released (Ci)		Annual Average Concentration Beta (μCi/ml)	Average Ambient Air Concentration Beta (μCi/ml)*
	Alpha	Beta		
1987	2.5×10^{-7}	1.2×10^{-5}	51×10^{-15}	29×10^{-15}
1986	4.6×10^{-8}	1.3×10^{-5}	40×10^{-15}	73×10^{-15}
1985	3.9×10^{-8}	9.0×10^{-6}	39×10^{-15}	35×10^{-15}
1984	7.4×10^{-8}	3.7×10^{-6}	1.1×10^{-15}	33×10^{-15}
1983	4.7×10^{-8}	1.1×10^{-6}	3.4×10^{-15}	32×10^{-15}
1982	2.4×10^{-8}	0.61×10^{-6}	1.8×10^{-15}	42×10^{-15}
1981	$< .87 \times 10^{-8}$	4×10^{-6}	12×10^{-15}	$< 120 \times 10^{-15}$

Source: Adapted from Rocketdyne Annual Monitoring Reports (1981–1987) by DOE Survey Team.

* 7-day samples at SSFL Building 100 from 1985 to 1988; at DeSoto Site from 1981 to 1984.

3.1.4 Findings and Observations

3.1.4.1 Category I

None.

3.1.4.2 Category II

None.

3.1.4.3 Category III

None.

3.1.4.4 Category IV

1. Lack of Meteorological Tower. Lack of a meteorological tower could result in inaccurate dose assessment in the event of an unscheduled release. Without a meteorological tower providing current wind speed and direction data, it is not possible to accurately predict the area of impact of an unscheduled release. In addition, annual calculations of the air pathway dose to the population using the AIRDOS-EPA computer model may be in error, since old and inappropriate information from the Burbank Airport (BAP) is used.

   It has been assumed that the BAP information is adequate because upper winds above the site are similar to upper winds at BAP, 22 miles east of the site. However, data taken from a meteorological tower that was operated in Area II during 1960–1961 shows some differences. For example, data for the NNW through NE quadrant (that is, the sum of the frequencies from the NNW, N, NNE, and NE segments) indicates that the wind is from that direction 41.7 percent of the time at BAP but varies from 33.8 percent of the time (winter) to 12.0 percent (summer) at SSFL.

asbestos exists in the area. SSFL has not investigated the area to determine the source of the asbestos.

3.2.3 Environmental Monitoring Program

Environmental monitoring of soil and vegetation for radioactivity was initiated in 1954 at SSFL and has continued to the present. The current program is directed and performed by the Radiation and Nuclear Safety Group of the Health, Safety, and Environment Department. The intent of the program is to adequately survey environmental radioactivity to ensure that nuclear operations do not contribute significantly to environmental radioactivity (Moore, 1988). The locations selected for on-site sampling were selected in the mid-1950s (prior to SRE construction), based on the planned locations for reactor experiments. The locations for monitoring have not significantly changed since the original selections were made, although site operations have changed relative to potential radioactive sources for contamination (see Finding 3.2.4.1.1).

The current program of soil monitoring consists of collecting 48 samples from on-site and off-site locations up to 16 kilometers (10 miles) from the facility on a quarterly basis (Moore, 1984; Moore, 1986). Figures 3-4 and 3-5 show on-site and off-site sampling locations. Samples are collected from an undisturbed area within 15 meters (50 feet) of the location listed in the Radiological Environmental Monitoring Program document (Moore, 1986). No sample location markers are used in the field to define the area to be sampled. The sample is collected by scooping up approximately 100 grams of soil from the top 2.5 cm (1 inch) of soil using a plastic scoop. The sample is prepared by drying, sieving on a 0.5 mm Coors crucible, and spreading with alcohol on a copper planchet. Analyses are performed by counting for 100 minutes for gross alpha and gross beta at an on-site laboratory. The balance of the raw sample and the furnaced sample are then composited and gamma scanned. Data analyses are reviewed by four site personnel. The samples are collected and analyzed by the same person, and the samples do not leave the sampler's possession. No formal chain-of-custody is used. Semiannually, samples are collected by SSFL and analyzed off-site for plutonium by an independent laboratory according to NRC guidelines.

Vegetation monitoring for radioactivity, which was conducted with monthly soil monitoring, was discontinued after 1985 when SSFL also decided to reduce soil monitoring from monthly to quarterly intervals.

Compilations of soil and vegetation monitoring data are presented in Tables 3-8 and 3-9, respectively. As previously discussed in Section 3.2.1, the average of on-site radioactivity analytical values for soil and vegetation are similar to the average of off-site values.

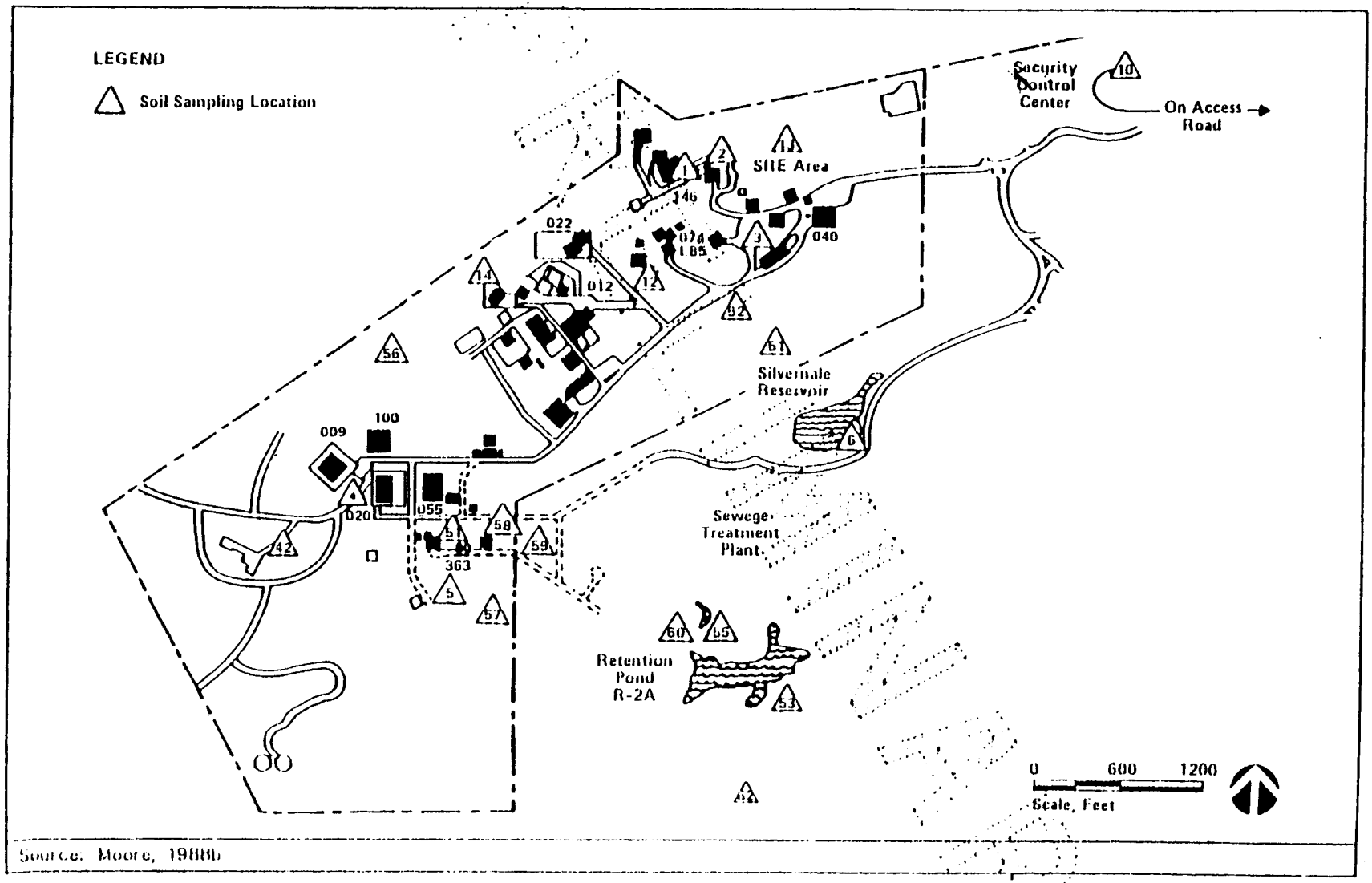
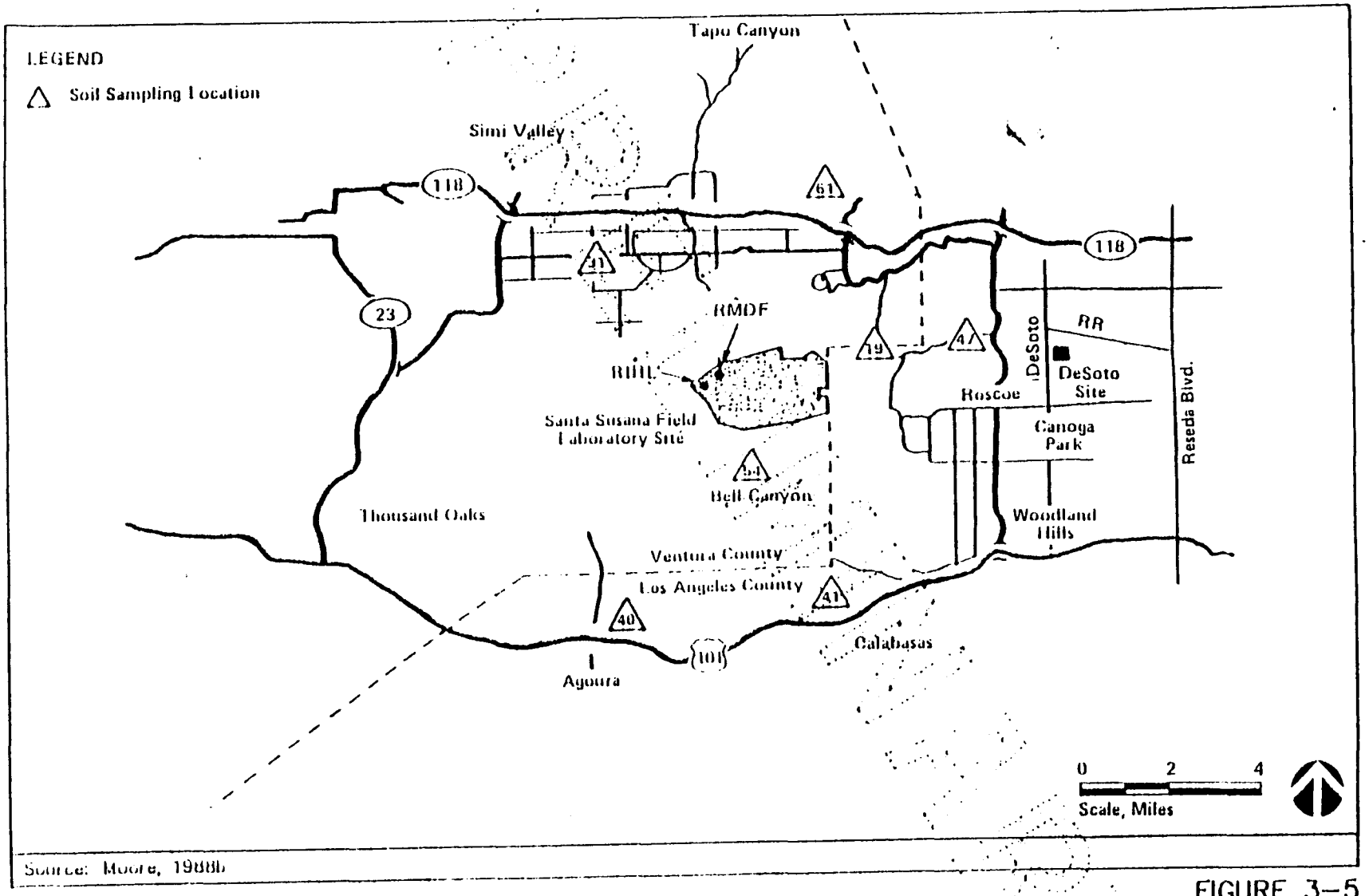


FIGURE 3–4

ON–SITE SOIL SAMPLING LOCATIONS
SSFL–VENTURA COUNTY, CALIFORNIA



Source: Moore, 1988b

FIGURE 3-5

OFF-SITE SOIL SAMPLING LOCATIONS
SSFL-VENTURA COUNTY, CALIFORNIA

TABLE 3-8

SOIL RADIOACTIVITY DATA 1987-1957
SSFL - VENTURA COUNTY, CALIFORNIA

Year	On-Site Average or Range (pCi/g)			Off-Site Average or Range (pCi/g)		
	Number of Samples	Alpha	Beta	Number of Samples	Alpha	Beta
1987a	48	27.1	25	48	25.7	24
1986a	48	26.7	26	48	25.1	25
1985a	144	25.2	24	48	26.3	24
1984a	144	25.8	24	48	26.2	23
1983	144	0.61	24	48	0.59	23
1982	144	0.69	25	48	0.68	23
1981	144	0.69	25	48	0.64	23
1980	144	0.60	24	48	0.58	23
1979	144	0.64	25	48	0.60	23
1978	144	0.63	24	48	0.61	24
1977	144	0.56	24	48	0.53	23
1976	144	0.56	25	48	0.56	24
1975	144	0.60	25	48	0.58	24
1974	144	0.60	25	48	0.64	24
1973	144	0.57	25	48	0.61	24
1972	144	0.56	25	48	0.57	24
1971	144	0.55	25	8	0.53	23
1970	144	0.47	27	48	0.48	25
1969	144	0.42	27	48	0.42	25
1968	144	0.47	26	48	0.48	26
1967	144	0.41-0.42	28	48	0.38-0.39	24
1966	144	0.40-0.41	29	48	0.43-0.44	25
1965	144	0.46	36	142	0.46-0.47	29
1964	152	0.44-0.46	32	299	0.40-0.44	25

TABLE 3-8
SOIL RADIOACTIVITY DATA 1987-1957
SSFL - VENTURA COUNTY, CALIFORNIA
PAGE TWO

Year	On-Site Average or Range (pCi/g)			Off-Site Average or Range (pCi/g)		
	Number of Samples	Alpha	Beta	Number of Samples	Alpha	Beta
1963	156	0.41-0.43	45	455	0.38-0.42	42
1962	147	0.42-0.44	48	453	0.35-0.41	47
1961	120	0.30-0.37	34	458	0.24-0.33	33
1960	115	0.34-0.41	23	362	0.27-0.37	19
1959	107	0.43	15	377	0.32	14
1958	80	0.27	21	309	0.26	10
1957	64	0.32	11	318	0.35	10

Source: Adapted from Moore, 1987, and Moore, undated.

[a] The change in alpha activity after 1983 is the result of an improved calibration method that provides a true measure of alpha activity in thick samples rather than the relative values used previously. Values for 1987 using the prior method would be 0.87 for the on-site average and 0.83 for the off-site average.

TABLE 3-9

VEGETATION RADIOACTIVITY DATA, 1985-1957
SSFL - VENTURA COUNTY, CALIFORNIA

Year	On-Site Average or Range (pCi/g-asn)			Off-Site Average or Range (pCi/g-asn)		
	Number of Samples	Alpha	Beta	Number of Samples	Alpha	Beta
1985[a]	144	3.8	135	48	4.7	133
1984[a]	144	4.0	136	48	5.9	136
1983	144	0.18	149	48	0.24	143
1982	144	0.16	140	48	0.17	130
1981	144	0.20	137	48	0.21	129
1980	144	0.25	160	48	0.19	142
1979	144	0.24	139	48	0.23	134
1978	144	0.24	166	48	0.24	143
1977	144	0.22	162	48	0.21	142
1976	144	0.19	170	48	0.22	147
1975	144	0.21	155	48	0.21	141
1974	144	0.20	152	48	0.27	141
1973	144	0.24	155	48	0.24	142
1972	144	0.23	145	48	0.36	125
1971	144	0.24	165	48	0.31	132
1970	144	0.33	159	48	0.30	142
1969	144	0.40	165	48	0.36	144
1968	144	0.51	158	48	0.51	205
1967	144	0.62	286	48	0.39	413
1966	144	0.37	169	48	0.37	123
1965	144	0.55-0.56	162	142	0.61	138
1964	152	0.49-0.50	211	293	0.50-0.51	181

TABLE 3-9
VEGETATION RADIOACTIVITY DATA, 1987-1957
SSFL - VENTURA COUNTY, CALIFORNIA
PAGE TWO

Year	On-Site Average or Range (pCi/g-ash)			Off-Site Average or Range (pCi/g-ash)		
	Number of Samples	Alpha	Beta	Number of Samples	Alpha	Beta
1963	156	0.43-0.44	465	456	0.36-0.37	388
1962	147	0.44-0.45	500	453	0.42-0.44	406
1961	120	0.32-0.35	224	459	0.25-0.29	246
1960	115	0.31-0.35	137	362	0.21-0.25	136
1959	96	0.29	212	293	0.18	168
1958	65	0.57	683	250	0.39	356
1957	58	1.1	208	304	0.89	200

Source: Adapted from Moore, 1987, and Moore, undated.

[a] The change in alpha activity after 1983 is the result of an improved calibration method that provides a true measure of alpha activity in thick samples rather than the relative values used previously. Values for 1985 using the prior method would be 0.19 for the on-site average and 0.23 for the off-site average.

3.2.4 Findings and Observations

3.2.4.1 Category I

None.

3.2.4.2 Category II

None.

3.2.4.3 Category III

1. Known and potential on-site soil contamination. There are at least two areas where soil is known to be or may be contaminated with radionuclides, organics, metals, or other hazardous substances. A description of each area and the known or suspected contamination is presented below.

   a. Old Sodium Burn Pit/Building 886 - The operation of this facility during the 1960-1970s time period for cleaning and disposal of sodium-contaminated components, disposal of other activated metal equipment, and disposal of various organic compounds has resulted in soil contamination at and near the facility. Recent investigation of the area for the CERCLA Program Phase II - Site Characterization (Olson et al., 1987) revealed soil contamination in the shallow subsurface soils in an area covering approximately 4,650 sq. meters (50,000 sq. ft.). The soil contamination was found to be principally volatile organic compounds, metals, oil and grease, PCTs, PCBs, terphenyls, and biphenyls. Table 3-10 lists soil sample concentrations resulting from that investigation. Because of the possibility that radioactive wastes may have been buried there, soil samples were screened in the field for radioactivity.

      Any samples indicating radioactivity were not taken to the laboratory for analysis. During a previous investigation and cleanup attempt in 1980, one area was found to be radioactively contaminated by a piece of buried equipment which was removed from the site. The piece of "pipe-like junk" registered greater than 3000 µR/hr (Lang, 1980) at the surface. Other meter readings taken of a dark sediment layer in the lower pond area generally ranged from 20 to 50 µR/hr. A later study for radioactivity was performed by

TABLE 3-10

SOIL SAMPLE ANALYSES - SODIUM BURN PIT
SSFL - VENTURA COUNTY, CALIFORNIA

Compound	Volatile Organic Compounds Concentration mg/kg	
	Low	High
Carbon tetrachloride	nd	500
1,1-Dichloroethane	nd	430
1,1-Dichloroethylene	nd	90
trans-1,2-Dichloroethylene	nd	22
Ethyl benzene	nd	44
Freon-TF	nd	3100
Tetrachloroethylene	nd	1200
Toluene	nd	800
1,1,1-Trichloroethane	nd	1840
Trichloroethylene	nd	740
Trichlorofluoromethane	nd	7.8
Metal	Metals Concentration mg/kg	
	Low	High
Cadmium	1	6
Chromium	10	710
Copper	16	159
Lead	10	864
Mercury	nd	3.0
Nickel	13	129
Compound/Analyte	Other Concentration mg/kg	
	Low	High
Oil and Grease	24	3600
Diesel Fuel	nd	375
PCBs	nd	12
PCTs	nd	1.4
Biphenyls	nd	35
Terphenyls	nd	48
pH	7.1	10.4

Source: Adapted from Olson et al., 1987.
nd = None detected.

taking gamma readings at one-meter above ground on a three meter grid spacing to locate potential hot-spots for soil sampling. The results of that study had not been finalized at the time of the on-site portion of the Survey.

b. Sodium Reactor Experiment (SRE) Watershed - Soil in the vicinity of the former cooling tower, and storm water impoundment may be contaminated with asbestos. A one-time sampling of storm water runoff from this area revealed levels of asbestos fibers and structures in excess of 220 million per liter (EMSI, 1987). There are several potential sources of asbestos in the area, in particular a fire which destroyed the cooling tower for the SRE contained "Munters Fill" which is composed of asbestos. Discussion of the surface water sampling is discussed in Section 3.3.3.

3.2.4.4 Category IV

1. Soil monitoring program deficiencies. There are deficiencies in the soil monitoring program which make it inadequate for current site conditions. The deficiencies include:

a. Sampling locations for monitoring soil radioactivity, as well as other types of contaminants, do not reflect current operations. Past operations at the site which included approximately ten experimental reactors, storage of radioactive fuel, and radioactive waste handling required a specific monitoring program relative to the location of operations during that period. The current operations at the facility are different than the past, but soil radioactivity is still monitored at the same locations.

b. Field sampling locations are not identified by markers. The lack of permanent field markers at soil sample collection locations could result in errantly located samples from substitute samplers, or new samplers replacing the current personnel. The lack of a repetitive sample location could invalidate the evaluation of annual changes in soil radioactivity at a specific location.

in the central portion of Area IV. During extremely heavy downpours, these basins would occasionally overflow and follow natural drainage channels toward the north. Building 143's basin is no longer in use, so the discharge valve is left open to drain off storm water. The basin at Building 028 continues to serve as a catch basin for runoff from the RMDF area. It is equipped with a radiation monitor connected to an alarm system to provide warning of any radioactive contaminants. Thus, there should be no possibility of off-site releases of contaminated wastewaters from this source.

3.3.3 Environmental Monitoring Program

SSFL has been issued an NPDES Permit to release "filtered domestic wastewater and industrial wastewater" from its two principal retention basins (R-2A Pond and Perimeter Pond), subject to criteria listed in Table 3-12. Total flows are combined to calculate discharge loads for comparison with criteria. There are also a number of additional requirements which pertain to SSFL's two sewage treatment plants (see Table 3-13). Monitoring requirements are spelled out in detail in SSFL's NPDES permit, as are notification and reporting requirements.

Since SSFL can control the release of its wastewaters and provide complete analysis of pond water prior to release, it can almost always provide whatever wastewater treatment or hold-up time is necessary to attain compliance with discharge requirements. As a result, its compliance record is exemplary, consistently achieving compliance 99+ percent of the time. A recurring violation of permit limitations, though rare, is the inability to achieve an average final effluent concentration of 15 percent by weight of the average sewage treatment influent concentrations of BOD_5 and total suspended solids (TSS). During extended periods of low activity on-site, incoming concentrations of BOD and TSS in the raw sewage are so low that the 85 percent removal requirement is very difficult to achieve. For example, even though an average influent BOD_5 concentration of 43 mg/l was reduced to an average monthly effluent concentration of 9 mg/l (30 percent of the effluent concentration limit), the net removal was only 79 percent of the inlet flow. Therefore, the mandated 85 percent removal requirement was not achieved. Similarly, incoming concentrations of 27 mg/l of TSS were treated and filtered down to only 6 mg/l TSS in the effluent. However, because of the low incoming load, this removal was only 78 percent. The effluent therefore failed to achieve the 85 percent removal requirement. Whenever the incoming raw sewage is more representative of normal loads, the two treatment plants consistently achieve 94-96 percent removal and are in compliance with all requirements.

Each release from the Perimeter Pond and R-2A Pond to Bell Canyon is monitored and reported to the Regional Water Quality Control Board. A review of NPDES monitoring reports showed that SSFL

methylene chloride (Rogers, 1986), runoffs RD-3 and RD-4 indicate that there may be some carryout of this organic from Area IV. Similar concentrations at locations RD-1 and RD-8 are not likely to be related to DOE operations, because of their distance from any DOE installations.

There may be a problem with other contaminants in the north-bound runoff. Since this runoff is not routinely monitored as part of any ongoing SSFL/Area IV surface water monitoring program, undetected release of contaminants may be occuring. Inadequate characterization of surface-water runoffs prevents SSFL from identifying potential problems (refer to Finding 3.3.4.4.1). For example, asbestos data in Table 3-15 show highest measurements in two locations that drain northward from SSFL. Sample RD-4 from the area behind Building 163 contained the single highest mass concentration of asbestos at 4,546 mg/l. Structure counts were read at 225 million structures per liter, of which 165 million were chrysotile fibers (EMSI, 1987). California had proposed a "significant risk level" for ingesting asbestos from drinking water of 140 million fibers per day, so the RD-4 runoff fiber content was at 118 percent of the proposed level. However, it is extremely unlikely that any of the asbestos in the runoff toward Meier Canyon could ever affect water supplies in the Simi Valley.

Even though SSFL uses bottled water as its sole potable water source, the freshwater distribution system is routinely analyzed for radioactivity and bacteriological parameters. Samples for radioactivity measurements are collected monthly from two widely separated sources on-site. In 1986, the average gross alpha measurement was 6.55 ± 9.09 pCi/l and the corresponding average gross beta measurement was 3.58 ± 0.95 pCi/l for the 24 samples. Individual supply wells are also analyzed twice a year. For the three most used wells, the following average values were reported for 1986 and 1987:

Well	Year	Activity in pCi/l	
		Gross Alpha	Gross Beta
WS-5	1986	11.34 ± 1.84	4.53 ± 0.38
WS-5	1987	4.06 ± 3.50	3.96 ± 0.63
WS-12	1986	7.79 ± 0.25	4.93 ± 0.07
WS-12	1987	12.97 ± 5.19	3.70 ± 1.21
WS-13	1986	9.72 ± 0	4.34 ± 0
WS-13	1987	3.99 ± 2.08	4.01 ± 0.32

All average measurements were below the recommended levels for drinking water, although an occasional individual gross alpha reading exceeds the 15 pCi/l recommended level for drinking water. The bacteriological analyses are uniformly reported at coliform counts of <2.2 MPN total coliform per 100 ml of sample, a count common to all 99 samples taken in 1987. Samples were collected twice monthly from two storage tanks (central storage and the westernmost tank) and from Well WS-13, whereas Wells WS-5 and WS-12 were sampled monthly. Other locations in scattered buildings were sampled once a year. From all available data, the freshwater system's quality with respect to radioactivity and bacteriological considerations is uniformly acceptable. Data on non-radioactive chemical parameters is not routinely collected, since the system does not serve as a drinking water supply.

Sediment sampling programs for radioactivity are conducted monthly for selected locations, including several which could be affected by DOE activities. These locations include mud from the bottom of the R-2A Pond and from sediments deposited in the drainage ditch leading to Bell Canyon. Data for 1985 and 1986 are presented in Table 3-16. Water samples covering the same periods are also presented for comparison. In 1986 beta activity in sediments and water for both locations was slightly higher by 3 to 7 percent. Alpha activities presented a different pattern. Both locations showed a 20-30 percent decline from 1985 to 1986 in sediment activity, but a 35-50 percent gain in water activity. All measurements indicated relatively low levels of gross radioactivity well below the drinking water criteria for radioactivity, with no serious deposition of activity in on-site or off-site sediments.

Very little data on nonradioactive parameters exists for on- or off-site locations, possibly because all data on radioactivity indicate minimal likelihood of problems with off-site migration of contaminants from SSFL and/or DOE operations. Monitoring requirements imposed by the site's NPDES permit and Proposition 65 appear to be the full extent of surface water measurements at the site. Other sampling appears to be related to special events, such as spills, leaks or the need to characterize new test solutions.

3.3.4 Findings and Observations

3.3.4.1 Category I

None.

TABLE 3-16

RADIOACTIVITY IN SELECTED SEDIMENT SAMPLES
SSFL - VENTURA COUNTY, CALIFORNIA

Location	Activity	Unit	Gross Radioactivity Measurement	
			1985	1986
Pond R-2A:				
Sediment	Alpha	pCi/g	31.4 ± 6.0	24.9 ± 1.9
	Beta	pCi/g	24.0 ± 1.1	24.8 ± 0.5
Water	Alpha	pCi/l	3.07 ± 1.94	4.18 ± 2.70
	Beta	pCi/l	3.59 ± 0.76	3.58 ± 1.14
Bell Canyon Drainage Ditch:				
Sediment	Alpha	pCi/g	21.9 ± 6.5	15.4 ± 4.4
	Beta	pCi/g	22.7 ± 1.1	24.2 ± 1.2
Water	Alpha	pCi/l	1.38 ± 7.09	2.02 ± 2.08
	Beta	pCi/l	2.49 ± 0.75	2.60 ± 0.52

Source: Moore, 1986a and 1987.

3.3.4.2 Category II

1. B-886 Sodium Disposal Facility Runoff. There is a potential for the release of contaminated runoff from the B-886 Sodium Disposal Facility due to inadequate control of stormwater run-on and runoff. Soils within the burn pit areas of the facility are contaminated with chlorinated organics, heavy metals, and low levels of radioactivity, principally cesium-137. Although the limited amount of testing of runoff has not indicated that elevated levels of contaminants are migrating downslope, the existing diversion structure may allow stormwater from areas upslope from B-886 to enter and leave the area. Sampling done in compliance with Proposition 65 at points downslope from the B-886 area indicated that there was some transport of arsenic, chromium, and lead, albeit at low concentrations (between 0.14 and 0.34 mg/l). Refer to Findings 3.2.4.3 and 4.3.2.3 for additional information regarding this problem.

3.3.4.3 Category II

None.

3.3.4.4 Category V

1. Surface Water Monitoring Program. The current SSFL Area IV surface water monitoring program does not include any periodic sampling (e.g., during rainfall events) of runoff leaving the site and entering Meier or Runkle Canyons to the north of Area IV. This could result in undetected releases of contaminants off-site. For example, the single attempt to collect runoff during the Proposition 65 sampling and analysis program did indicate that asbestos contamination in surface water runoff from location RD-4 (the area behind Building 163, the Box Shop) was as high as 225 million structures per liter, of which 165 million were chrysotile fibers. The State of California had listed a "significant risk level" for such fibers as 140 million per day when ingested as potable water. While it is unlikely that the present release could affect water supplies in the Simi Valley downslope of SSFL, the fact that the release was occurring undetected until Proposition 65 required SSFL to consider runoff sampling raises questions about the adequacy of the monitoring program.

4.3 Radiation

4.3.1 Background Environmental Information

The potential sources of radiation at the SSFL Site can be described by assessing individual media (i.e., air, soils, surface waters, and hydrogeology). Each of these primary pathways is responsible for radionuclide transport and potential contamination of ambient air, soils, drinking water, groundwater, vegetation, and food.

Ambient radiation in the vicinity of SSFL is a consequence of both natural and man-made sources. These sources include cosmic radiation, natural radioactive materials in the soils and building materials, fallout from past atmospheric weapons detonations, and releases of radioactive materials from nuclear power plants and other facilities handling radioactive materials worldwide. These releases can result in public dose from the intake of or exposure to radioactive materials in air, drinking water, and food. The most significant of these exposures is that to the lungs from background levels of radon. The annual average effective dose equivalent for natural background in the United States is approximately 189 millirem/year (mrem/year) (United Nations, 1982). This dose is detailed in Table 4-7. About one-half of the dose equivalent is attributable to the inhalation of radon-222 and its decay products. Previously accepted estimates of background doses did not include the radon contribution and were at levels of about 100 mrem/year.

The data in Table 4-7 were derived in accordance with the approach recommended by the International Commission for Radiation Protection (ICRP) in ICRP Reports 26 and 30. This approach allows direct comparison of the effective dose for various organs by reflecting the distribution of and organ sensitivity to various radionuclides. This is accomplished by applying "weighting factors" to the doses received by individual organs. The weighting factors are expressed as the fraction of the total risk for the entire body attributable to the organ. The sum of the dose equivalent for the individual organs provides an estimate of the total effect of the radiation on the whole body.

The EPA reports gamma radiation exposure rates on a quarterly basis for select locations throughout the United States in Environmental Radiation Data (EPA, 1987). Although a considerable distance from the site, measured exposure rates equivalent to an annual dose of approximately 65 mrem ± 7 mrem were reported for the Berkeley, California, monitoring location during the reporting period of April through June, 1987.

TABLE 4-7

U.S. AVERAGE ANNUAL EFFECTIVE DOSE EQUVALENT TO HUMANS FROM NATURAL BACKGROUND RADIATION

Organ	Annual Effective Dose Equivalent (mrem)
Gonads	24
Breast	14
Lung (Total)	100
Red Bone Marrow	13
Bone Surfaces	6
Thyroid	3
Other	29
TOTAL(1)	189

Source: United Nations, 1982.

(1) Total represents the major product of the appropriate weighting factor times the annual dose equivalent for pulmonary, tracheal/bronchial, and mean doses.

As required by DOE Order 5484.1, Chapter III, 4d2d1-3, SSFL conducts an annual "assessment and reporting of potential dose to the public." In 1985, DOE adopted an interim radiation protection standard for environmental activities to be implemented in calendar year 1985 (Vaughan, 1985). It is DOE policy to follow the guidance of the National Council on Radiation Protection and Measurements (NCRP) to the extent practicable with respect to radiation protection standards. A comprehensive revision of previous NCRP recommendations on a basic radiation protection is still under development. However, current NCRP guidance is available regarding protection of the public in its September 18, 1984, advice to the Environmental Protection Agency published under the title "Control of Air Emissions of Radionuclides." In this document, the NCRP endorses the recommendation of the International Commission on Radiological Protection (ICRP) to limit the continuous exposure to any member of the public from other than medical sources and natural background to 100 mrem per year whole-body dose-equivalent. The previously recommended limit of 500 mrem per year is retained for noncontinuous exposures. This recommendation is now adopted as an interim standard for DOE environmental activities for the sum of all exposure pathways.

Radiation exposures are received from external sources and from radionuclides taken into the body by inhalation of air and ingestion of water and foodstuffs. Radionuclides taken into the body will continuously irradiate the body until they are removed through either radioactive decay or metabolic processes. Consequently, internal dose estimates are calculated as "50 year dose commitments." These are obtained by integrating the total dose received by an individual's body over an assumed remaining lifetime of 50 years. The doses to the various major organs are considered for various exposure pathways. The radiation doses received by a specific organ are weighted and summed to determine the total dose.

4.3.2 General Description of Pollution Sources and Controls

During the 1950s and 1960s, SSFL conducted research and development on many nuclear reactor projects. These projects include the Sodium Reactor Experiment (1957–1964), the Space Nuclear Auxiliary Power (SNAP) reactor, and critical experiments (1957–1973). Some of these programs or portions thereof were licensed under Nuclear Regulatory Commission (NRC) and predecessor agencies, while others were under the auspices of the Department of Energy (DOE) and its predecessor agencies. As funding for various programs decreased, SSFL began a program of radioactive Decontamination and Decommissioning (D&D) of select operations under the Surplus Facilities Management Program (SFMP). Criteria for Environmental Analyses of at least seven of these facilities are outlined in Berger, et al., 1979. The current D&D status of former nuclear operations at SSFL is shown in Table 4-8. Source documents for listed D&D activities were numerous

TABLE 4-8

CURRENT DECONTAMINATION AND DECOMMISSIONING (D&D)
STATUS OF FORMER NUCLEAR OPERATIONS
SSFL – VENTURA COUNTY, CALIFORNIA

Building No	Facility	Approximate Years of Operation(1)	D&D Status	Nuclear Regulatory Commission (NRC) Status
003	Hot Cave	1954-1973	Building dismantled - non salvaged equipment sent to Beatty, Nevada (DRIDA, 1976). Released for unrestricted use (Lanni, 1984)	N.A.
005	Uranium Carbide pilot fuel fabrication	1966-1967	Rooms 110 and 113, exhaust ducts and filter plenums need to be decontaminated (Chapman, 1987)	N.A.
009	Sodium graphite reactor (SGR) organic moderated reactor (OMR)	1959-1969 1959-1969	Conditionally released to unrestricted use (Owens, undated)	N.A.
010	Systems for nuclear auxilliary power • SNAP 8ER • SNAP 2SER	 1962-1963 1959-1960	Facility razed and shipped to Beatty, Nevada (Stelle, 1979)	N.A.
012	SNAP critical	1962-1973	Areas in the concrete building will require monitoring during D&D (Begley, 1985)	N.A.
024	SNAP Environmental Test Facility (SETF) S2DR, S10FS-3, SCA-4B, Snaptran 1	1960-1971	Released to conditional unrestricted use (Speights, 1978)	N.A.
028	Shield Test Irradiation Reactor (STIR)	1961-1973	"The facilities were decontaminated to levels which were as low as practicable, but in all cases to levels below the limits described as acceptable for future unrestricted use" (DRIDA, 1976)	N.A.
055	Nuclear Materials Development Facility (NMDF)	1965-1979	Meets requirements for unrestricted use (Chapman, 1986) and criteria in Dismantling Plan	Released and Removed from SNM-21 license (Rouse, 1987)
059	SNAP 8DR	1962-1969	D&D not complete. Pipe chase remediation project is under way (Meyer, 1988)	N.A.

TABLE 4-8
CURRENT DECONTAMINATION AND DECOMMISSIONIING (D&D)
STATUS OF FORMER NUCLEAR OPERATIONS
SSFL – VENTURA COUNTY, CALIFORNIA
PAGE TWO

Building No.	Facility	Approximate Years of Operation(1)	D&D Status	Nuclear Regulatory Commission NRC Status
073	Kinetics experiment water boiler (KEWB) also includes Buildings 643,123 and 793	1956-1966	All structures and foundations razed except for the floor and foundation of Building 73 (Ureda, 1976).	N.A.
093	AE-6/L-85 Reactor also includes Building 83, 74 and 453	1956-1980	Meets criteria for release of facilities for unrestricted use (Begley, 1986) and in Dismantling Plan	Released and R-118 license terminated (Wenslawski, 1987)
100	Advanced epithermal thorium reactor (AETR) fast critical experimental laboratory (FCEL)	1960-1972	Meets criteria in dismantling plan (Remley, 1980).	CX-17 License terminated (Reid, 1980)
143	Sodium reactor experiment (SRE) includes Buildings 41, 724, 686, 163, 695, 723, 753, 453, 653, 654, 773 (drainage control)	1957-1964	D&D 1974-1983 released for unrestricted use (Lanni, 1984 and Baublitz, 1983).	N.A.
373	SNAP critical assembly (unshielded)	1957	No D&D documents available.(2)	N.A.

Source: DOE Survey team.

(1) Dates provided by Dr. Marlin Remley
(2) Survey Report on Building 373 in preparation as part of overall DOE Site Survey

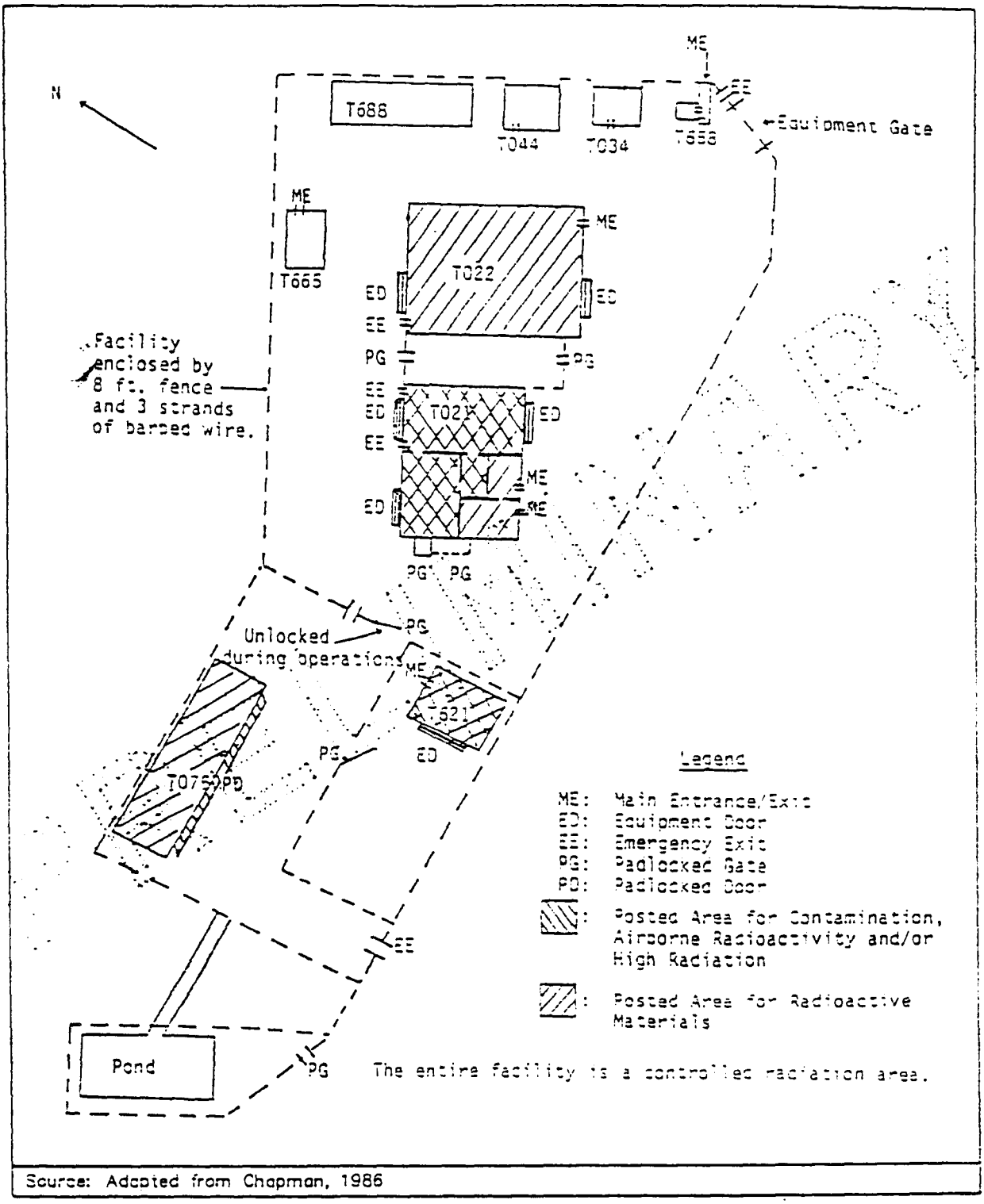
and spanned many years. Principal radioactive contaminants of concern over the entire period of operation at SSFL have primarily been mixed fission products.

In addition to the SFMP D&D activities, SSFL proposed a radiological survey plan and is now conducting these surveys for the purpose of determining "if radioactive contamination exists to such an extent that further surveying or decontamination is warranted...." (Badger and Tuttle, 1985) for facilities outside the SFMP decommissioning program. This program will help to further characterize or identify additional radioactive sources.

The two major sources of SSFL radioactive material use are the Hot Lab (Building 020) and the Radioactive Materials Disposal Facility (RMDF). The first is a facility that is designed for fuel decladding and other activities requiring hot cell facilities. It is licensed under Special Nuclear Materials License SNM-21 issued by the NRC (Page, 1984). Spent DOE-owned fuel elements have been decladded for further reprocessing at other facilities; however, no such activities were being conducted during the on-site survey. A diagram (Figure 3-3) and discussion of airborne radionuclide emission control equipment is provided in Section 3.1.1. Process liquid effluents are piped to a hold-up tank, which is analyzed and processed at the RMDF for ultimate disposal.

The principal source of potential radiation dose to the public from SSFL activities is the RMDF. The term "Disposal" in the RMDF name is rather misleading, since only decontamination and packaging for ultimate disposal take place at this facility. The RMDF consists of the following areas (see Figure 4-1):

- Building T021, Radioactive Waste Processing and Packaging, and Equipment Decontamination.
- Building T022, Radioactive Material Storage Vault.
- Building T034, Administrative and Engineering Offices.
- Building T044, Health Physics Services.
- Building T075, Packaged Radioactive Waste Ready for Transport Off-Site.
- Building T621, Radioactive Source Storage.
- Building T665, Emergency Supplies Storage.
- Building T688, open, covered building for temporary storage of chemicals and equipment.
- Building T658, hardened security post at the main gate.
- RMDF drainage pond.



Source: Adapted from Chapman, 1986

FIGURE 4–1

SECURITY AND RADIATION AREA ACCESS PROVISIONS
SSFL–VENTURA COUNTY, CALIFORNIA

Airborne effluent controls for the RMDF are shown in Figure 3-2 and discussed in Section 3.1.2. Airborne dose assessments of this facility may be imprecise, as described in Finding 4.3.4.4.3, because of AIRDOS computer modeling difficulties. Process liquid effluents from the RMDF itself as well as from other on-site radioactive liquid effluents are concentrated in the evaporator located in Building 021 and then packaged for off-site disposal.

Building T-075 is the principal direct radiation source of environmental concern. Radioactive waste materials that have been packaged for off-site shipment are stored here, frequently in concentrated form. Despite added shielding, this building continues to be of concern from the standpoint of potential public exposure to direct radiation (see Finding 4.3.4.4.1).

4.3.3 Environmental Monitoring Program

Environmental monitoring for the purpose of determining site-related increases in environmental radioactivity is conducted for various media, including air, water, and soil. Airborne radioactivity is monitored in process stack effluents at the RMDF and the Hot Lab. Ambient air is also monitored for radioactivity, as described in Section 3.1.3. Surface water at SSFL is only monitored following rainfall, as there are no continuously flowing discharges as described in Section 3.3.3. As already discussed in Section 3.2, soil monitoring has been conducted at SSFL since 1954. Representative monitoring data have already been presented in these sections and will not be repeated here.

Airborne particulate emissions from the RMDF are well controlled, as described in Section 3.1. Particulate emissions from the RMDF are shown in Table 3-7 for the period 1981 to 1987. Dose to the general population is extremely low, as evidenced from the calculated total dose to the receptor population living within 80 km. In recent years this dose has ranged from a low of 0.0029 person-rem in 1982 to a high of 0.017 person-rem in 1985. The majority of emissions of airborne particulates occurs from the 130-foot stack located between Buildings 021 and 022 (see Figure 4-1).

Environmental soil, water, and ambient air samples are counted for alpha and beta radiation with a low-background, gas-flow, proportional counting system. The system is capable of simultaneously counting both alpha and beta radiation. Because the observed radioactivity in environmental samples primarily results from natural sources and is at low concentrations, constituent radionuclides are not identified for each sample. Dose calculations are performed conservatively, assuming that all alpha activity is plutonium-239 and all beta activity is strontium-90. Collected samples are also composited for gamma spectrometry of accumulated sample materials. The detection of significant levels of radioactivity would lead to an investigation of the radioactive material involved, the sources, and the possible causes (Moore, 1988).

In addition to the significant quantities of transient direct radiation from materials being processed in Buildings 021 and 022, wastes packaged for transport off-site and stored in Building 075 are also a source of direct radiation. Sealed sources (well-shielded) are stored in Building 621, and temporary storage of larger moderate concentration material occurs in the fenced areas nearby B-075 and B-621. Numerous devices are in use to provide continuous monitoring of direct radiation from these sources.

SSFL uses Victoreen, manganese-activated, calcium fluoride, glass-bulb, thermoluminescent dosimeters (TLD) for measuring direct radiation. As discussed in the previous section and in Finding 4.3.4.4.1, direct radiation measurements at the property boundary north of the RMDF are greatly influenced by quantities of packaged waste materials stored in Building T075. Additionally, the perimeter radiation monitoring program has deficiencies, as discussed in Finding 4.3.4.4.2.

4.3.4 Findings and Observations

4.3.4.1 Category I

None.

4.3.4.2 Category II

None.

4.3.4.3 Category III

None.

4.3.4.4 Category IV

1. North Boundary Penetrating Radiation Doses. Although many improvements have been made to reduce radiation exposure rates, because of changing operations involving radioactive materials handling at the RMDF, these exposure rates may exceed the DOE guideline of 100 mrem/year for continuous exposure from all pathways at the property boundary north of the RMDF. This guideline is intended to prevent members of the public from unknowingly receiving excessive exposure as a result of DOE operations. However, long-

term exposure to a member of the public is unlikely due to the rugged terrain along the north boundary and daily security patrols.

2. Penetrating Radiation Monitoring Program. The perimeter penetrating radiation monitoring program is deficient because formally approved and updated procedures are not available. Specific areas of concern include the following:

   a. Environmental TLD (Victoreen, glass-bulb type) handling procedures do not correspond to existing written procedures. For example, the calibration source currently used is not the one described in the written procedure, and the annealing furnace referenced in the procedure is no longer used.

   b. Calculations, assumptions, and other supporting data used to determine boundary dose and dose to the nearest resident are not formally documented. For example, source term, inverse square, and air attenuation calculations to determine the boundary dose are not presented in the environmental monitoring report or summarized in a report outlining these assumptions. Written integration of the site's Landauer (film badge) dosimetry program (for the purpose of measuring perimeter radiation), including QA requirements, has not taken place.

3. AIRDOS Calculations. AIRDOS modeled population exposure and estimated dose information may be imprecise because of computer code difficulties. Specifically, the AIRDOS-version SSFL used at the time of the Survey would not run multiple source terms for all 80 km sectors and would not accept multiple dose conversion factors. Because of these deficiencies, site personnel must run the code repeatedly for various nuclides and sum the calculated doses external to the computer code. The Survey team believes site personnel are currently taking a conservative approach in favor of public safety, and doses are well below guidelines. However, multiple calculations external to the computer code increase the potential for errors in final calculated dose estimates (see Finding 3.1.4.4.1).

4.4.1 General Description of Data-Handling Procedures

Three analytical chemistry laboratories at SSFL perform analyses of environmental samples from the DOE programs: the Rocketdyne Chemistry Laboratory in Building 300, the Radiation Measurements Laboratory in Building 100, and the Chemistry and Metallurgical Laboratory in Building 065. In addition, off-site laboratories are used extensively for the overflow environmental samples and some special projects such as the Proposition 65 sampling and analysis program conducted in 1987 by Environmental Monitoring & Services, Inc., a subsidiary of Combustion Engineering.

Outside laboratories are required to have adequate QA/QC programs. Water samples for chemical analyses are sent only to those laboratories which are approved by the State of California and are required to maintain adequate QA/QC programs.

Radiological Monitoring

The Radiological Environmental Monitoring Program is the responsibility of the Radiation and Nuclear Safety Group of the Health, Safety, and Environment Department. The purpose of the program is to evaluate the effectiveness of the safety procedures and of the engineering safeguards included into facility designs, to ensure that SSFL operations do not increase radiation levels in any significant amount. This monitoring program is conducted by the Radiological Measurements Laboratory with a staff of two experienced analysts.

The laboratory monitors radioactivity levels in on-site and off-site samples of ambient air, surface soil, surface water, groundwater, and ambient radiation levels. The details concerning the specific sampling location, sampling frequency, and type of analyses performed are presented in Sections 3.1.3, 3.2.3, 3.3.3, 3.4.3, and 4.3.3.

A written quality assurance procedure for the radiological measurements program is available at SSFL (Moore, 1984). This Rockwell International Department includes a laboratory quality control program that is intended to help ensure the accuracy and precision of the results generated in the laboratory and to continuously monitor the quality of laboratory data. The essential elements for analytical quality control are presented as follows:

- Use of high-quality reagents
- Low-level radiation in laboratory air supply

- Controls to minimize laboratory contamination
- Use of reagent and sample blanks
- Use of control charts
- Use of standard reference materials
- Use of blind replicates
- Use of spiked samples
- Participation in laboratory intercomparison programs
- Use of calibration standards

In general, the laboratory utilizes these quality control techniques with one exception: spiked field samples were not being used at the time of the Survey (see Finding 4.1.2.4.1).

Spiked samples provide a measure of the accuracy of the analytical measurements and are an important aspect of a laboratory's quality assurance program. Although the laboratory participates in the DOE interlaboratory comparison program, a more frequent measure of the analytical accuracy is required than once every 6 months. Also, spiked samples provide information concerning any specific sample matrix effects on the analytical results. However, the laboratory is generating good quality data, as is demonstrated by the results of the semiannual DOE Environmental Measurement Laboratory Program and the biennial DOE Radiation Dosimetry Intercomparison Project.

Another shortcoming of the quality control program is the lack of procedures for confirming the analyst's calculations and entry of the results into the computer data base. This deficiency could result in errors becoming a permanent part of the data base and thereby decrease its reliability (see Finding 4.1.2.4.1).

The Rocketdyne Analytical Chemistry Laboratory

The Rocketdyne Analytical Chemistry Laboratory is certified by the State of California for the analysis of NPDES and hazardous waste samples. Most of the workload consists of environmental samples (75 percent), and the remaining analyses (25 percent) are in support of the test stands and engineering operations.

The laboratory has established an extensive quality assurance/quality control program based on the EPA guidelines (EPA Quality Assurance Management Staff Guidelines, QAMS Document, December 20, 1980, and the Handbook for Analytical Quality Control in Water and Wastewater Laboratories) that is designed to produce results that are scientifically valid, defensible, and of documented precision and accuracy.

The laboratory uses one-on-one, and on-the-job training for new personnel or new procedures. The manufacturer's manuals are relied on for instrument operating procedures.

This laboratory is part of an engineering group in the Materials Engineering and Technology Organization, which operates within the Engineering and Test Department of Rocketdyne.

The main elements of the quality control program include the use of internal standards, external standards, working standards, spiked samples, duplicate samples, appropriate blanks, use of quality control charts, and participation in the EPA laboratory assessment program. The quality control samples make up 10–20 percent of the samples analyzed by the laboratory. These samples are tracked by a computer, which flags any unacceptable results. Such results are evaluated to determine their cause, and appropriate corrective action is taken.

The laboratory's operation procedures are described in the Rocketdyne publication (MPR 82-0229), "Water Analysis Laboratory Operation and Procedures Manual." This document contains information on certification, quality assurance outline, laboratory organization, personnel qualifications, personnel responsibilities, records, sampling procedures, instruments and methods, statistical control, education, NPDES permit, and legal aspects.

The laboratory has written analytical procedures for each analyte measured. These procedures are consistent with EPA protocols, are reviewed frequently, and are revised as required. Written procedures were also available that describe sampling, sample containers, holding times, and storage. Chain-of-custody procedures are followed for all NPDES samples, and these samples are kept in a locked refrigerator prior to analysis.

The Chemical and Metallurgical Laboratory

The Chemical and Metallurgical Laboratory serves a very limited function for environmental analysis. The analysis of materials for asbestos is the only environmental monitoring function of interest to the Survey team. Materials are analyzed for friable asbestos by low-and high-power optical microscopy.

An inspection of the three laboratories demonstrated that they are equipped with state-of-the-art instruments and equipment for the monitoring function required of each. The laboratories were clean and well organized. Discussions with individual analysts indicated the appropriate expertise required for the analyses assigned to each of them. The laboratory staff maintains appropriate

sample logs, and analytical notebooks, as well as calibration and instrument maintenance records. The maintenance of the analytical balances and the infrared spectrophotometer is managed through service contracts. All standards and limited-life reagents are dated when received.

4.4.2 Findings and Observations

4.4.2.1 Category I

None.

4.4.2.2 Category II

None.

4.4.2.3 Category III

None.

4.4.2.4 Category IV

1. Deficiencies in QA Procedures for Radiological Monitoring. Environmental monitoring data may be less defensible as a result of the following quality assurance deficiencies observed at the Radiological Measurements Laboratory at the SSFL Site:

   a. Lack of formalized procedures for confirming the analyst's calculations and entry of results into the computer data base.

   b. No use of spiked samples on a routine basis for internal quality control (although the laboratory participates in the external test program of DOE/EML).

Appendix B-1

Dempsey Review Report

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
215 Fremont Street
San Francisco, Ca. 94105

Mr. Steve Lafflam
Environmental Manager
Rockwell-Rocketdyne Inc.
6633 Canoga Ave.
Canoga Park, CA 91303

Dear Mr. Lafflam

Enclosed is a memorandum from Gregg D. Dempsey, EPA Office of Radiation Programs-Las Vegas Facility) to Daniel Shane, On-Scene Coordinator, Emergency Response Unit, Region 9. This memorandum contains preliminary findings of Mr. Demsey based on his site visit to Santa Susana Field Laboratory on July 12, 1989.

I would appreciate your review of and response to Mr. Dempsey's preliminary findings. Please forward your comments to Carmen Santos of my staff by September 10th. After reviewing your response we will finalize our findings and recommendations. Thank you for your cooperation.

Sincerely,

Rich Vaille, P.E.
Assistant Director (for Waste Programs)
Hazardous Waste Management Division
EPA Region 9

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION PROGRAMS-LAS VEGAS FACILITY
P.O BOX 98517
LAS VEGAS NEVADA 89193-8517
(702-798-2476 - FTS 545-2476)

JUL 28 1989

MEMORANDUM

SUBJECT: Site Visit to Santa Susana Field Laboratory Operated by Rockwell/Rocketdyne

FROM: Richard D. Hoffer for Gregg D. Dempsey, Chief
Field Studies Branch, ORP

TO: Daniel M. Shane, On-Scene Coordinator,
Emergency Response Unit

On July 5, 1989, I reviewed documentation that your office had assembled on the Rockwell/Rocketdyne Santa Susana Field Laboratory (SSFL) located near Canoga Park, California. The purpose of my consultation to your office was to help assess the relative magnitude of health hazards, health risks, past, present, and future environmental problems and how Superfund, through your office, might address those concerns.

In the two and a half days I spent in your office reviewing that documentation, I studied previous Rocketdyne Environmental Reports, contractor reports on wells and DOE site reviews. As I communicated to you during my exit interview, it was my opinion that I could not come to a conclusion about conditions relating to the site without a visit which would include; discussions with Rocketdyne's laboratory personnel, my personally making measurements on the various sites identified, and possibly collecting environmental samples for radiation analysis. You arranged for your technical assistance team (T.A.T.) contractor, Ecology and Environment, Inc., to prepare a site safety plan and outline of measurements and sampling protocol with my input according to your internal procedures. Arrangements were made at that time and in the following days for a site visit. I also made assurances to the Ecology and Environment Corporate Health Physicist, Jackie Gillings, that I would provide dosimetry and exit personnel surveys for T.A.T. personnel working at my direction on the SSFL site.

On July 12, 1989, I met with you at SSFL for the purpose of reviewing site and laboratory operations. I spent the afternoon of the 12th reviewing the environmental monitoring laboratory procedures and protocols. On July 13, I personally visited the locations at the SSFL that there were questions about, performed an environmental survey with hand-held radiation survey equipment and directed your T.A.T. contractor to collect environmental samples in areas where I felt they were warranted. Explaining and communicating my concerns and the physics of and analytical processes for environmental radioactivity are difficult to do in a short memorandum. It may be appropriate for me to visit you in the near future to answer any questions you may have about this or my future evaluation of the analytical data.

Rocketdyne has had an environmental monitoring program for over 20 years at this site. Many facilities of this type have not had an environmental program until forced by some legislation or other need. The personnel whom I questioned regarding the laboratory were most cooperative. The Manager of Radiation and Nuclear Safety, Robert Tuttle, and the Manager of the Radiological Laboratory, John Moore, were extremely open and helpful during my review of their laboratory.

During my review, I questioned Mr. Moore and Mr. Tuttle extensively concerning their procedures and protocols relating to laboratory equipment and sampling procedures. Laboratory equipment that has been provided to this laboratory is state-of-the-art and seems to be in good working order.

However, certain problems exist within this laboratory that make me question the validity of some, if not all, of their environmental data. This laboratory apparently has never had a thorough review or audit by Rocketdyne or DOE. These reviews are conducted to assess the direction of the environmental program, identify problems in procedures and protocols, and make recommendations for improvement. Both Mr. Tuttle and Mr. Moore admitted that such reviews had not been conducted. It is a common practice among good laboratories to conduct peer reviews. Such a review should have revealed many of the problems I will describe below. DOE apparently conducted a limited audit in February 1989, but the report has not been finalized.

Much of the environmental sampling consists of sampling soil on site and counting it to determine radioactivity. SSFL lab personnel analyze soil for gross alpha and beta radioactivity. This is not a good method for assessing environmental radioactivity. In the Rocketdyne procedure, soils are heated in a muffle furnace for 8 hours at 500°C. Several problems were identified: first, this temperature is sufficient to volatilize most man-made radionuclides of concern, including cesium-137 and strontium-90. Second, from the Rocketdyne procedure, soil is sieved through a Coors crucible to obtain uniform particle size.

Mr. Moore told me that approximately 10% of the soil will not pass through the crucible, mainly due to the fact that the sand, clay or pebble size is too large. It is common practice that if one wishes to obtain a uniform particle size, soil is ground in a machine designed for this purpose. Two grams of soil are used in a planchet for counting. Because of absorption of the alpha and beta radioactivity within the soil, the procedure has highly variable results. The procedure attempts to make a correction for this but it is not adequate. The environmental report states that samples are to be counted in a stainless steel planchet, but the current SSFL procedure (Rockwell Document Number N001DWP000008, dated July 9, 1984) states that a copper planchet is called for. This also makes a difference in counting and calibration. I asked Mr. Tuttle and Mr. Moore for the basis of the 500 degrees and was shown an EPA procedure that is used to prepare a sample for an analysis for americium-241 by alpha spectroscopy, an entirely different procedure. I asked for documentation or references on the validity of the procedure used by SSFL. I was told by Mr. Moore that this procedure was worked out a long time ago and he did not know where that documentation might be or if it existed. He also stated that while the SSFL does participate in DOE/EML quality assurance rounds, this procedure for soil is not included. Spike samples have apparently never been prepared and run through this procedure to provide internal quality control. I discussed this procedure with Dr. Paul Hahn, an EPA radiochemist who has over 30 years experience in preparing and counting samples for radioactivity, and he verified my conclusions. In short, gross alpha and beta data on soil, even though it has indicated some radiation areas on this site, is not a true representation of conditions present in the environment. This procedure is a screening method at best and is not an accurate quantitative procedure.

Water samples are also collected on the SSFL site. The procedure is to evaporate the water to dryness and count for gross alpha and beta radioactivity. I inspected typical samples and found that alpha and beta self-absorption is, again, likely to be a problem. I asked Mr. Moore for a typical beta counting efficiency for this procedure. Simply, this is a measure of the ability of the counter to detect radiation. Mr. Moore told me that this is typically 2 dpm/cpm (two disintegrations per minute per count per minute) or 50%, I called the manufacturer of this counter and was told that their specifications will only guarantee 45-47% with a massless point source, something a water sample can never be. For similar reasons as stated above, I doubt the validity of these analyses as well.

Vegetation samples were collected until 1986. This was stopped only two years after an internal SSFL review determined that problems existed with alpha and beta counting and changes should be made. I reviewed the procedure for vegetation counting. It is similar to the soil counting in that the vegetation is essentially ashed before counting and only one gram of ash is analyzed. The procedure states: "Gently wash the vegetation in the

container with warm tap water to remove external foreign matter." If past operations at Rocketdyne had produced airborne contamination and it settled on the surface of the vegetation instead of being absorbed through the roots, it is washed off before counting. Or it may be volatilized during ashing at 500°C. Even so, I do not think the reasons were good enough to stop vegetation sampling.

Part of a good environmental program involves checking other pathways to man through which radionuclides might travel. One of these is through meat samples obtained from feral species. I realize that hunting is probably not permitted in the area around SSFL, but I saw abundant evidence of deer (bedding spots, hoofprints) and squirrel (directly). These animals are not sampled. A permit to collect these species should be obtained or SSFL should occasionally examine a road kill. This is not being done.

Air samples are collected at SSFL and are examined. I did not see the procedure for gross alpha and beta counting, but I think it is adequate to measure what it is supposed to from what I saw in the lab. Air flow calibrations on air samplers are necessary to complete a good program. I did not review these procedures.

Environmental samples are analyzed quarterly for gamma radioactivity. I examined the procedure to calibrate this counter and found that an acceptable, well-documented procedure is used. As an example of this counting, I was given a printout of an air filter composite that was counting and had finished while I was in the lab. I asked how the bag of filters was counted and was told that basically the bag was draped over the detector and counted. Later, upon examination of the printout and SSFL procedures, I found that the counting time of 10,000 seconds violated the SSFL stated procedure time of "at least 36,000 seconds". I also found that the procedure stated that the sample be counted in a Marinelli beaker instead of loose in a bag. Statistically, one could defend the technique and counting time which I was shown, but it violates SSFL written procedure. One or the other should be changed. The SSFL lab participates in a quality assurance program and provides acceptable data for the media tested by gamma spectroscopy.

The lab also provides environmental thermoluminescent dosimetry for the facility and offsite areas. Certain questionable practices are alluded to in the environmental report. The first is that data obtained by dosimeters is normalized to a 1000-foot altitude, by using an adjustment factor equal to 15 mR/1000 ft. elevation difference to obtain site averages. I talked to two nationally recognized dosimeter experts and neither had heard of this practice. This 15 mR/1000 ft. is undocumented by reference in the environmental reports. Both experts I spoke to felt that this normalization is meaningless. Also, in both the calendar year 1987 and the unpublished calendar year 1988 SSFL environmental reports, comparisons for the dosimeters placed by the State of California and a DOE intercomparison project were "not available"

for inclusion at the time the report was published. Bill Watson of the California Department of Health Services, Environmental Management Branch, assured me that data was available and provided to SSFL. Even if data was unavailable for inclusion in a previous year's report, it should have be added as an addendum for the following year's report. The unpublished 1988 report does not contain information about 1987 omissions. This leads me to think that the SSFL dosimetry program might not compare favorably with the other groups. Systematic error that might be present in dosimetry analyses might make SSFL dosimetry data look comparable to itself but still may make these analyses invalid or suspect. A more thorough review needs to be conducted.

Also on July 12, you, your T.A.T. contractor, a representative of the State of California, Department of Health Services, Charles Myers, and myself met with SSFL staff to determine the course of action regarding visiting contaminated or formerly contaminated locations at SSFL. We reviewed several locations and as a parting question you asked if there were any other locations that SSFL personnel could tell us about that were not in the environmental reports. The location which was shared with us we later learned was near the Special Nuclear Materials Storage Area and had involved a liquid spill in the early 1960's. It was agreed that we would look at that location along with the others.

On July 13, I prepared the T.A.T. contractor and myself to go onto these locations. In accordance with arrangements I made with the Ecology and Environment Corporate Health Physicist, I placed "pocket" or "pencil" type gamma dosimeters on all T.A.T. personnel. I extended that level of protection to both you and myself as well. No dosimeter accrued a measurable exposure during the course of the day although dosimeters worn by Mr. Suter and Mr. Chambers of the T.A.T. did drift off zero in the first two hours after charging. This potential exposure is negligible. I also prepared a Ludlum Model 19 Micro-R Gamma Scintillation Counter, an Eberline E-520 Geiger-Mueller Counter with both HP-260 and HP-270 Gamma Probes and a Ludlum Model 14C Geiger-Mueller Counter with a "pancake" type gamma probe, all recently calibrated. The Ludlum 14C was used to verify that contamination had not been removed from each location. Each person from EPA and the contractor were surveyed with this instrument following exit from each site and none were found to be contaminated. We were escorted through the SSFL site by Randy Ueshiro, at times by Mr. Tuttle, and Gary Lavagnino of the Department of Energy, ESQA Division.

The first site visited was described as the "Old Sodium Burn Pit," an area where radiologically contaminated materials had been dumped at some time in the past. There were "Caution-Radioactive Materials" signs around the perimeter of this pit. At one time, a protective dike or berm around this area had washed away and material from this pit was allowed to move off this site in an uncontrolled fashion. The dikes had been rebuilt and a concrete gutter had been constructed on the upslope side of the pit to

prevent rain or wash water from damaging these pits in the future. Survey instrument readings with the Ludlum Micro-R meter were unremarkable for this area. Background in the immediate area and for most of the SSFL site was about 20 μR/hr (microroentgens per hour). For comparison, in Simi, the background is about 8 μR/hr. This 20 μR/hr background at SSFL is normal for that altitude and site geology. The highest reading I was able to find in walking the site area for over two hours was about 30 μR/hr in the upper pit near a location SSFL personnel had identified. I also walked down the natural drainage channel about a tenth of a mile and around the area and recorded between 16 and 20 μR/hr. Because of the lack of information concerning the spill at this site, soil samples were taken in both pits. These pits had areas which were obviously lowest, that is, where any rainwater that might accumulate in these pits would evaporate last. The sample in the upper pit was collected from mud in this lowest spot. The sample will be analyzed for gamma emitting isotopes and tritium by the contractor lab. Duplicate samples were collected at this site for quality control. In the other pit, a sample was collected to be analyzed for gamma emitting isotopes at a spot where old "cooling tubes" were sticking through the surface. Both locations were marked with red surveyor's flags should additional samples or measurements be needed in the future.

SSFL or Rocketdyne has not collected soil or water samples to be analyzed for tritium, a radioactive isotope of hydrogen. If the materials accidently dumped at this area and others contained tritium, there was no way in their measurement protocol to detect it. SSFL personnel could not assure me that materials dumped did not contain tritium. Tritium, with a 12 year half-life, has gone through about two complete half-lives since this spill and it is rapidly distributed in the environment. This means that if ground or waterborne radionuclides are traveling toward the offsite areas, tritium will migrate the quickest. The samples collected above may verify the absense or presence of tritium.

The second area visited was called the "Leach Field" because it had been used as a sewage leach field at one time. Radioactive materials had been accidently dumped into it. SSFL had initiated a cleanup and it is probable that most of the radioactivity was contained. Gamma radiation in this area showed between 20 and 30 μR/hr with about a 30 μR/hr average. This radiation is due largely or totally to naturally occurring radioactivity in the rock outcroppings in the area. One soil sample to be analyzed for gamma emitting isotopes was collected in this field at a location identified by SSFL personnel as having "high beta readings."

The next location surveyed was Building 059, a location where a reactor had once been housed. Contaminated items had been removed. The site was considered clean, except for some sand in the building itself. Readings were 15-18 μR/hr in the immediate area. There was a pump installed on the French drainage system for this building and SSFL samples it. Two water samples were collected directly from the pump for radioanalysis, one for

cific gamma emitting isotopes and one for tritium.

The "Old Conservation Yard" was surveyed next. This is an area which had recently been cleaned up by SSFL personnel because of "high beta readings." The area was unremarkable at 13 - 15 μR/hr. No samples were collected from this location for radioanalysis.

We then went to the "New Sodium Burn Pit Area." It was also described as having "previously high beta readings" but again was unremarkable at 18 - 20 μR/hr. No samples were collected for radioanalysis.

The last site we visited was the site we had been told about only the day before in the meeting with SSFL officials. It was described as "Building 064, the Special Nuclear Materials Storage Area." An area around this site was in the process of being cleaned up. I spoke to a technician, Mr. Wallace, who was conducting a survey of this area. He showed me an area of 60 μR/hr. I got a shovel and upon digging at this location in about a foot was able to increase the surface reading to 200 μR/hr. Mr. Wallace stated that about 50 pCi/gm of beta radioactivity had been seen at this site. SSFL personnel were unsure of the nature or time of the spill at this location but were confident it was in the early 1960's. Apparently SSFL environmental surveys had identified this site. One soil sample to be analyzed for specific gamma emitting radionuclides was collected at this site. A duplicate was also collected for quality control of the contractor laboratory.

There are several reasons why I did not collect certain environmental samples. Vegetation both on and off site was of interest to me. The majority of grasses in the area were dry and apparently had been that way for some time. I would have sampled typical forage on which deer might browse, but SSFL personnel were unsure about what these might be. Second, it might be necessary once the gamma results are obtained from the contractor to go back and get samples analyzed for Sr-89/90 or actually collect new samples. As you are aware, a contract laboratory for the radioanalyses was selected without a review of their laboratory performance. The Sr-89/90 analysis is extremely difficult and tedious and it will be necessary to verify lab performance before samples are analyzed so worthless data is not generated.

It is also important to comment on the audit that was conducted by the Department of Energy in February 1989. This document is in preliminary form and was supplied to me by your office to assist in my review. DOE made an attempt to review many aspects of the SSFL Environmental Program in this document. I echo their concerns about the well and air sampling at SSFL and offsite. Both of these items, as well as environmental sampling in general, need to be reviewed for adequacy. DOE also identified some problems in the Radiological Laboratory but did not do an extensive review. The lack of a meteorological tower onsite was also mentioned as a concern. SSFL uses the EPA code AIRDOS to define dose to affected offsite areas. However, the tower information used is from the

Burbank Airport. Better AIRDOS information could be generated with a closer-to-site or onsite met tower.

I had mixed feelings about what I saw at SSFL. The staff was most cooperative and were very willing to show us everything we needed to see. They believe they are doing a good job.

The SSFL Radiological Lab needs updating very badly and this should be highly stressed in your report to your superiors. I don't think analyses of the samples collected by our group onsite will show a serious radiological health hazard. I will reserve commenting on those analyses until they are complete. However, the SSFL sampling, placement of sample locations, and analyses cannot guarantee that past actions have not caused offsite impacts. If the environmental program stays uncorrected, SSFL cannot guarantee that unforseen or undetected problems onsite will not impact the offsite environment in the future.

It is also clear to me that Rocketdyne does not have a good "handle" on where radiation has been inadvertently or intentionally dumped onsite. Most of the evidence on site spills is incompletely documented or anecdotal. DOE or Rocketdyne should conduct a complete survey of the site, specifically looking for other spill areas. A good start and a valuable aid for these surveys would be contracting with the EG&G Energy Measurements group in Las Vegas, Nevada for a flyover with their gamma radiation counting equipment. This group is already under contract to DOE/NVO. This survey would rapidly identify potential areas of concern. Site aerial readings are plotted on a site photo in this survey.

I will be in touch with you in the near future to discuss the results of the samples collected at SSFL. If there are any questions about the material above, I will be happy to discuss it with you.

CC: Mike Bandrowski, Region 9
Robert S. Dyer (ANR-461)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION PROGRAMS-LAS VEGAS FACILITY
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NOV 8 1989

MEMORANDUM

SUBJECT: Rocketdyne SSFL Site Sample Analysis Report

FROM: Gregg D. Dempsey, Chief
Field Studies Branch

TO: Rich Vaille, Assistant Director
Toxics and Waste Management Division

Attached are the results and my analysis of those results concerning the samples collected at the Rocketdyne Santa Susana Field Laboratory, July 13, 1989. There are several outstanding issues that should be investigated in the future; those items are discussed in the summary of the report. Acceptance and funding of the proposal we first discussed on September 13, 1989, would add to the information needed by providing EPA follow up.

If you decide to make a formal press announcement concerning this report, I would like to be advised and participate, if possible.

I appreciate the help your staff has given me in preparation of this report.

cc: Carmen Santos, Toxics & Waste Management Division
Daniel M. Shane, Emergency Response Unit
Michael Bandrowski, Region 9
Robert Dyer (ANR-461)

Appendix B-2

Dempsey Results Report

EPA
Office of Radiation Programs
Las Vegas Facility
P.O. Box 98517 Las Vegas, NV 89193-8517 (702) 798-2476 FTS 545-2476

Report on Environmental Samples Collected at the Rocketdyne Santa Susana Field Laboratory July 1989

Gregg Dempsey, Branch Chief
Field Studies Branch
Office of Radiation Programs
Las Vegas Facility
November 8, 1989

I. FOREWORD

On July 12 and 13, 1989, personnel from the U.S. Environmental Protection Agency went to Rockwell International's Santa Susana Field Laboratory, near Simi Hills, CA to review laboratory operations and collect environmental samples. The samples were collected from specific areas onsite where evidence of radiological or hazardous materials contamination had been found.

This report addresses only radiological analyses performed by the contractor used by EPA for this project, Controls for Environmental Pollution, Inc. (CEP). Samples were collected and shipped with EPA direction by the EPA technical assistance team contractor, Ecology and Environment, Inc.

Delays were encountered during EPA review of CEP data because it was discovered that CEP had made an error that reduced the number of radionuclides that were reported. In order to assure validity and quality of data, EPA requested complete spectral, radioisotope library, and minimum detectable activity data on each environmental sample collected. This review process necessitated that CEP provide additional information and served to delay this report.

EPA is satisfied with CEP data quality. Reanalysis of any sample is unwarranted.

The transmittal submitted to Region 9 by Gregg Dempsey of the Office of Radiation Programs - Las Vegas Facility, dated July 28, 1989, should be referenced for further details on the sample locations discussed in this report.

II. ABBREVIATIONS AND TERMS

Several abbreviations and terms are used in describing the analyses:

1. Gamma Isotopic Analysis - This is an analytical technique which uses a device sensitive to penetrating gamma rays called an intrinsic germanium detector. The sample, be it soil or water, is placed in a specially calibrated counting container, called a counting geometry, for analysis. Soil samples are often dried prior to placement in the counting geometry. A specialized computer is used to record a spectrum of gamma energies which is them compared with two calibration factors - one is an energy calibration which determines that a "peak" in the spectrum is a certain energy, and the other factor takes into account the counting geometry and thereby enables the computer to convert a spectrum into a specific analytical result. Results are often expressed in pCi/L (picocuries per liter) or pCi/g (picocuries per gram). The fact that an analysis can be expressed in terms of

a few picocuries per liter or picocuries per gram often means that the sample has only background levels of radioactivity. In this report, only gamma emitting isotopes that were detected are listed. The counting system is capable of detecting and quantifying many isotopes. To aid the analyst if a specific isotope is sought, a table is often generated to show the minimum detectable activity for nuclides not found in the sample.

2. Natural Gamma Emitters - Just about everything - soil, air, water, food, and living things (including people) contain some small amount of radioactivity that is natural or terrestrial in origin. Most environmental samples will contain some natural radioactivity. These are elements like radium, lead, actinium, thallium, and bismuth. In the report, the specific radium isotope found, radium-226, is abbreviated with the notation Ra-226. In a similar fashion, the lead isotopes encountered are lead-212 and 214, they are abbreviated Pb-212 and Pb-214. Actinium is encountered as actinium-228, abbreviated Ac-228. Thallium is found as thallium-228, abbreviated Tl-228, and bismuth is found as bismuth-214, or Bi-214. Perhaps the most widely found isotope is potassium-40, or K-40.

3. Cesium-137 - A gamma ray emitting isotope of cesium, abbreviated Cs-137. Because of atmospheric testing of nuclear weapons and other activities, Cs-137 is typically found in most types of environmental media. Since it has been produced by, and only by, man's activities, the concentration varies quite a bit from place to place.

4. Tritium - This is the common name for a radioactive isotope of hydrogen, abbreviated H-3. It can be produced in the high atmosphere and is commonly found in surface water in small amounts. Typically, well water or other protected water is very low in tritium, so low, in fact, that it is difficult to measure by common analytical techniques. Tritium is also be produced in nuclear reactors.

5. Liquid Scintillation Counting - This is a laboratory technique used to analyze samples with weak beta emitters, like tritium. The sample, after sometimes being purified through azeotropic distillation or simple distillation, is placed in a scintillation vial and a counting "cocktail" is added. As a beta particle strikes a molecule of cocktail, a photon of light proportional to the energy of the beta particle is given off. This process is called scintillation. These scintillations are counted electronically and are converted into activity in pCi/L using specific calibration factors.

6. Azeotropic Distillation - A method to remove water from soil or other media. Typically, a soil or other type sample is boiled in cyclohexane or another low boiling point organic hydrocarbon. As the cyclohexane boils, water is carried in the vapor and condenses in a special container, where it separates from condensed cyclohexane. Simple distillation of the separated water usually follows to remove other organic materials which can interfere with analysis.

III. ENVIRONMENTAL SAMPLE ANALYTICAL RESULTS

Old Sodium Burn Pit

The Old Sodium Burn Pit was an area where radiologically contaminated materials had been dumped at some time in the past. The area was posted with "Caution - Radioactive Materials" signs around the perimeter of the two pits. Walking surveys with a gamma survey instrument indicated what is probably only background levels of radioactivity. The upper pit had moisture in the soil at its lowest spot. One separate sample plus a duplicate was collected in the upper pit to be analyzed for gamma emitting isotopes and for tritium through azeotropic distillation. One sample was collected in the lower pit for gamma isotopic analysis only since this pit was completely dry.
Results of analyses are below:

Upper Pit

Sample Type: Soil
Requested: Gamma Isotopic, Tritium (by Azeotropic Distillation)

Gamma Results:

K-40	9.76 ± 1.68 pCi/g
Pb-212	0.54 ± 0.10
Pb-214	0.19 ± 0.18
Ra-226	0.56 ± 0.19
Ac-228	0.79 ± 0.34
Tl-208	0.81 ± 0.22
Bi-214	0.28 ± 0.10
Cs-137	0.90 ± 0.22

Tritium Results:

H-3	0.59 ± 0.11 pCi/g soil

Duplicate Sample of Upper Pit

Sample Type: Soil
Requested: Gamma Isotopic, Tritium (by Azeotropic Distillation)

Gamma Results:

K-40	10.10 ± 0.76 pCi/g
Pb-212	0.73 ± 0.05
Pb-214	0.40 ± 0.10
Ra-226	0.38 ± 0.09
Ac-228	0.77 ± 0.33
Tl-228	0.76 ± 0.10
Bi-214	0.42 ± 0.28
Cs-137	0.94 ± 0.04

Tritium Results:

H-3	0.05 ± 0.02 pCi/g soil

Lower Pit

Sample Type: Soil
Requested: Gamma Isotopic Only

K-40	28.81 ± 1.62 pCi/g
Pb-212	1.90 ± 0.11
Pb-214	1.31 ± 0.27
Ra-226	1.29 ± 0.16
Ac-228	1.62 ± 0.76
Tl-208	1.55 ± 0.19
Bi-214	0.87 ± 0.62
Cs-137	0.93 ± 0.06

Analyses from samples collected in the Old Sodium Burn Pit indicate what are probably normal or background environmental levels of radioactivity for this area. The bismuth, lead, actinium, thallium, radium, and potassium are naturally-occurring radioactive materials. Cesium-137 is found at levels similar to what would be expected at other locations in the United States due to the atmospheric fallout from nuclear weapons testing. One might notice that the Lower Pit gamma levels are roughly twice the Upper Pit. This is to be expected since the Upper Pit samples were counted wet and Lower Pit samples were dry. In addition, the tritium analyses performed on two samples from the upper pit, the original and duplicate, used the azeotropic distillation method. In the case of these two samples, tritium levels are consistent with what would be present naturally and are therefore insignificant.

Leach Field

The Leach Field is the site of a former sewage leach field that had radioactive materials accidentally dumped into it at one time. SSFL had initiated a cleanup that removed soil down to bedrock and then restored the land. Walking surveys with a gamma survey instrument indicated what is probably only background levels of radioactivity. Results of the analysis of the sample collected in this area is below:

Sample Type: Soil
Requested: Gamma Isotopic Only

K-40	31.05 ± 1.27 pCi/g
Pb-212	1.88 ± 0.09
Pb-214	1.11 ± 0.18
Ra-226	1.27 ± 0.13
Ac-228	2.15 ± 0.73
Tl-208	1.58 ± 0.17
Bi-214	1.41 ± 0.53
Cs-137	1.02 ± 0.05

As in the case of the Old Sodium Burn Pit, the isotope levels encountered are representative of natural background.

Building 59, Former Reactor Building

Building 59 was the location of an old test reactor that removed at some time in the past. Walking surveys with a gamma instrument indicated background levels of radiation. Supposedly sand from the area around the building had been contaminated with cobalt-60 and a french drain had been installed in the subfloor to collect infiltrating groundwater. This small quantity of water is pumped to the surface and analyzed. Two separate samples were collected for analysis:

Sample Type: Water
Requested: Tritium

H-3 1890 ± 538 pCi/L

Sample Type: Water
Requested: Gamma Isotopic

Reportable Gamma's NOT DETECTED

There were two findings of interest on these samples. First, that Co-60 or other gamma emitters were not detected, and second, that tritium was. It is evident that from the drainage system set up, that Rocketdyne has successfully prevented Co-60 from getting outside this building. However, tritium was found in a level far above what could be called a background amount and might be attributable to this facility. Rocketdyne previously did not test water for tritium activity. Although the level encountered is orders of magnitude below what could be described as an environmental concern, further study is needed to determine the origin and spread of tritium on the SSFL site.

Trench Near Building 64, SNM Storage Area

Building 64 was described as a Special Nuclear Materials Storage Area. An area around this site was in the process of being cleaned up when samples were collected. This area showed higher than background gamma readings. Two samples were collected, an original and a duplicate, and results are below:

Sample Type: Soil
Requested: Gamma Isotopic Only

K-40	29.33 ± 1.30 pCi/g
Pb-212	1.56 ± 0.15
Pb-214	1.27 ± 0.31
Ra-226	1.25 ± 0.19
Ac-228	1.92 ± 0.27
Tl-208	1.67 ± 0.26
Bi-214	1.49 ± 0.50
Cs-137	331.4 ± 0.6

Duplicate of SNM Sample

Sample Type: Soil
Requested: Gamma Isotopic Only

K-40	31.67 ± 0.96 pCi/g
Pb-212	1.57 ± 0.14
Pb-214	1.32 ± 0.32
Ra-226	1.43 ± 0.18
Ac-228	2.40 ± 1.41
Tl-208	1.67 ± 0.25
Bi-214	1.67 ± 0.25
Cs-137	367.0 ± 0.6

In the case of both samples, all gamma emitters are reasonably consistent with background, with the exception of cesium-137. This is directly attributable to this spill. Rocketdyne was in the process of cleaning up this area when this sample was collected. Further samples should be collected to verify that this cleanup has been completed.

IV. SUMMARY AND CONCLUSIONS

From the samples collected at SSFL, it is evident that contamination exists on site property. From the levels of contamination detected and their location, it is doubtful that contamination has spread offsite. SSFL personnel were apparently unaware of the presence of tritium at Building 59. While not an environmental concern or health risk, the source of this tritium needs to be investigated. It should also be documented that the cesium-137 around Building 64 is brought back to background levels following SSFL cleanup.

In the original report documenting the survey and collection of samples on this site, dated July 28, 1989, it was stressed that certain types of samples were not collected due to time constraints and difficulty of obtaining a contractor laboratory capable of performing those specific analyses required. For a follow-up study, it is first recommended that more water samples be collected and analyzed for tritium. At least a representative group of samples should be analyzed for strontium-90, a beta emitter whose use is known at the site. Since this analysis is difficult in soil, vegetation, and other media, a contractor laboratory must be chosen carefully. It is also recommended that vegetation and other media, specifically samples from feral species be collected and analyzed as warranted.

The Office of Radiation Programs - Las Vegas Facility has presented the Region 9 Office in San Francisco a proposal to assist the region and state in their efforts to bring the SSFL investigation to a close and allay questions that have arisen concerning the SSFL environmental program.

Appendix B-3

Remley Response to Dempsey Review Report

EXHIBIT 5-1

REVIEW OF DEMPSEY REPORT

The memorandum from Gregg D. Dempsey, EPA Office of Radiation Programs - Las Vegas Facility, summarized Mr. Dempsey's preliminary findings based on his site visit to the Santa Susana Field Laboratory on July 12, 1989. The review was performed by Mr. Dempsey to help the EPA task force assess the relative magnitude of health hazards and environmental concerns and how these concerns might be addressed. The report properly states that there has been "an environmental monitoring program for over 20 years at this site"; in fact the program has existed since 1954, approximately 35 years at the time of his visit.

His review consisted of a review of an EPA collection of documents on the Rockwell/Rocketdyne Santa Susana Field Laboratory followed by a visit to the site, where he discussed the operation of the Rocketdyne environmental monitoring laboratory and some of the laboratory procedures. This was followed by visits to a number of areas at the site which had been indicated as possibly containing radioactive contamination. The sites were surveyed with appropriate instrumentation, and representative soil and water samples were taken from the areas for subsequent analyses. Subsequent to his site visit he was requested to write a report on his review, which was issued on July 28, 1989, and which is the subject of this document.

In his report he stated that he found the laboratory equipment to be state-of-the-art and indicated he found some procedures he reviewed well

documented and acceptable and others he questioned. His surveys of the areas showed no radiation readings greater than those associated with naturally occurring radioactivity, except for the one area near Building 064 known to have been contaminated by a previous spill, and which was being decontaminated at the time of his visit. Analysis of the samples taken by Mr. Dempsey, as reported in his memorandum of November 8, 1989, showed only activity representative of natural background, except for the soil sample from the area near Building 064 cited above and a water sample from the french drain at Building 059. These showed Cs-137 and tritium activities, respectively, above background but not large enough to represent a hazard to the public. In fact the tritium was characterized as "orders of magnitude below what could be described as an environmental concern".

While Mr. Dempsey did not indicate any items of environmental concern, he did recommend that additional samples be collected for further analyses to allay questions that have arisen concerning the SSFL environmental programs.

Mr. Dempsey's findings did not identify health hazards or environmental concerns, but he did indicate that he had questions about the validity of the results of the environmental monitoring program. His major general concern was that there had never been a thorough review or audit of the program. It is correct that there has not been a detailed peer review by external consultants, which is what we believe he was recommending. However, the program has been active for 35 years and was designed to provide the monitoring necessary to support Rockwell's activities with radioactive materials. The program has evolved to retain compatibility with Rockwell's

business activities and has been continuously reviewed by the DOE, NRC (and their predecessors) and the State of California. These reviews, representative copies of which are attached, have consistently indicated the program to be satisfactory for protection of the public and the environment, and have also resulted in periodic recommendations, which have been implemented. for the improvement of the program.

In addition to the continuing overview described above, the radiation protection program of the Santa Susana Facility was reviewed in April 1982 by John Handloser, an independent consultant in Health Physics under contract to the Ventura County Board of Supervisors. The results of that review were summarized in the attached report, "Review of the Radiation Protection Program of the Santa Susana Facility of Rockwell International", May 3, 1981. That report contains the following salient conclusions by the consultant:

> "In considering the hazards involved at SSFL I believe the health physics program to be adequate and complete in comparison to other facilities and to my concept of good health physics practices.
> "The levels of radiation exposure for both people on-site and for people off-site are far below the recommended maximums as stated by NCRP Report 39, and therefore below all the regulatory limits.
> "Considering the philosophy of Rockwell, the knowledgeable staff, the equipment available and the facility, I believe that living in the neighborhood of SSFL poses no risk from the radiation or the radioactive material part of the operations. Even if Rockwell relaxed its standards, the constant vigilance of the regulatory inspectors would

keep the radiation part of the activities below the permissible limits."

The report also discusses the environmental and contamination measurement activities and concludes them to be satisfactory for the facility.

Though the Handloser review was conducted 9 years ago, the program as reviewed by him has been continued with updating from evolving technology, evolving Rockwell programmatic objectives and continuous oversight by DOE and the regulatory agencies. Even with these types of appraisals, arrangements have been made for a complete peer review of the program by an independent consultant in accord with Mr. Dempsey's implied recommendations.

A number of questions about individual parts of the monitoring program are outlined in the report. These can be characterized as follows:

1. Use of gross analysis for alpha and beta radioactivity.
2. Questionable analysis of soil samples.
   a. Sieving of samples to obtain uniform particle size.
   b. Heating of soil samples to 500°C prior to counting.
   c. Inadequate correction for self absorption in samples.
   d. Use of copper vs. stainless steel planchets for counting.
   e. Apparent lack of spiked samples for internal quality control.
3. Questionable counting efficiency for analysis of water samples.
4. Questionable analysis of vegetation samples.

a. Washing of samples

b. Ashing at 500°C

5. Lack of samples from feral species.

6. Questionable analysis of air samples.

a. Counting times

b. Counted in poor geometry

c. No indication of calibration of air samplers

7. Questionable practices in radiation field measurements with thermoluminescent dosimeters (TLD's).

8. No analysis for tritium in water samples

9. No meteorological tower at SSFL to provide data for use with AIRDOS to calculate offsite dose.

10. Incomplete documentation of spills and other discharges of radioactive material onsite.

These are addressed by number below.

1. The Rockwell program has utilized gross alpha and beta measurements for screening purposes, which, in our judgement, is satisfactory for general environmental monitoring. This judgement is based upon the simple fact that we are only seeking to determine the presence or absence of fission

products, activation products, or special nuclear material, and separate those from naturally occurring radioactivity. We are not seeking to conduct a detailed radioassay. A combination of gross alpha and beta activity is sufficient to achieve this end. Where these measurements have indicated the presence of potential contamination from other than natural sources, additional assessment and evaluation is performed using gamma spectrometry and/or radiochemistry. These additional methods are sufficient to provide appropriate determination of the radioactivity present. Results of the gross radioactivity measurements have been reported routinely in annual reports and submitted to both Federal and State regulatory agencies, the Department of Energy, and other interested organizations and provide a long term record of environmental radioactivity at the site. Copies of recent issues of these reports are included in the license application.

2.a The soil samples are sieved to eliminate pebbles, which if included would result in a lower value for the concentration of radioactivity and would also contribute to increased self absorption in the soil sample. The correction for self absorption for alpha activity is determined by use of sieved soil spiked with enriched uranium. Beta absorption is determined by use of potassium chloride of the same mass as the soil sample. Again when potential contamination from other than natural sources is found, samples are analyzed by more specific methods, such as high resolution gamma spectrometry and radiochemistry.

2.b The procedure for heating soil to 500°C has been in use in this

laboratory for an extended period and provides consistency in the sample preparation, which is necessary in the screening program. Our procedures are consistent with procedures used by both EPA and DOE as published in EPA 520/5-84-006, "Eastern Environmental Radiation Facility Radiochemistry Procedures Manual," and HASL-300, "Environmental Measurements Laboratory Procedures Manual," respectively. These procedures call for the baking or ashing of samples at 500°C in the analysis for strontium and cesium. The possible loss of cesium in the heating of samples to 500°C has been investigated empirically in our laboratory by analysis of soil contaminated with Cs-137. The counting of samples before and after heating to 500°C showed no observable differences in the counting rates. Further, our procedures have been found satisfactory in both NRC and DOE reviews.

2.c Absorption of alpha radioactivity in soil has been determined with local soil spiked with enriched uranium. Verification of the correction factor for the absorption has been obtained with analysis of spiked samples by an independent analytical laboratory at the Idaho National Engineering Laboratory operated by EG&G.

The beta self absorption is determined by use of KCl samples with the same mass as the soil. This correction is quite satisfactory for natural activity but will result in too small a correction factor for low energy beta emitters, such as Co-60 and Cs-137, and too large a correction factor by about a factor of two for Sr-90, which is accompanied by its Y-90 daughter. However, when increased beta activity

is found, selected samples are analyzed by more specific methods. such as high resolution gamma spectrometry for Co-60 and Cs-137 and radiochemistry by an outside laboratory for Sr-90.

2.d The difference in use of copper and stainless steel planchets is trivial, since background and counting efficiencies are determined in all cases with the same planchets as those used with the samples. Analysis of water samples includes making the samples slightly acidic in preparation of the sample for counting. Because of this, stainless steel planchets are used to avoid corrosion. The copper planchets are used for soil analysis, since the copper gives somewhat lower background.

2.e "Blind" spiked samples to be analyzed along with the environmental samples have not been routinely used. However, samples spiked with enriched uranium and KCl are used in counting all the environmental soil samples. This assures proper calibration and performance of the laboratory counting equipment.

3. The questioned quoted counting efficiency of 50% for betas was given to Mr. Dempsey on the occasion of his visit as a rough approximation. He then erroneously assumed that we use that value in the analysis of samples; that is not correct. The actual counting efficiencies are determined for both thick and thin sources with each set of environmental samples and are used in the analysis of the samples.

4.a The vegetation analysis program was designed specifically to analyze for radioactivity uptake, since the soil, water and air monitoring programs were aimed at detecting contamination from releases from Rockwell activities. Thus it was necessary to assure removal of any external contamination on the samples prior to the preparation for counting. For the purposes for which the program was intended, the Rocketdyne procedure is correct, and Mr. Dempsey's suggestion is inappropriate.

4.b The ashing of vegetation samples at 500°C prior to counting is included in the procedures in both the EPA Manual and the DOE Environmental Measurements Laboratory Manual referenced in 2.b above. Our procedures, described in Document N001DWP00008, "Radiological Environmental Monitoring Program Sampling Procedures, Analysis Procedures, and Radioactivity Measurement Methods", July 18, 1984, which is attached here, are consistent with the referenced EPA and DOE procedures and have been found satisfactory in both NRC inspections and DOE reviews.

5. Hunting is prohibited at the SSFL, and there is no indication that animals present there make any contribution to the human food chain. Therefore no analysis of any of the animals (either through permits to take the animals or of roadkills) had been initiated. However during the past two months, samples from two rabbits, one squirrel, one mouse and a deer have been analyzed. Results of these show no Cs-137 or Co-60 and concentrations of K-40 of about 1.35 pCi/gm and uranium and thorium alpha activity of about 0.07 and 0.23 pCi/gm, respectively. The K-40 activity is consistent with the average concentration of 1.6 pCi/gm for

the "average man" as derived from models in ICRP No. 23, "Report of the Task Group on Reference Man", October 1974. The lack of cesium and cobalt indicate no uptake of fission products and activation products.

6. Mr. Dempsey's concerns about the analysis of air samples appear to have resulted from either a miscommunication or a misunderstanding during his visit. He indicated that the procedures were well documented and acceptable, but that a counting time of 10,000 seconds was used on a bag of loose filters instead of the "at least 36,000 seconds" in the procedure. Further the procedure stated that samples were to be counted in a Marinelli beaker - not loose in a bag. Two errors are evident here: First the counting time in the procedure was for a composite of filters to be counted in the Marinelli beaker to obtain data acceptable for the monitoring program. The counting time of 36,000 sec was a typographical error in the procedure that was reviewed by Mr. Dempsey and should have read at least 3600 sec, which was the time normally used; this has been corrected in the procedure; secondly, the bag of filters that was being counted during his visit was a scanning operation to get a cursory evaluation of the filters. Final counting in analysis of the filters is always done with the Marinelli beaker, and it was incorrect to assume on the basis of his observations, that the procedures were not being followed.

Finally in the review of the air sampling, he indicated that calibration of the air sampling equipment should be performed. We point out here that air flow calibrations are made quarterly.

7. As indicated during the visit, the TLD monitoring program is directed to measurement of the radiation fields at selected locations to determine if Rockwell's activities are contributing to the radiation. In addition to the onsite locations a few widely distributed locations off site are monitored to obtain measurements of natural background radiation. We do not understand the questioning of normalizing the doses for altitude; the unnormalized values of the doses are presented in the same table of data in the monitoring report. The normalization was included to reduce the dependence on altitude and attempt to make any contribution from our activities more evident. The normalizing factor was derived from data on various locations in the U.S. as presented in "Environmental Radioactivity", by Merril Eisenbud, published by McGraw-Hill Book Company in 1963.

There is apparently some misunderstanding or lack of communication relative to the data from the dosimeters placed by the State of California. The data had been indicated as unavailable in the annual environmental monitoring reports, because it had not been received by Rockwell at the DOE deadline for publication of the reports. It was not believed necesssary to publish an addendum to the annual report, since both the State data and Rockwell data are presented and compared in a later report; viz., Document N001TI000301, "Annual Report on Radiological Controls-1988", May 12, 1989, which is included as a part of the NRC license application and was available during Mr. Dempsey's review on July 12, 1989. It was presumptuous of Mr. Dempsey to conclude

that there might be unfavorable comparisons without making some investigation. In fact the data for 1988 compare quite well with the Rockwell data having wider variation from calendar quarter to calendar quarter. The Rockwell data for 1987 also show more variation and generally show somewhat higher radiation fields than the State data.

The DOE data were for a special intercomparison of TLD calibrations with Co-60 and Cs-137 sources. Their results have yet to be reported.

8. Extremely little tritium was produced in the types of reactors operated at SSFL, and there have been essentially no other available sources for contamination. The permitted concentration of tritium in water in unrestricted areas as given in Table II of Appendix B to 10CFR20 is 3 x 10^{-3} μCi/ml or 3 x 10^{6} pCi/l. In addition Footnote 5 to Appendix B states that a radionuclide may be considered as not present in a mixture if the ratio of the concentration of that radionuclide in the mixture to the concentration for that nuclide specified in Table II of Appendix B does not exceed 1/10 or 10%. Thus it has not been necessary to analyze for tritium. This is corroborated by the results of the analysis of the water samples taken by Mr. Dempsey, which showed a tritium concentration of 1.89 $\pm$ 0.54 x 10^{3} pCi/l, which is only 0.06% of the concentration permitted in Table II.

9. It is agreed that better AIRDOS information could be generated with a closer-to-site or onsite meteorological tower. However, the use of the data from the Burbank Airport for the SSFL site is consistent with the

EPA's general guidance on the use of meteorological data, as given in EPA-450/2-78-027R, Guideline on Air Quality Models (Revised), July 1986. This guidance states "Five years of representative meteorological data should be used when estimating concentrations with an air quality model. Consecutive years from the most recent, readily available 5-year period are preferred. The meteorological data may be data collected either onsite or at the nearest National Weather Service (NWS) station ...the use of 5 years of NWS meteorologial data or at least 1 year of site-specific data is required."

The use of at least five years of data covers the natural variability in the meteorological conditions from year to year. For purposes of modeling potential impacts, use of most recent data is not critical. The data for the Rockwell modeling are for the 5-year period 1960-64 inclusive accumulated at the Burbank Airport by the National Oceanographic and Atmospheric Administration (NOAA).

In addition the use of the Burbank data has been approved for the site by the EPA in its recent release of the software and User's Guide for AIRDOS-PC to be used to determine compliance with Clean Air Act NESHAPS radionuclide standards for Department of Energy facilities, as described in the attached letter and excerpt from Appendix B of the EPA Guide.

It is also pertinent to review the results of the use of the AIRDOS-PC with the Burbank data for the calculation of exposures for 1989 from activities at the SSFL site. These results show the average annual

individual exposure in a five mile radius of the site to be only 10^{-9} rem. The average annual individual exposure for people in the ring around the site with radii of 10 and 20 miles is only 1.1×10^{-10} rem. These exposures compare to the average annual individual radiation exposure in the U.S. from natural background and medical X-rays of 0.2 rem. Thus even orders of magnitude increase in the exposure would result in negligible effects on the general public and the environment.

10. It is doubtful if complete documentation of all spills and releases of radioactivity at the SSFL site could ever be retrieved. This situation basically exists for any site at which major research and development activities with special nuclear materials and radioactive materials have been conducted for an extended period such as the approximately 35 years of activity at SSFL. Incidents involving minor spills and releases were cleaned up, and any radioactive materials were disposed at an approved site. Surveys were made to assure the clean up was satisfactory, and these survey results have been retained as required. The incidents were reported in internal memoranda. Incidents which require formal reporting to appropriate agencies have been documented in formats dictated by the agencies and have been retained as required by the agencies. Over the years many of the files in which these memoranda and reports were retained have been discarded, as permitted by DOE and NRC requirements, and thus are no longer available.

It has long been recognized that it would be necessary to conduct a detailed survey of the SSFL site prior to releasing the site for

unrestricted use. Such a survey is not required as long as Rockwell controls the site and maintains an appropriate monitoring program. The Corporation continues to do both of the above, as both a licensee and a DOE contractor in compliance with regulations, license conditions and DOE requirements, with all activities under continuous review and inspection by the agencies. As part of the program, surveys of 25 areas either known or suspected to have low-level contamination were conducted during 1987-88. These surveys showed only six of the areas to have detectable contamination. Decontamination of the areas and final surveys to permit release of the areas for unrestricted use are currently in progress.

Mr. Dempsey's suggestion of a flyover of the area by EG&G with their gamma radiation counting equipment is inappropriate at the present time, since the survey program discussed above is continuing. The desirability of a flyover may well be questionable because of the lack of sensitivity of the counting system for the low levels of activity now present at the SSFL site. We might point out that an EG&G flyover of the site was made in 1978. This showed no major contamination but some areas were obscured because of activities in progress with rather large quantities of radioactive materials.

In summary, Mr. Dempsey's memorandum outlined a number of activities together with what he believed to be shortcomings in the Rocketdyne environmental monitoring program. A number of his questions and criticisms may have resulted from misunderstandings or miscommunications during his visit

and from the lack of time or opportunity to obtain a more complete understanding of the program. We would point out that in some areas he was reviewing activities in which explicit standards do not exist, and there is no universal agreement among knowledgeable people. In some instances, as noted, he was incorrect in his assumptions based on his limited observations, and some of his suggestions were inappropriate.

The summary presented here should clarify the questionable areas and respond to the criticisms and demonstrate that the Rockwell program is not deficient in meeting the requirements of the regulatory agencies and in providing for protection of the public health and safety and the environment.

Appendix C

Berger Report

Department of Energy
San Francisco Operations Office
1333 Broadway
Oakland, California 94612

DEC 22 1989

Mr. Jon Nagamatsu
Rockwell International
Rocketdyne Division
Dept. 597, 055, AA24
6633 Canoga Avenue
Canoga Park, CA 91303

Dear Mr. Nagamatsu:

Enclosed is a copy of the Oak Ridge Associated Universities (ORAU) report on their September 1989 review of Rocketdyne's radiological monitoring practices. The overall conclusions of the report have been discussed between Mr. James D. Berger, the leader of the review team, and Mr. Robert Tuttle of your staff. The report was also provided to EPA's SSFL regulatory agency Work Group at the December 14, 1989 meeting in Simi Valley.

The report indicates that the review identified no evidence of radiological conditions which pose an imminent threat to public health or the environment, and that Rocketdyne's radiological monitoring program has a strong basic foundation of capabilities in its staff, equipment, and procedures. The report also provides a list of recommendations which ORAU believes would strengthen the Rocketdyne program.

It is DOE's intent to provide the most complete and thorough radiological monitoring of DOE's activities and sites that can be reasonably achieved. Therefore, Rocketdyne is requested to respond to the ORAU report recommendations with a proposed corrective action plan which would provide a plan of action to address each of the suggested improvements contained in the ORAU report. Once DOE has reviewed the proposed corrective action plan and approved it, Rocketdyne will be requested to implement the plan and to provide regular progress reports on the implementation.

Should you have any questions on this request, please contact Mr. Gary Lavagnino at (415) 273-6597.

James K. Hartman
Team Leader
ETEC Environmental Review

Enclosure

cc: Steve Lafflam, RD
Robert Tuttle, RD
Manny Tessier, ETEC

00315 cc

Oak Ridge Associated Universities
Post Office Box 117
Oak Ridge, Tennessee 37831-0117

Energy & Environment Systems Division

December 12, 1989

Mr. William E. Murphie
U.S. Department of Energy
SFMP Project Manager
Decontamination and
Decommissioning Division
Office of Environmental Restoration
and Waste Management
Washington, D.C. 20545

Subject: REVIEW OF SURPLUS FACILITIES RADIOLOGICAL MONITORING AT SANTA SUSANA SITE - FINAL REPORT

Dear Mr. Murphie:

Enclosed is the final report of ORAU's review of the Santa Susana Field Laboratories (SSFL) radiological monitoring program as related to identifying, characterizing, and decommissioning surplus facilities. This report incorporates comments received from Mr. Hartman of the San Francisco Operations Office and Mr. Tuttle of Rockwell.

If there are questions or comments regarding this document, they may be referred to me at FTS 626-3305.

Sincerely,

James D. Berger, Director
Environmental Survey and
Site Assessment Program

JDB:jls

Enclosure

cc: J. Hartman, DOE/SAN
M. Harmon, DOE/EM

REVIEW OF SURPLUS FACILITIES RADIOLOGICAL MONITORING SANTA SUSANA FIELD LABORATORIES VENTURA COUNTY, CALIFORNIA

Prepared by

J. D. Berger

Environmental Survey and Site Assessment Program
Oak Ridge Associated Universities

INTRODUCTION

In May 1988, the Department of Energy (DOE) conducted an internal review of environmental activities in Area IV at the Rockwell/Rocketdyne-operated Santa Susana Field Laboratories (SSFL) Site in Ventura County, California. While this survey did not find evidence of environmental problems, representing an immediate threat to human health, it did identify the presence of facilities and land areas containing residual hazardous and/or radiological substances from previous site operations. These residual materials are considered potential sources of soil and/or groundwater contamination; several areas of groundwater contamination by chlorinated organics were also identified, and an expanded groundwater monitoring program was recommended.

Findings of this survey generated concern by residents of surrounding communities. In response to these concerns the Environmental Protection Agency (EPA) Region IX created a Work Group to ensure coordinated environmental regulatory management of this site and on July 12-13, 1989, a site inspection was conducted by the EPA Region IX Emergency Response Unit. This inspection also identified some deficiencies in the SSFL environmental radiological

Prepared by the Energy/Environment Systems Division of Oak Ridge Associated Universities, Oak Ridge, Tennessee, under Contract DE-AC05-76OR00033 with the U.S. Department of Energy.

monitoring program, but it concurred with the 1988 DOE survey findings that the site does not represent an imminent health or environmental hazard.

Results of the DOE and EPA surveys, indicating radioactive material contamination of facilities and land areas and identifying deficiencies in the SSFL radiological monitoring program, raised concerns at the DOE San Francisco Operations Office (DOE/SAN) and the DOE Office of Nuclear Energy (DOE/NE), regarding the capabilities of the Rockwell/Rocketdyne program to accurately assess the radiological status of its facilities. The DOE/NE Division of Facility and Site Decommissioning therefore requested that the Environmental Survey and Site Assessment Program of Oak Ridge Associated Universities (ORAU) review the SSFL radiological monitoring program, relative to capabilities for identifying, characterizing, and decommissioning sties associated with past and current DOE activities. Mr. J. D. Berger, Director of the ORAU Environmental Survey and Site Assessment Program (ESSAP), and Dr. C. F. Weaver, Senior Radiochemist with the ESSAP, visited the SSFL Site on September 28-29, 1989. Discussions with SSFL staff members, document reviews, facility tours, and limited independent radiological monitoring of several facilities were conducted at that time. Because of conflicting schedule demands, several key SSFL Radiation and Nuclear Safety staff were unavailable during portions of the site visit; additional documentation was thus requested and was provided to the ORAU reviewers at a later date. The findings and recommendations resulting from the ORAU review are presented in this report.

SITE DESCRIPTION

The Santa Susana Field Laboratories Site is located in southeastern Ventura County, about 47 kilometers (29 miles) northwest of Los Angeles, at the western border of the San Fernando Valley. It is situated on a plateau, near the crest of the Simi hills, about 300 meters (1000 feet) above the Valley floor. Surrounding terrain is rugged; zoning of neighboring property is rural or rural-agricultural. The nearest resident is about 2.1 kilometers (1.3 miles) to the southeast. Population density in 1980 was estimated at

about 8,000,000 persons within 80 km (50 mi) of the site. The climate of the region is subtropical with mean monthly temperatures ranging from 10° C to the mid 20's; the region is semi-arid with a mean rainfall of about 45 cm (17.5 in).

The site comprises a total of approximately 1090 hectares (2700 acres) and is divided into four administrative areas (Areas I-IV) and a Buffer Zone. DOE programs are conducted in Area IV of the SSFL Site. This area consists of about 117 ha (290 acres), owned by Rockwell, of which 36 ha (90 acres) are DOE optioned land.

Since the early 1950s, Rockwell and its predecessor organizations have conducted programs in Area IV of the SSFL for the Atomic Energy Commission, Energy Research and Development Administration, and their successor, the Department of Energy. These programs have included engineering, research and development, testing, and manufacturing operations, primarily related to nuclear reactor systems and components. In 1966 the Energy Technology Engineering Center (ETEC) was established at this Site to provide engineering, development, and testing of components for the Liquid Metal Fast Breeder Reactor Program. Although primarily conducting programs for DOE, the site has also conducted activities for the Nuclear Regulatory Commission, Department of Defense, and other government related or affiliated organizations and agencies.

Numerous facilities and associated land areas have become contaminated -- either as a result of their intentional use with radioactive material or inadvertently -- with low-levels of radioactivity. Potential radioactive contaminants identified at this site include uranium (depleted, natural, and enriched), plutonium, americium-241, fission products (primarily cesium-137, and strontium-90), activation products (cobalt-60, europium-152, nickel-63, promethium-147, and tantalum-182) and tritium. As facilities were removed from service, Rockwell performed decontamination and/or stabilization. In 1985 Rockwell/Rocketdyne initiated a project to survey or resurvey selected sites where knowledge of the radiological status was felt to be inadequate.

FINDINGS

Staffing

The radiological monitoring program responsibilities reside with the Radiation and Nuclear Safety group, managed by Mr. R. J. Tuttle. In addition to the manager there are seven professional level staff positions in the group, of which one is a contact position. The Radiation and Nuclear Safety group is supported by Radiation Instrument Services (three staff positions). Most of the individuals in these organizations have multiple years of experience in radiological monitoring and control related activities at SSFL; several of the key individuals have been at the SSFL for 25-35 years and are thus well acquainted with site activities and the history of radioactive materials usage at the site. At the present time there are two vacancies on the Radiation and Nuclear Safety staff and one vacancy on the Radiation Instrument Services staff; replacement of these vacancies is being pursued. In addition, the head of the laboratory operations has announced intentions to retire in approximately six months; replacement efforts and cross-training in laboratory activities have not yet been initiated. Several staff members appear to have the major portion of the site radiological monitoring responsibilities, without provisions for complete backup in their absences.

Although the current staffing level is considered adequate to perform the necessary radiological monitoring and control services required for routine operations, significant additional demands are being placed on the staff to respond to recent DOE and EPA reviews and concerns of nearby residents, the State of California, federal and state legislative representatives, miscellaneous independent environmental concern organizations, and the media. An increased level of effort to identify and decontaminate all facilities and land areas is being sought. Such demands will likely require additional manpower, beyond that required for day-to-day operations.

Equipment

Portable radiological monitoring and laboratory equipment are state-of-the-art. Portable equipment includes a variety of detectors and display instruments; this equipment is capable of measuring surface activity and exposure rate levels to satisfy the DOE guidelines for decommissioning. This instrumentation appears to be well maintained and calibration was current for the instruments observed during the site visit. Laboratory analytical instrumentation includes a low-background gas proportional counter and a pulse height analyzer with a 15% high-purity germanium gamma detector. The laboratory does not have wet chemistry radio-analytical capabilities. As with the portable instrumentation, the laboratory equipment appeared to be well maintained and calibrated within the established SSFL procedures. (See item 3 for further discussion on calibration.) Although the proportional counter and gamma spectrometer are adequate for most of the radionuclides and sample media anticipated at SSFL, certain specific analyses, e.g. isotopic plutonium, strontium-90, and tritium, must be performed by an outside commercial laboratory. The presence of tritium, promethium-147, and nickel-63 as potential radionuclide contaminants may justify the on-site capabilities for measurement of these low-energy beta emitters in water and on filter papers (smears and air samples); acquisition of a liquid scintillation counter would provide that capability. Implementing wet chemistry capabilities is not considered appropriate with the current staffing levels and anticipated sample load.

Procedures

SSFL has documented procedures for many aspects of the radiological monitoring program; however, detailed standard operating procedures have not been prepared for some activities. For example, collection, preparation, and analysis of samples are described in a document entitled "Radiological Environmental Monitoring Program Sampling Procedures, Analysis Procedures, and

Radioactivity Measurement Methods," but there is not a comparable Rockwell procedure document, describing the methods for performing direct measurements of alpha and beta-gamma surface activity and exposure rates or for performing tests for removable contamination. It should be pointed out that individual facility survey reports do describe instrumentation, measurement techniques, and procedures used. Several of the pertinent radiological procedures reviewed were issued 3 to 5 years ago; they are currently being revised in response to recent audit recommendations.

SSFL has reviewed guidelines for residual radioactivity, relative to land and facility use without radiological controls, presently used by the DOE and NRC, and has adopted the most restrictive of the values when there are differences between the guidelines. The guidelines being used for surface contamination of facilities are those used by both the NRC and DOE's Division of Facility and Site Decommissioning. Exposure rate guidelines at SSFL (5 μR/h above background) were adopted from NRC practices for reactor facility decommissioning; they are more restrictive than those being used by DOE and for non-reactor NRC-licensed facilities. With exception of Ra-226, Ra-228, thorium, and uranium, neither the DOE or NRC have established generic guidelines for residual concentrations of radionuclides in soil. Instead, such guidelines are developed, as needed, on a site specific basis. Therefore, guidelines for such radionuclides as Cs-137, Sr-90, Pu-239, Ni-63, and Co-60, which are potential contaminants at SSFL, have not been established. Rockwell has been using soil contamination guidelines of 46 pCi/g for gross alpha and 100 pCi/g for gross beta (these values include background). The gross alpha value is comparable to levels for most nuclear fuel cycle materials (uranium and plutonium) which have been used by the NRC. However, guideline levels for Cs-137, Sr-90, and Co-60, which have been used for decommissioning at other DOE and NRC sites, are typically equivalent to less than 100 pCi/g of gross beta activity. Both DOE and NRC have developed procedures for establishing site-specific soil guidelines; Mr. Moore of the SSFL staff attended a DOE workshop on developing guidelines, using the RESRAD program, in mid September. The use of gross alpha and gross beta guidelines for soil is not consistent with the September 1986 DOE directive to report environmental data in terms of

specific radionuclides and does not enable comparisons of contamination levels with established guidelines. In addition, while analysis for gross alpha and gross beta is a useful "screening" technique for soil, it is not a reliable and accurate quantitative technique for radiological analysis of soil. While gross alpha and gross beta analyses were used for determining acceptance of decontaminated soil areas in the past, (in come cases with correlation by other analyses), recent changes in procedures now require gamma spectrometry or other radionuclide specific evaluations. Gross alpha and gross beta analyses continue to serve as screening techniques, particularly in the environmental monitoring program.

Field survey techniques (sampling and measurement) are consistent with those in use by industry, government contractors, and regulatory organizations, involved in facility decommissioning activities. Instrumentation and procedures are capable of measuring surface activity levels with adequate sensitivity to assure that current federal guidelines are being satisfied. SSFL also performs statistical analysis of all survey data to demonstrate, on the basis of cumulative probabilities, that there is greater than a 90% confidence level that guidelines are met. ORAU has had occasion to perform confirmatory evaluations of several Rockwell facilities, which were being decommissioned for release from NRC license restrictions. These included fuel fabrication areas at the DeSoto site (in Canoga Park) and the T055 (mixed oxide) and T093 (L-85 reactor) facilities at SSFL. In each case, it was the finding of the confirmatory survey that Rockwell's decommissioning activities were effective and that data were adequate and accurately described the radiological status of the facility. Several areas where the field survey program could be improved are:

a. Survey measurements and sampling locations should be referenceable to the state and/or USGS grid system to enable future location, i.e. following facility demolition and possible rebuilding.

b. Micro-R meters are used to scan soil areas to locate "hot-spots" of gamma-emitting radionuclides for removal. Exposure rate measurements at 1 m above the surface are used for the acceptance survey, following

decontamination. Based on findings of limited EPA and ORAU monitoring at Building T064 (see page 11) the scanning procedure does not appear to be effective in identifying all gamma "hot spots" and the instrumentation and/or technique should be reevaluated.

c. A comprehensive listing of detection capabilities (sensitivities) for the various field survey equipment and survey techniques should be developed.

With some exceptions, laboratory procedure are also consistent with those used by other organizations performing decommissioning activities. One of the areas of concern is the past reliance on gross alpha and gross beta analyses of soil, rather than conducting specific radionuclide analyses (see earlier discussion - page 7). Another concern, raised by the July 1989 EPA report, was the possible loss by volatilization of cesium and strontium (and possibly other radionuclides) from soil samples, during a drying/ashing cycle at 500° C. Procedures at EPA and DOE analytical labs typically recommend temperatures of 450° C to 480° C, without identifying concern for volatilization of cesium or strontium. Although the ORAU laboratory staff does not believe that volatilization of these two elements should be a potential problem at 500° C, they recommend reducing the temperature to 450° C, to be consistent with other standard procedures. The effect of such temperatures on other potential contaminants should also be evaluated and laboratory procedures adjusted accordingly. In the gamma spectrometry procedures, photopeaks which are potentially encumbered, are being used for determination of certain radionuclides. For example, the 186.2 keV peak is being used for Ra-226 and the 183.7 (185.7) keV peak for U-235. Difficulties in resolving these close peaks and possible shifts in peak location could result in misidentifying contaminants and/or miscalculating concentrations. Use of alternate photopeaks, such as the Bi-214 (Ra-226 daughter) 609 keV peak (equilibrium status must be considered) and the U-235 143 keV peak, would provide more reliable measurements in cases where both contaminants might be present. To estimate the level of U-238 in soil, the Ra-226 level is being measured, and an equilibrium state is assumed. This approach will greatly underestimate the U-238 level in the case where the

contaminant is processed uranium, such as is the case at SSFL. If gamma spectrometry is to be performed for measuring U-238, either the 1.001 MeV Pa-234m photopeak (very low abundance) or the Th-234 photopeaks at 63 keV or 93 keV (doublet) could be used. Gamma spectrometer calibration does not use a simulated soil matrix. Although the effects are negligible at medium and high photopeak energies, there can be a significant change in calibration at energies below 100 keV. The magnitude of the change will be dependent upon the energy, soil density, content of heavy elements in soil, and counting geometry selected.

The QA (quality assurance) program, relative to radiological monitoring for facility decommissioning, is described in the Rockwell procedures document, "Radiological Environmental Monitoring Program Quality Assurance." While this program is very adequate in many areas, some aspects of the program do not appear to have been implemented and some standard QA requirements have either not been incorporated into the program or should be more specific. Equipment calibration is in accordance with the established SSFL procedures and appropriate for the nuclides of concern; calibration source certificates and calibration records were reviewed and no deficiencies noted. The laboratory and field conduct an adequate QC (quality control) program of regular background and source checks of equipment response; documentation of results is good. Calculation procedures are also well documented with an adequate paper trail of calculational program validation and records of changes to such programs. A chain-of-custody procedure for samples has not been implemented. Although the SSFL procedure requires documentation of personnel qualifications for the various program activities, records supporting training and certification in specific laboratory and field survey procedures could not be provided. Periodic internal audits of limited aspects of the program have been performed by the Radiation and Nuclear Services group management; the frequency of such audits is not specified. The program has not been included in QA audits performed by other Rockwell organizations, DOE, or outside organizations.

The laboratory performs analyses of spike, blank, duplicate, replicate, and split samples, but the minimum frequency or percentage of such control

analyses is not specified. The laboratory also participates in the DOE/EML interlaboratory comparison program for selected radionuclides in air, water, vegetation and soil samples; results have been acceptable, based on a review of 9/88 and 4/89 test results. Although samples for tritium and some other specific nuclide analyses are performed by a commercial laboratory, Rockwell does not include quality control samples (spikes, blanks, and duplicates) to evaluate the performance of such vendors.

Independent Monitoring of Selected Sites

Limited gamma monitoring with a sensitive sodium iodide scintillation detector and countrate meter was performed at five facilities, for the purpose of independently assessing the adequacy of decontamination efforts and/or confirming radiological data and information presented in Rockwell survey documents. Findings are described below:

Conservation Yard

Contaminated surface soil had been recently (August [illegible] from about a 100 m^2 area in the Conservation Yard (also kn[illegible] Yard). The contaminant was identified as Cs-137; level[illegible] 100 pCi/g (gross beta). The follow-up survey report had not yet completed. Thorough near-surface gamma scans were performed over remediated area, and random scans were conducted at other locations in the Conservation Yard. There was no evidence of residual surface contamination by gamma emitting radionuclides (the instrumentation used for this survey is capable of identifying small areas of surface Cs-137 contamination at concentrations of less than 10-15 pCi/g).

Old T028 Building Site

Building T028 was originally a small test reactor facility and portions of the building were later used for uranium metal alloy operations. The upper

story of this facility has been removed; a survey in November 1988 concluded that the remaining portions of the facility meet the guidelines for release without radiological restrictions. Limited surface scans were performed in the remaining portions of the building, on the pad (floor of the demolished upper section), and around the surrounding grounds. Ambient background levels in portions of this facility are 3 to 4 times higher than the typical SSFL area background; due to stored radioactive materials at the nearby RMDF facility. This condition decreased the ability to identify very low levels of residual contamination in small areas by the gamma scan; however, as with the Conservation Yard area, no evidence of localized elevated readings, which would suggest significant residual contamination, were detected.

Building T064

Portions of the paved grounds and soils area near the entrance to the T064 (Source and Special Nuclear Material Vault) Building became contaminated in the early 1960s and partial cleanup was performed at that time; more recently (August and September 1989) further remediation was performed. The contaminent was identified as mixed fission products from a leaking (but empty) shipping cask. Cleanup involved excavation of soil to remove an estimated 100 m^2 of contaminated area. Cleanup was based on meeting a 5 $\mu R/h$ (above background) exposure rate at 1 m above the surface and satisfying the gross alpha and gross beta soil levels of 46 pCi/g and 100 pCi/g, respectively. Gamma spectrometry was also performed on soil samples. The report on follow-up monitoring was not yet complete at the time of the review, and SSFL conclusions as to the effectiveness of decontamination were therefore not available. Gamma scanning of the remediated area identified several (about 6) small areas with contact radiation levels 5 to 10 times the ambient background rate. The levels appear to increase with depth. These findings suggest that there is residual subsurface contamination at the site, which may be in excess of the DOE guidelines. Because there is no generic DOE guideline for Cs-137 in soil, SSFL will be evaluating the residual contamination, using the RESRAD program.

General above-background gamma levels and several "hot spots" were noted in a portion of the excavation, containing a clay pipe (similar to tile sewer piping). Radiation and Nuclear Services personnel could not identify the purpose of the pipe or its outfall location. Because of the presence of residual contamination in the vicinity of the exposed section of pipe, there is a question as to whether the pipe had contained radioactively contaminated liquids and whether there was an old leach field in the vicinity of the T064 Building, which might be contaminated.

Sodium Burn Pit

A December 1987 systematic survey of the Old Sodium Disposal Facility (Sodium Burn Pit) revealed areas of surface contamination containing Cs-137, Sr-90, and uranium. This contamination is limited to small isolated areas of the two former evaporation ponds. The survey did not address subsurface conditions; however, the potential for subsurface contamination exists because cleaned items were previously buried near the pit and the integrity of the sodium reacting pool (pit) is unknown. Gamma surface scans of the pad, the two former ponds, and some of the adjacent area, including several surface runoff pathways, identified only several small areas of elevated direct radiation in the ponds. These areas were the same ones identified by the July EPA survey.

Catch Pond and Old Leach Field Area for the Radioactive Material Disposal Facility

Southwest of the Radioactive Material Disposal Facility (RMDF) is catch basin for surface runoff from the facility grounds. The basin and the drainage trough leading to this basin are concrete and have been coated with an asphalt sealer. Contaminants are primarily Cs-137 and Sr-90. Ambient radiation levels in portions of this area were slightly elevated, due to the proximity to the RMDF where radioactive material is processed and stored. Gamma scans did not identify any evidence of surface contamination around the edges of the catch basin, but levels ranging from 10 to 15 times above background were noted on portions of the drainage trough. A thorough survey of this area has not yet been conducted.

To the north of the RMDF there is a land area which was inadvertently contaminated with Cs-137 and Sr-90, due to an accidental release to the facilities leach field and a surface spill from a waste treatment operation. Cleanup was performed in 1978; however there are remaining small areas of surface contamination and residual contamination in cracks in the bedrock. Ambient gamma levels in this area were elevated due to the ongoing RMDF operations. Several small isolated locations of surface radiation, several times the background level, were identified near the old leach field; because of the rugged terrain and limited time for the survey, no monitoring was conducted on the hillside between the RMDF and the leach field. Of the known or suspected contaminated facilities at SSFL, this area is the nearest to the site property line.

Summary of Independent Monitoring

Results of the limited independent monitoring were consistent with the earlier findings of Rockwell and EPA. They also indicate that the Rockwell monitoring program is capable of identifying significant areas of residual radioactive contamination. Although monitoring at two of the sites (the Old Conservation Yard and the T028 facility) indicated that remediations at these sites have likely been effective in reducing residual activity to within the applicable DOE guidelines, small areas of contaminated soil may still be present at the T064 facility.

Status of Site Radiological Conditions

In 1985, SSFL initiated a project to identify facilities in Area IV, which might be contaminated, based on use history, known incidents, and/or previous monitoring information. Twenty-five facilities were identified, and radiological surveys, conducted during 1987 and 1988, confirmed that residual contamination at six of these facilities, was above the current DOE decommissioning guidelines. Rockwell has performed remediation on several of these facilities and has developed a plan to address the remaining facilities, identified during that survey, between now and FY 1994.

Document reviews and discussions with Radiation and Nuclear Services staff indicated that the surveys concentrated on surface conditions and only minimal information is available on subsurface conditions at most of the sites. Prior to installation of the site sewer system, many of the facilities had leach fields to which potentially contaminated liquid wastes could have been discharged; with only a few exceptions, radiological conditions of these former leach fields have not been determined. Subsurface contamination is also possible in the vicinity of the Old Sodium Burn Pit, the RMDF and associated areas such as the catch basin, and other facilities where surface contamination has already been identified. There are other facilities and land areas where radioactive materials were previously used, but which were not included in the 1987 and 1988 survey project. For these reasons it is ORAU's opinion that the extent of radioactive contamination on the SSFL DOE property has not yet been thoroughly determined. It should be noted that the environmental monitoring program at SSFL has not identified any evidence of offsite migration of radioactive contamination in surface runoff or groundwater.

The San Francisco Operations Office of DOE has directed Rockwell to prepare a complete listing of the facilities and sites, where radionuclides have been used at SSFL and to provide copies of documentation which has been developed for those areas.

SUMMARY

At the request of the DOE's Division of Facility and Site Decommissioning Projects, the Environmental Survey and Site Assessment Program of Oak Ridge Associated Universities performed a review of the radiological monitoring program at the Santa Susana Field Laboratories Area IV site during September and October 1989. The review consisted of discussions with SSFL staff, document reviews, facility visits, and limited radiological monitoring. Findings of this review identified no evidence of radiological conditions which pose an imminent threat to public health or the environment. The radiological monitoring program has a strong basic foundation of capabilities in its staff, equipment, and procedures. There are aspects of the program which should be

strengthened. The following section contains a list of recommendations arising from the findings of this review. Many of the deficiencies which were identified are related to activities or lack of activities which could adversely affect or make questionable the quality level of data. It is ORAU's opinion that with relatively minor changes and additions to the present radiological monitoring program, SSFL will be capable of conducting thorough and accurate assessments of the radiological status of the site. Portions of the site have been recently evaluated, but additional data and information are needed to provide a comprehensive evaluation of some of those areas. Current radiological data have not been developed for other portions of the site, some of which may contain residual contamination. An accelerated schedule or expanded scope of site surveys would likely require a level of effort, beyond the currently available resources.

RECOMMENDATIONS

1. Evaluate staffing requirements relative to the current and anticipated workload. Actively pursue staff replacements and additions, as determined appropriate. Initiate plans for replacement of laboratory head. Cross-train staff in key activities to provide backup capabilities.

2. Evaluate potential low-energy beta analytical needs to determine whether acquisition of a liquid scintillation counter would be cost effective.

3. Develop additional detailed procedures, covering aspects of the radiological monitoring program such as monitoring surveys and measurement of surface activity and exposure rates. Finalize revisions of procedures, as appropriate, and establish a regular schedule for procedure review and update.

4. Develop guidelines for residual concentrations of radionuclides in soils at SSFL. It is suggested that the DOE RESRAD program be used for this purpose.

5. Use gross alpha and gross beta soil analysis only for screening purposes; develop radionuclide-specific analyses for evaluating soil contamination levels.

6. Implement referencing of surveys to state and/or USGS grid systems.

7. Review surface gamma scanning procedures for improved identification of "hot-spots" and small areas of contamination.

8. Develop a list of equipment detection capabilities.

9. Modify drying/ashing procedure for soil to reduce the peak temperature to 450° C. Also, evaluate possible effects of temperature on loss of other potential contaminants.

10. Evaluate use of alternate photopeaks for gamma spectrometry of certain radionuclides.

11. Obtain a simulated soil matrix standard for gamma spectrometer calibration.

12. Develop a chain-of-custody procedure for samples.

13. Initiate an auditable program of training and qualification of personnel in radiological monitoring procedures.

14. Develop and implement a program to assure periodic comprehensive audits of radiological monitoring activities, related to decommissioning. This program should include internal audits and audits by Rockwell, DOE, and external agencies.

15. Initiate a program to including quality control samples for evaluating performance of commercial analytical laboratories.

16. Implement a program to systematically characterize the radiological status of the entire SSFL Area IV site. This characterization should include evaluations of surface activity levels on structures and in surface and subsurface soils. The findings should be compared to applicable guidelines, including site-specific guidelines for soil, as established by the DOE's Surplus Facilities Management Program.

17. Conduct additional investigations of questionable conditions, identified at the remediated are of the T064 facility.

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4. "Summary of Environmental Restoration and Waste Management Plan Provisions Relevant to the Santa Susana Field Laboratory," attachment to memo from Donald W. Pearman, DOE San Francisco Operations Office, September 15, 1989.

5. "Listing of Locations in the SSFL Area IV associated with radioactive material," September 1989, attachment to letter from R. J. Tuttle (Rockwell) to R. Vaille (EPA/San Francisco), October 2, 1989.

6. Rockwell International, "Rocketdyne Division Environmental Monitoring and Facility Effluent Annual Report, DeSoto and Santa Susana Field Laboratories Sites, 1988," RI/RD89-139, May 1989.

7. "Radiological Environmental Monitoring Program," procedure N001SRR140094, August 8, 1986 (with pen and ink revision, September 1989).

8. "Radiological Environmental Monitoring Program Sampling Procedures, Analysis Procedures, and Radioactivity Measurement Methods," procedure N001DWP000008, July 18, 1985 (with pen and ink revision September 1989).

9. "Radiological Environmental Monitoring program Quality Assurance," procedure N001DWP000009, October 3, 1984 (with pen and ink revision September 1989).

10. Rockwell International, "Annual Review of Radiological Controls - 1988," N001TI000301, May 12, 1988.

11. "Radiological Survey Plan for SSFL," 154SRR000001, September 25, 1985.

12. "Radiological Survey of the Sodium Disposal Facility - Building T886," GEN-ZR-0004, June 3, 1988.

13. "Radiological Survey of the Source and Special Nuclear Material Storage Vault T064," GEN-ZR-0005, August 19, 1988.

14. "Executive Summary of the DOE SSFL Site Radiological Survey," GEN-ZR-0015, October 10, 1988.

15. "Radiological Survey of the Old Conservation Yard (Salvage Yard)" GEN-ZR-0008.

16. Additional radiological survey reports for facilities T009, T513, Old R/A Laundry Area, Plot 333, areas between SRE and RMDF, areas between KEWB and RMDF, and T028.

Appendix D

Montgomery Report

Peer Review of the

ROCKWELL INTERNATIONAL SANTA SUSANA FIELD LABORATORY'S ENVIRONMENTAL MONITORING PROGRAM

Conducted By:

Daniel M. Montgomery, Ph.D.
Analytics, Incorporated

May 31, 1990

EXECUTIVE SUMMARY

During a two week period, Dr. Daniel M. Montgomery performed an onsite review of the SSFL radiological environmental monitoring program. This review included an assessment of program adequacy and compliance with state and federal regulations. Dr. Daniel M. Montgomery is an independent consultant contracted by Rockwell International with concurrence by the U.S.EPA.

Based on a review of historical environmental and effluent monitoring data, site tours, observation of laboratory operations, and discussions with site personnel, the following conclusions were made:

1. The environmental and effluent monitoring program has been conducted in accordance with applicable state and federal regulations.

2. Environmental monitoring data show that nuclear operations at SSFL have not adversely impacted the environment outside of the SSFL site.

3. Laboratory operations were and currently are of sufficient quality to maintain acceptable standards.

4. There is no evidence that groundwater in the vicinity of SSFL is contaminated with radioactivity from SSFL. Tritium detected in groundwater from a limited number of onsite wells is quite low and does not pose a safety concern.

5. The Radiation and Nuclear Safety staff is competent and committed to protecting workers, the public, and the environment.

Specific recommendations were made to enhance the radiological measurements program. Some of the more important recommendations include:

1. Perform specific radiochemical analyses on environmental samples as part of a final environmental survey.

2. Evaluate historical environmental data with statistical techniques as part of a final assessment of the environmental impact of SSFL operations.

3. Analyze environmental samples by gamma spectrometry and radiochemical analyses whenever possible and use gross alpha and gross beta analyses only for screening samples.

4. Revise alpha/beta calibrations for environmental sample types and utilize standards that are more representative of natural activity present in environmental samples.

5. Improve internal laboratory and contractor laboratory quality control through submission of blind quality control samples.

Recent assessments by the EPA (Dempsey Report) and ORAU (Berger Report) for the DOE were also reviewed.

In general the recommendations and conclusions in the Berger report were sound. This reviewer noted that the recommendation to systematically characterize the radiological status of the site including surface and subsurface soil does not appear to be necessary and would probably not be cost effective.

This reviewer took exception to many conclusions in the EPA report. Some of the conclusions appeared to result from a lack of understanding of the SSFL program by the EPA reviewer. The reviewer does not agree with the EPA conclusion questioning the validity of the SSFL environmental monitoring data or the statement that SSFL does not have a good "handle" on where radiation has been inadvertently or intentionally dumped onsite.

I. INTRODUCTION

During the period of April 16-20 and May 7-10, 1990, Dr. Daniel M. Montgomery of Analytics, Inc. performed an onsite review of the radiological environmental monitoring program at Rockwell International's Santa Susana Field Laboratory (SSFL). This review was requested and funded by Rockwell International in response to commitments made to an Interagency Work Group that is reviewing the environmental impact of SSFL operations. The EPA concurred with the selection of Dr. Montgomery to perform this review.

The purpose of this review was to have a disinterested third party provide an assessment of SSFL operations in the following areas:

1. Review the past, present, and planned work with radioactive materials as described in existing licenses and reports and by interviews with Rocketdyne staff.

2. Identify regulatory requirements for radiological monitoring and requirements for compliance under state and federal agencies.

3. Review past, present, and planned radiological monitoring in terms of sample types, locations, collection, preparation, and analysis, and interpretations with respect to meeting regulatory requirements defined in 1 and 2.

4. Analyze two recent reviews of the SSFL radiological monitoring program prepared by the EPA (Memo from Gregg Dempsey, EPA-LV to Daniel Shane, EPA-Region 9) and by James Berger of Oak Ridge Associated Universities.

5. Prepare a summary report discussing the review with conclusions with respect to compliance with applicable regulations and provide recommendations for program enhancement.

Information was obtained by review of appropriate reports, records, memos, laboratory data, site tours, and discussions with SSFL employees. Lists of primary documentation reviewed and the individuals contacted are presented in Attachments 1 and 2, respectively.

II. SSFL SITE HISTORY AND SOURCES OF RADIOACTIVITY

The SSFL site is located in the Simi Hills of Ventura County, approximately 30 miles northwest of downtown Los Angeles. It consists of approximately 2700 acres that is divided into four areas (I-IV) and a buffer zone. Nuclear work in support of DOE has been conducted in Area IV which consists of approximately 290 acres owned by Rockwell International.

Activities at the SSFL Area IV site that utilized or generated radioactivity commenced in 1954. The site was initially managed by North American Aviation with nuclear operations conducted by the Atomics International Division. North American Aviation became Rockwell International and, in 1984, the Rocketdyne Division absorbed Atomics International and is currently

responsible for operation of the entire site. Nuclear activities at SSFL were primarily nuclear reactor research programs conducted for the federal government. The main support for these programs was from the Atomic Energy Commission and from agencies that succeeded the AEC, the Energy Research and Development Administration and the Department of Energy. Currently, nuclear activities are limited to the decontamination and decommissioning of the remaining facilities. These facilities are being decommissioned as funds are made available from the DOE.

The primary source of radioactivity generated at SSFL was from ten research reactors and seven criticality test assemblies. Additional sources of radioactivity were brought onsite for fuel fabrication and fuel disassembly.

SSFL staff have estimated that 90 per cent of the radioactivity (mixed activation and fission products) generated onsite was from the operation of the 20 MWt Sodium Reactor Experiment which operated from mid 1956 until February 1964. Final decommissioning of the SRE facility was completed in 1982, and the area was released for unrestricted use. In 1974 operations at the last of the criticality facilities, the Fast Critical Experiment in Building 100, were terminated. The last operating reactor, the L-85 Nuclear Examination Reactor (3 kWt), was shut down in February of 1980.

Operations associated with fuel manufacturing utilized uranium, plutonium, and thorium, and were conducted in the following areas:

1. Building 003 where SRE fuel elements were assembled using uranium and thorium slugs. Decommissioning was completed in 1975, and it has been released for unrestricted use.

2. The Nuclear Materials Development Facility (Building 055) was decommissioned in 1986 and released for unrestricted use in July 1987.

3. The Uranium Carbide Pilot Plant (Building 005) which has not been released for unrestricted use.

4. The Fuel Storage Facility (Building 064) where decontamination and decommissioning activities are in progress.

The Hot Laboratory (Building 020) is currently being decontaminated. It was used for a variety of operations including: decladding of fuel and examination of test specimens from reactors, manufacture of sealed Co-60 sources, and fabrication of sealed sources using approximately 140,000 Ci of Pm-147.

Processing of solid waste and liquid waste for disposal has been carried out at the Radioactive Materials Disposal Facility (RMDF) since 1958. A variety of waste has been processed including mixed fission and activation products, uranium, plutonium, and thorium.

Based on the operations described above the following radionuclides were produced or used in large quantities and have sufficiently long half lives to be potentially present in contaminated structures and adjacent areas: U-234, U-235, U-238, Am-241, Pu-240, Pu-241, Pu-239, Cs-137, Sr-90, Co-60, Fe-55, Ni-63, Eu-152, and Pm-147.

As of May 1, 1990 there were only two potentially significant sources of effluent releases to the environment. These are the RMDF (Buildings 21 and 22) and the Hot Laboratory (Building 20). Based on the material handled in both facilities, the following radionuclides may be present in airborne effluents: uranium, plutonium, Cs-137, Sr-90, Pm-147, and Co-60. Potentially contaminated air from these facilities is filtered through HEPA filters and sampled continuously for subsequent radiochemical analysis. Stack monitors have alarm systems that are set to alarm at levels below the release limits.

Decontamination and decommissioning activities at SSFL are in the final stages. All reactor and subcritical components have been removed and shipped offsite for disposal. Rockwell has estimated that only approximately 60 curies of site related radioactivity remains in activated or contaminated structures that are currently being decommissioned. The same study estimated that only 0.1 curies of radioactivity is presently unconfined. Unconfined radioactivity is defined as radioactivity that is not fixed in place within structures (i.e. contaminated soil from spills). The concentrations of unconfined radioactivity are low, and these areas are within controlled areas of SSFL Area IV. Areas that have been identified as containing unconfined contamination include: areas adjacent to the Hot Lab (Building 020), a slope on the hill adjoining RMDF, the sodium disposal facility, and a soil area near Building T064.

III. LICENSING AND REGULATION OF RADIOACTIVE MATERIALS AT SSFL

Initial operations at SSFL were under contract with the AEC and as such were license exempt. Radiological safety programs including effluent and environmental monitoring were subject to review by the AEC and Advisory Committee on Reactor Safeguards (ACRS). Responsibility for overview of SSFL operations within the AEC was assigned to the San Francisco Operations office until 1958 when it was transferred to the Chicago Operations Office. Responsibility was transferred back to the San Francisco Office in 1966 where it remains at the present time.

During the period from 1958 to 1966 the Chicago Operations Office was assigned the responsibility for the SSFL site and determined that all DOE contracted operations were license exempt. During this period the Hot Laboratory, the RMDF, and the AETR (critical experiment) were built. The AETR was built on Rockwell property for the Southwest Atomic Energy Associates (an association of private utilities) and was therefore licensed by the AEC.

Operationally the regulation of licensed and exempt facilities were very similar. Program requirements for both licensed and exempt facilities were developed by the AEC. Generally, the license exempt facilities were expected to meet comparable standards to those for licensed facilities.

Overview of the SSFL Site was transferred back to the San Francisco Operations Office in 1966. This office determined that only prime contractor operations on government owned property were license exempt. As a result licenses were obtained for the Hot Lab and the NMDF.

In 1969 a broad scope license for the use of by-product material at the SSFL site was issued by the State of California. Responsibility for regulation of special nuclear material was retained by AEC for both licensed and license exempt operations. Regulatory limits for the discharge of radioactive effluents were the same for both the State of California and the AEC.

The AEC was abolished in 1975 and responsibilities transferred to DOE's successors, the Energy Research and Development Administration and the Nuclear Regulatory Commission. ERDA was given the responsibility for managing and regulating prime government contractor's license exempt operations. The NRC was assigned the responsibility for regulating licensed facilities. License agreement states such as California maintained the authority to license and regulate by-product material. Since 1975 operations at SSFL have been regulated by the State of California, the NRC, and the DOE (or ERDA).

The State of California and the NRC currently share regulatory responsibilities for licensed facilities. The California Department of Health Services regulates licensed by-product material associated with the Hot Lab (Building 020) and radioactive sources used in other buildings, and the NRC regulates special nuclear material in these facilities.

Operations associated with the RMDF are considered to be DOE license exempt and are subject to DOE guidance with respect to radiological safety and effluent monitoring. Maintenance and decommissioning activities associated with DOE facilities are subject to DOE guidance and overview by the DOE San Francisco Operations Office.

Standards for radiation protection including limits for the release of radionuclides to air and water are contained in the following documents:

California Department of Health, California Code of Regulations, CCR-17, "California Radiation Control Regulations."

U.S NRC. 10CFR20. Standards for Radiation Protection.

U.S. DOE Order 5400.5 (2-8-90) and preceding Orders and Directives.

Radiation exposure limits and radionuclide limits in these regulations were essentially the same until DOE issued new standards in DOE 5400 series, "Radiation Protection of the Public and the Environment." NRC and California regulations limit the annual exposure of any member of the public to 500 mrem. Limits for the discharge of radioactivity to air and water to uncontrolled areas (outside the exclusion fence) are given in 10CFR20 Appendix B Table II. 10CFR20.106 states "A licensee shall not possess, use, or transfer licensed material so as to release to an unrestricted area radioactive material in concentrations which exceed the limits specified in Appendix B, Table II of this part...For purposes of this section concentra-

tions may be averaged over a year." Appendix B, Table II, Column 1 lists values for individual radionuclides and for unidentified mixtures. The limits for unidentified mixtures discharged to the atmosphere in unrestricted areas are 2×10^{-14} and 3×10^{-8} for alpha and beta activity, respectively. These values correspond to those for the most restrictive radionuclides in discharges, Pu-239 for alpha and Sr-90 for beta radioactivity. No values are presented for liquid concentrations since there are no planned discharges of radioactivity in liquid effluents from the SSFL site.

Current DOE guidance provides for control of radioactive emissions by limiting the effective dose equivalent from all pathways to 500 mrem for any member of the general population for occasional exposures and to 100 mrem/year from all pathways for prolonged exposures. DOE has published tables with derived concentration guides (DCG) for radionuclides in air and water. The DCG for a given nuclide in air or water corresponds to the concentration that would give a dose of 100 mrem assuming that an individual's entire source of breathing air or liquid intake contained that radionuclide at the DCG.

In addition with the passage of the National Emission Standards for Hazardous Air Pollutants (NESHAPs) for radionuclides, effective in 1985 and revised in 1989, the EPA limits exposures to any member of the public to 25 mrem/year for the whole body dose and 75 mrem/year to any organ from airborne radioactivity releases. The 1989 revision established a limit of 10 mrem/year for the effective dose equivalent from the air pathway.

Compliance with limits for emissions to the air are controlled by filtering radioactivity through high efficiency particulate filter systems (HEPA) to remove particulate radioactivity. Filtered air is discharged via stacks equipped with air monitoring systems. The monitoring systems utilize a particulate filter with a radiation detector for real time, on-line measurements to ensure that releases do not exceed limits. The filter is subsequently counted with laboratory instruments to determine the activity released to the atmosphere. Prior to 1985 only gross alpha and beta measurements were made. Since 1985 the DOE has requested that specific radionuclides be reported and SSFL has sent the filters to a contractor laboratory for analysis after gross alpha and beta measurements were made. As noted previously, the RMDF and Hot Laboratory are currently the only significant sources of airborne activity and the discharge stacks are monitored continuously. Other potential sources of airborne activity are associated with building ventilation air in facilities where decontamination activities are being performed. These discharges are controlled by measuring the air concentration at work sites with air monitoring stations. Limits for exposure of workers to radioactivity in air are given in 10CFR20 as follows: "No licensee shall possess, use, or transfer licensed material in such a manner as to permit any individual in a restricted area to inhale a quantity of radioactive material in any period of one calendar quarter greater than the quantity which would result from inhalation for 40 hours per weeks for 13 weeks at uniform concentrations of radioactive material in air specified in Appendix B, Table I, Column 1. These values are approximately thirty times higher than those allowed for unrestricted areas; however, dilution with building air and atmospheric dilution from the point of discharge to the unrestricted area would ensure that concentrations in the unrestricted areas would be well below regulatory limits.

No specific DOE requirements for environmental monitoring were noted: however, an environmental monitoring program has been in place since 1954. In 1976 the NRC imposed environmental monitoring requirements as license conditions based on commitments made by Rockwell International in their license applications for a special nuclear materials license and a subsequent application for renewal.

Prior to curtailment of the environmental monitoring program in 1990 in response to the termination of work with nuclear material in 1987, the environmental monitoring program included the following. Continuous air samples were collected on a 24 hour cycle at five locations within Area IV and two additional locations within SSFL but just outside of Area IV. Soil samples were collected at 12-15 soil locations within Area IV and seven locations within the SSFL site but outside of Area IV. The frequency of soil collection was reduced from monthly to quarterly in 1986. Vegetation was collected at 12 onsite and 4 offsite locations on a monthly basis prior to termination of vegetation sampling in 1986. Surface water samples were collected monthly from two ponds and seasonally from Upper Bell Creek. Pond R-2A receives surface water from site runoff and water from the site sewage plant outfall drain. Direct radiation measurements were and continue to be made with thermoluminescent dosimeters (TLD's) at 13 locations within the SSFL site boundary. The site TLD's are changed on a quarterly basis along with TLD's at 5 offsite control locations. Soil, air, water, and vegetation samples were assayed for gross alpha and gross beta activity with the lower limits of detection given in the following table. In addition, Pu analysis of soil at 5 onsite locations and 1 offsite location was initiated in 1978 on a semi-annual basis.

LOWER LIMITS OF DETECTION FOR ENVIRONMENTAL SAMPLES

SAMPLE	ANALYSIS	DETECTION LIMIT
Soil	Alpha	3.2×10^{-6} microCi/gram
	Beta	3.7×10^{-7} microCi/gram
Water	Alpha	4.9×10^{-10} microCi/ml
	Beta	1.1×10^{-09} microCi/ml
Air	Alpha	9.1×10^{-15} microCi/ml
	Beta	3.8×10^{-14} microCi/ml

A ground water monitoring program was initiated in 1984. A total of twenty five wells both offsite and onsite are sampled for radiological measurements. These wells include site water supply wells, offsite water wells for groundwater monitoring, and onsite shallow zone groundwater monitoring wells. The water samples are analyzed for gross alpha and gross beta activity. In addition special groundwater studies have been initiated. These studies are under the direction of the California Regional Water Quality Control Board.

IV. RADIOLOGICAL MEASUREMENTS AND QUALITY ASSURANCE

The SSFL radiological measurements laboratory is well equipped for the scope of the measurements that are performed. Laboratory equipment includes analytical balances, equipment for homogenizing samples, ovens for drying and ashing samples, and other necessary equipment for sample preparation.

Counting equipment includes a shielded intrinsic Ge detector coupled with a computerized multichannel analyzer system for measuring gamma-ray emitting radionuclides. The system is calibrated for counting 450 cc samples in a marinelli beaker. The calibration standard is a water equivalent standard with eleven gamma rays covering the energy range from 88 keV to 1836 keV. This standard is appropriate for liquid samples but a soil standard should be obtained for soil counting. The analysis of soils using the soil standard would increase the measured values by approximately 10 per cent for gamma ray emitters below about 400 keV and approximately 5 percent above 400 keV. This system should also be calibrated for single air filters and smear samples to permit identification and quantification of radioactivity when gross counting of these sample types indicate quantities that are measurable by gamma spectrometry.

Gross alpha and beta measurements are made with a Tennelec alpha beta gas proportional counter equipped with an automatic sample changer. This counter permits simultaneous alpha/beta counting by energy discrimination. Gross alpha and beta efficiencies for air samples are determined with NIST (NBS) traceable U-235 and Tc-99 sources prepared by electrodeposition on 2-inch stainless steel disks. The gross alpha efficiency for counting soil samples is determined with a soil sample spiked with 40 pCi of enriched U. This method may not give the most representative efficiency for counting soil because of the uncertainty associated with the quantity of natural alpha radioactivity in the soil. This uncertainty results from an indeterminate loss of radon from soil which can be anywhere from 30 to 60 percent. Since radon and its daughters contribute 4 alpha disintegrations in the U-238 chain and 3 alphas in the Th-232 chain, radon loss can significantly affect the observed activity from natural radioactivity. If a soil spiked with enriched uranium is used for calibration, it should be spiked at a higher level (i.e. 500 pCi or more) so that the uncertainty associated with the natural activity in the soil is negligible compared to the enriched uranium. An alternative would be the use of sea sand in place of soil. The concentration of alpha activity in sea sand is quite low; and, it would not contribute significant activity to the enriched uranium. Beta counting efficiencies are determined by counting K-40 from natural KCl. Self-absorption curves are generated from sources of various thicknesses from 100 to 3000 mg total weight. Soil, water and vegetation counting efficiencies are determined from the self-absorption curve to correct for the sample mass.

Soil samples are prepared for counting by ashing the soil at 450°C (500°C prior to EPA Dempsey Report) and sieving through a Coors crucible. Two grams of sieved soil is transferred to a 2-inch diameter stainless steel planchet, and counted.

Vegetation samples are washed, dried to constant weight, ashed at 500°C, and weighed to determine the dry/ash weight ratio. One gram of vegetation is weighed, transferred to a

stainless steel planchet, and counted. Consistent with the reduction in the soil ashing temperature to 450°C, ashing of vegetation will be done at 450°C in the future.

Water samples are prepared by evaporating 500 mL to dryness, dissolving the residue in a few mL of water and transferring to a tared stainless steel planchet, and evaporating to dryness. The final planchet is weighed to determine the weight of the residue for determining beta efficiencies from the efficiency-mass relationship.

Quality control of the alpha beta counter is accomplished by counting a series of background and standards with each set of samples. The resulting data are plotted on control charts to ensure the counter is operating properly. During a review of the data it was noted that control charts had not been prepared for the previous two months. With the retirement of the Laboratory Manager there appeared to be some lack of continuity regarding counting room operations. It is recommended that management assign interim responsibility until the Laboratory Manager position is filled. In addition management should be reviewing quality control data to ensure that quality control functions are being performed in accordance with the procedures.

Quality control of the gamma spectrometer system consists of periodic counting of a mixed gamma standard in a 450 cc marinelli beaker. The quality control procedure does not specify frequency nor the plotting of the data on control charts. Good practice would dictate counting the standard daily or prior to use. Control charts or acceptance criteria should be established for energy calibrations, efficiency checks, and detector resolution.

Additional quality control checks included in the program were analysis of blanks, analysis of replicate and split samples, analysis of spiked samples, and duplicate counts of samples. There was no specified schedule for performing the above checks and this part of the program did not appear to be consistent. Spiked samples were not analyzed to check gross alpha/beta measurements in air, soil and water. SSFL participates in the DOE Quality Assurance Program but only measures the samples by gamma spectrometry. Since most effluent and environmental samples are analyzed by gross alpha/beta, quality control samples (spiked samples) should be analyzed by this technique. It appears that some of the DOE samples would be appropriate for gross alpha and beta measurements. In addition the EPA provides environmental quality control samples that could be analyzed by the SSFL laboratory.

In reviewing the quality control program it was noted that the primary emphasis was on instrument quality control. Since the measurements do not involve chemical separations, the need for other types of quality control (internal spikes, interlaboratory cross checks) is not as important. However, as noted above, some improvements and consistency in the established program are needed. The laboratory was operated by one individual for approximately 30 years. This individual was responsible for sample collection and preparation, instrument calibration, sample counting, and data reduction. This provided continuity and uniformity over a long period and helped assure the quality of data.

With regard to the quality of effluent and environmental measurements, the methodology provides data that are consistent and reproducible. The air sample measurements are adequate

to demonstrate compliance with limits and when used in conjunction with specific radioisotope analysis provide the means to calculate population doses from airborne releases. Gross alpha measurements in soil, water, and vegetation are not very sensitive due to the low counting efficiency of alpha particles from self-absorption in the sample matrix. Due to the non-specificity of gross alpha and gross beta measurements and the presence of high natural background, individual sample results are of little value in assessing the environmental impact. These results are most useful for determining long term trends to determine if there have been significant increases in environmental radioactivity levels. Gross alpha and beta activity measurements in environmental air samples are more sensitive and accurate with respect to identifying increases in releases from airborne effluent releases and evaluating potential exposures from the inhalation pathways.

V. REVIEW OF EFFLUENT AND ENVIRONMENTAL MONITORING RESULTS

The results of the airborne effluent monitoring program from 1975 to 1989 were reviewed. These results were summarized in the Annual Reviews of Radiological Controls through 1984 and in the Environmental Monitoring and Facility Annual Reports through 1989. The annual average alpha and beta radioactivity concentrations were reported for each building where airborne releases were monitored. These results showed that releases were less than 1 per cent of the regulatory limits. Prior to 1987 only gross alpha and beta measurements were made. Beginning in 1987 radiochemical analyses of filter composites were initiated in response to DOE guidance requiring isotopic identification. These analyses were requested to identify and quantify releases for calculating exposures to the general public from airborne releases. Isotopic analyses have shown that a large fraction of the reported alpha and beta activity was associated with natural activity from the makeup air. These data show that the SSFL program for controlling airborne releases to the environment was effective and that releases were negligible. The estimated maximum radiation dose to a person at the nearest residence from SSFL airborne effluents was calculated to be $1.5 \times 10^{-}$ mrem in 1988. The projected radiation dose to the public from atmospheric emissions are so low that they are of no concern compared to the radiation exposure from natural background.

A large quantity of environmental monitoring data for the SSFL site has been generated and data from 1966 to 1989 was reviewed. In 1984 alpha counter efficiencies were changed to reflect the effect of sample thickness. Prior to this time efficiencies were determined using a weightless electrodeposited source which gave much higher counting efficiencies. Beginning in 1984 the alpha concentrations in soil, vegetation, and water were approximately 40 times higher than values reported in earlier years as a result of the revised calculation method.

Soil samples are most useful for monitoring long term changes in environmental radioactivity levels. The SSFL monitoring program included soil sampling locations around the entire site. Site contributions to radioactivity would generally result from the deposition of radioactivity from atmospheric emissions. As such soil provides an indicator and integrator of airborne emissions from the site. There are onsite locations where soil is contaminated; however, these have resulted from spills or leaks associated with site operations. These areas have been identified by special surveys and are not considered part of the environmental program.

Decontamination of these areas will be completed prior to release of the site for unrestricted use and will be done in accordance with regulatory guidance.

As noted previously there are large uncertainties associated with soil analyses by gross alpha and beta measurements. For alpha counting the uncertainty associated with counting errors at the one sigma level is about 10 per cent and about 3-5 per cent for beta counting. The soil monitoring results were reported as the average for all on site sample with its associated standard deviation about the mean and the average plus standard deviation about the mean for all offsite locations. There were no significant differences between average alpha and beta concentrations on site and the concentrations offsite. This data indicates that airborne emissions have not resulted in significant increases in the radioactivity in soil. The results for Pu analyses in soil from 1978 to 1989 were consistent with values expected from global fallout and did not indicate any contribution from SSFL operations.

Vegetation samples were collected at most soil sampling locations until the end of 1985 and then discontinued since vegetation was not an exposure pathway The concentration of beta activity in vegetation samples from onsite locations tended to be 10-20 per cent higher than offsite locations and in 1967 and 1968 were 44 and 30 per cent higher, respectively. The most recent values for vegetation, 1980-1985, did not show any significant differences between site and offsite samples. Vegetation results can be highly variable due to differences in surface area exposed, moisture content, and the type of vegetation. Since specific radiochemical analyses were not performed on vegetation samples, these results do not allow for quantitative assessment of the results. It would be useful to perform additional statistical analyses of the vegetation monitoring data to determine if any specific onsite locations were generally higher than other onsite or control locations. This type of analysis would be necessary to determine if higher onsite concentrations were related to site operations. However, it should be noted that the measured gross beta activities in vegetation would not have posed an environmental hazard or significantly increased the radiation exposure of people in the vicinity of SSFL.

The results of gross alpha and beta measurements from environmental air sampling stations from 1966 to 1989 showed that radioactivity levels were less than 1 per cent of limits for beta activity in unrestricted areas and less than about 10 per cent for alpha activity. It should be noted that these measurements were gross measurements and included contributions from natural radioactivity. Comparison of air concentrations at onsite locations with control and offsite locations indicated that there were no measurable contributions from SSFL to radioactivity in air.

Although liquid radioactive effluents are not released from the SSFL site, surface water runoff from the site is a potential source of radioactive effluents discharged to the environment. The majority of site runoff is diverted by drainage ditches and ponds to a site retention pond, R-2A which is routinely sampled and also sampled prior to discharge as required by the California Regional Water Quality Control Board. Analyses for radioactivity includes gross alpha and beta activity. Results for these analyses from 1966 to 1989 showed that both alpha and beta concentrations were low and consistent with values expected from natural radioactivity in water.

Groundwater monitoring results from 1986-1989 showed that gross alpha and beta concentrations were highly variable and generally consistent with values expected from natural radioactivity. Special groundwater investigations were initiated in 1989. Nineteen monitor wells were constructed within Area IV. This study was initiated to investigate the impact of SSFL operations on the chemical and radiochemical quality of groundwater. This investigation was carried out by an independent consulting company, Groundwater Resources Consultants, Inc. Radiochemical analyses of water samples included gross alpha, gross beta, tritium, gamma spectroscopy, isotopic uranium, isotopic Pu, and Ra-226. Gross alpha and beta analyses of water samples were performed by B C Laboratories, Inc. Specific radionuclidic analyses including gamma spectrometry were performed by U.S. Testing.

The report summarizing the initial phase of the groundwater study concluded that "the radioactivity in groundwater underlying SSFL Area IV is at background levels and consistent with levels determined from monitor wells located throughout the facility." A possible exception to this conclusion was the detection of tritium in well RD-28 where samples collected on 9-13-89 and 10-19-89 were reported to contain 665 ± 149 and 699 ± 234 picoCi/liter, respectively. RD-28 is adjacent to Building 59 where the EPA detected tritium in a water sample from the Building 059 french drain at a concentration of 1890 ± 538 pCi/L. Tritium was also detected at a concentration of 589 ± 267 pCi/L in a well RD-23 near the Old Sodium Burn Pit. The presence of tritium in ground water near Building 059 has been attributed to the reactions of neutrons with Li in concrete from the SNAP reactor that was in Building 059. Final decontamination of this facility has not been completed. Tritium was also detected at a concentration of 589 ± 267 pCi/L in a well RD-23 near the Old Sodium Burn Pit. The source of tritium in well RD-23 is not known. Since the concentration was quite low and near the detection limit, additional samples should be collected to verify this finding.

Considerable attention has been directed to the detection of tritium in groundwater. Dempsey's EPA report noted that Rockwell International had not analyzed soil or water samples for tritium and that it was important because tritium present as tritiated water would migrate quickly in groundwater. Rockwell International has stated that tritium was not monitored because the source term was quite small and it was not considered to be an important pathway. It would appear that EPA's data and Groundwater Resources Consultants' data supports this conclusion since the tritium concentration is quite low and does not constitute a serious level of contamination when compared to the limit of 20,000 pCi/L for drinking water. Onsite wells are not a source of potable water and would not likely to be a source of potable water if the site were released for commercial development. Since the detection of tritium in groundwater has been a source of concern to some members of the public, Rockwell International has initiated tritium analyses by electrolytic enrichment. This technique is much more sensitive and permits better differentiation between background tritium from weapons testing and cosmic-ray production in the atmosphere and tritium from SSFL operations. With respect to the failure of Rockwell International to institute monitoring of soil and groundwater for tritium, the analysis of soil for tritium is of questionable value and the small source term for tritium and lack of exposure pathways did not dictate the need for tritium monitoring.

Ambient radiation levels on the SSFL site are monitored with thermoluminescent dosimeters (TLDs) at 13 onsite locations and five offsite locations. These measurements were initiated in 1975. Evaluation of these measurements are complicated by the relatively high natural background levels which vary depending on the altitude and the natural background radioactivity levels in soil. Because of the variable background, absolute numbers are not extremely useful in evaluating potential contributions from the site. The increase in the radiation dose rate at a particular location is estimated by comparison with values at locations (onsite or offsite) with similar background levels. In reviewing recent TLD data, 1980-1988, the locations at the site boundary near the RMDF appear to be elevated relative to expected background levels by approximately 20-40 mrem/year. This represents a fence line dose and not a dose to an individual. Due to the inaccessibility of the site, there are no residences in close proximity to this location. For a 40 mrem "fenceline" dose near the RMDF facility, the corresponding dose for the nearest resident has been estimated to be less then 4.5×10^{-6} mrem. Historical data show that direct radiation exposure of the population in the vicinity of SSFL as a result of site operations has been extremely low and met all regulatory limits. It was noted that there was more variability in the TLD measurements from year to year than expected; however, the relative values from location to location were consistent and support the above conclusions.

Additional special environmental samples were collected and analyzed in response to "recommendations" associated with the EPA Dempsey Report. These included isotopic analyses on soil samples, wildlife from road kill, and water samples for tritium analysis. These samples did not show any evidence of radioactivity that could be attributed to SSFL operations.

Review of effluent and environmental monitoring data from 1964 through 1989 indicate that SSFL operations have not had an adverse radiological impact on the surrounding environment. Although most of the available environmental monitoring data lacks the specificity (isotopic analyses) that would be desirable in evaluating the environment impact of the site, the available environmental monitoring data, together with effluent data, are adequate to support the above conclusion. While there is no evidence of adverse impacts on the environment outside of SSFL, Rockwell International has identified radiologically contaminated areas associated with past operations that must be "cleaned up" prior to releasing the site for unrestricted use. Based on my review of surveys and discussions with management, Rockwell International has acted responsibly with respect to identification and decontamination of these areas. Additional site surveys are being planned to ensure that all contaminated areas are identified and cleaned up prior to release of the SSFL Area IV for unrestricted use. After final decontamination of the site and offsite disposal of radioactive waste, an aerial survey by the EG&G aerial surveillance team is highly recommended. This type of survey is very sensitive in identifying gamma emitting radionuclides and provides uniform coverage of the entire site.

Beginning in 1990, following a three year hiatus in work with nuclear materials and in response to a determination by Rockwell International not to resume such work, the SSFL site routine environmental monitoring program was discontinued. Routine sampling and analysis of surface and groundwater will be continued by independent laboratories. Rockwell has informed DOE, the State of California, NRC, and other interested agencies that the routine environmental monitoring will be replaced with monitoring in conjunction with decontamination activities at specific sites. In view of the current source terms at the SSFL site, a

comprehensive site environmental monitoring program is no longer necessary since the potential for releases to the environment is quite low.

Since the routine environmental monitoring program did not provide specific isotopic information, it would be desirable to perform a "final" detailed analysis of the environmental pathways that were previously monitored. The "final" survey should include isotopic identification and include as a minimum the following analyses, gamma isotopic, Sr-90, isotopic uranium, and isotopic plutonium. Additional analyses would be dictated by initial results. For example elevated levels of Co-60 may indicate a need to analyze for other activation products such as Fe-55 that are not detected by gamma analysis. Samples should include soil, vegetation, pond sediment, and surface and groundwater. In addition to the locations associated with the previous environmental monitoring program, additional soil samples should be collected at locations that would have a higher probability of elevated radioactivity levels based on past operations. One approach would be to utilize local meteorological data and calculations together with atmospheric source terms to predict locations where the highest air concentrations would have occurred and collect environmental samples at these locations. It may also be useful to collect soil in two layers such as 0-10 cm and 10-20 cm and analyze each separately. This would detect activity that may have deposited on the surface in earlier years and migrated to lower levels. As part of this final environmental assessment it may also be useful to review historical environmental monitoring data and perform statistical analysis on data from individual sampling stations. Probability plots may be particularly useful for identifying points that are different from normal background values. Determination of mean concentration values and associated deviations from the mean for individual monitoring stations may aid in interpreting results.

Although routine environmental monitoring has been discontinued, radiological measurements are being performed in support of decontamination operations and will continue to be needed for close out surveys. Specific recommendations for program enhancements for radiological measurements and environmental monitoring are provided in Appendix A.

In accordance with the work plan the EPA Dempsey Report and the ORAU Berger report were reviewed with respect to conclusions and recommendations regarding environmental monitoring and decontamination surveys. These reviews are presented in Appendices B and C for the Dempsey and Berger reports, respectively.

APPENDIX A

RECOMMENDATION FOR ENHANCEMENT OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM AT SSFL

1. The Laboratory Quality Assurance program should be revised to include the following:

   a. Provide for the development and implementation of detailed operating procedures for all counting instruments. Procedures should include detailed instructions on setup, calibration, and operation.

   b. Implement regular quality control tests for gamma spectroscopy system with acceptance criteria and documentation of data via control charts. Tests should be performed daily or prior to use and include the following: energy calibration, detector efficiency, and detector resolution.

   c. Provisions should be made for periodic review of quality control data by the person(s) responsible for laboratory operations. Since the retirement of the laboratory manager, routine quality control associated with the Tennelec alpha/beta counter had not been routinely reviewed.

   d. Provisions should be made for implementing quality control of contract laboratories by submission of blind samples for analysis. In view of the limited laboratory facilities this could be accomplished by repackaging of EPA and DOE quality assurance samples and sending them to contractor laboratories for analysis.

   e. Improve internal laboratory quality assurance by analyzing DOE and EPA samples for gross alpha and beta activity. The number of samples that would be useful for this purpose are limited and the availability of other environmental test samples from NIST and IAEA should be investigated.

   f. Provide training for individuals performing radiological analyses. Establish minimum requirements and qualifications for all individuals. Training and Qualification records should be maintained.

2. Improve calibration of gamma spectroscopy systems by using soil standards rather than water equivalent standards. The current method for calibration could produce results that are as much as ten per cent lower than actual values. Although this is not a large bias, it is systematic and should be eliminated.

3. Calibrate gamma systems for counting single air filters and smears. These calibrations should be available in order to accurately identify radioactivity if isotopic analyses are dictated by gross radioactivity measurements.

4. Implement procedures and/or protocols with Rockwell Shipping and Receiving Department to ensure expeditious receipt of radionuclide standards at the SSFL site. Radioactivity standards that are needed for calibrations or testing have been held up at Rockwell Receiving area for months.

5. Efforts to hire a qualified person to operate the radiological measurements laboratory should continue to receive the highest priority. Until this position is filled the current staff should be supplemented with qualified part time or contract employees.

6. Calibration of alpha/beta counters for soil and water should be redone. Priority should be given to alpha calibrations in soil and water. If water measurements are to be continued, EPA or other standard methods should be used.

7. Whenever possible, environmental samples should be analyzed by gamma spectrometry in addition to gross alpha and beta activity measurements.

8. Perform periodic reviews and updates of procedures to assure that they are accurate and reflect current practice.

APPENDIX B

REVIEW OF EPA DEMPSEY REPORT

Rockwell International requested an independent review of the memorandum from Gregg D. Dempsey of the EPA Office or Radiation Programs-Las Vegas to Daniel M. Shane of Region 9 of the EPA that summarized the results of Mr. Dempsey's Site Visit to SSFL. The Dempsey memo was reviewed and the following assessment was made on the basis of my site visits and information provided by discussions with site personnel.

Evaluation of the environmental impact of the SSFL is difficult because the techniques and measurements that would be used today were not available or thought to be necessary during the operation of the SSFL site. The lack of specific radiochemical analyses makes it difficult to determine "what is different from background." It is, therefore, possible for "experts" in radiological environmental monitoring to differ in their conclusions while being as objective as possible.

I do not question the objectivity of Mr. Dempsey; however, in my opinion, this report was somewhat premature in that some of the reported "problems" were based on incomplete information or poor communication with Rockwell staff. This could have been avoided by providing a draft to Rockwell International prior to release. Since the EPA report did not involve an enforcement issue with respect to radioactivity, review by Rockwell would not have compromised the public's interest. It is my opinion that a thorough review of the SSFL environmental monitoring program would require substantially more effort than was expended during the EPA review.

While environmental monitoring is recommended for nuclear facilities with a potential for releasing radioactivity in quantities that could adversely impact the environment, it is only a small part of an overall program to protect the public and the environment. In my judgement the accurate measurement of radioactive emissions at the source is the most important means of ensuring the releases will not have an adverse impact on the environment and people living near the site. The measurement of radioactivity at the source provides more accurate identification and quantification of the radionuclides than is possible with environmental monitoring. Source term monitoring also provides information necessary for designing an effective environmental monitoring program based on critical pathways. The identification and measurement of radioactivity after dilution in the environment is difficult because of the low concentrations and contributions from natural radioactivity. If accurate source term information is available, sophisticated models are available to assess the environmental impact. Environmental monitoring plays an important role in : confirming that effluents are being adequately controlled, verifying model calculations, and in some cases identifying unmonitored or uncontrolled release pathways, and providing data for assessing the radiation exposure of residents living in the vicinity of the facility. Decisions regarding the impact of nuclear operations at SSFL on the environment cannot be made solely on the basis of environmental measurements.

The Dempsey memo addressed a number of specific practices or procedures at SSFL that he considered questionable. These will be addressed individually later in this review. It is important to first address the major concerns of this memo.

In my opinion the most serious concern of the Dempsey memo was "certain problems exist within this laboratory that make me question the validity of some, if not all of their environmental data." This concern was, in part, based on the fact that the laboratory had never received a thorough review by Rocketdyne or DOE. Although routine audits of a laboratory's program are recommended in various quality assurance documents including DOE and NRC sources, the failure to have a routine audit program is not sufficient cause to discredit the data generated by the laboratory. I also noted that the radiological effluent and environmental monitoring program has been inspected periodically by the NRC and no serious problems or violations were noted in this area. In addition, a private consultant under contract with Ventura County, provided an assessment and concluded that the environmental and effluent monitoring program was adequate. I spent two days with John Moore who retired approximately a month before I initiated my onsite review. Mr. Moore was responsible for measurements during a 30 year period which covers most of the operating history of the site. I found Mr. Moore to be quite knowledgeable, thorough, and competent with respect to laboratory operations. The analysis of samples by a single individual is a very positive factor in ensuring the quality, reliability, and reproducibility of measurements. Although the gross activity measurements in soil, water, and vegetation do not provide the information needed for quantitative dose assessments, these measurements can be used for screening purposes. Screening provides a means for making decisions as to whether a sample or series of samples contains elevated levels relative to background or control values. In my opinion the SSFL monitoring data are reliable for this purpose.

Another major concern was "the SSFL Radiological Lab needs updating badly." My site review identified a number of areas in the laboratory where recommendations have been made. The most serious concern at this time is the replacement of the laboratory manager who retired in March, 1990. With respect to the need improving the laboratory for environmental measurements, the routine environmental monitoring program has been discontinued. Since current operations involve decontamination of a few remaining facilities and the very small quantity of radioactivity left on site, there is no longer as need for an environmental monitoring program. Since the laboratory will continue to support close out surveys , decontamination efforts, and limited environmental measurements, improvements in the laboratory are needed.

The final major concern was stated as follows: "Rocketdyne does not have a good handle on where radiation has been inadvertently or intentionally dumped onsite." I am not aware of any documented instances where radioactivity was dumped intentionally. I reviewed a number of survey reports, internal memos, and discussed survey plans with Bob Tuttle, the Manager of Radiation and Nuclear Safety. It was my conclusion that Rockwell has, and is, expending substantial effort to identify contaminated areas. Based on past surveys, it appears that most contaminated areas have been identified and there are plans to decontaminate these areas to meet or exceed regulatory requirements. A major site survey with portable survey instrumentation is planned. The EPA recommendation regarding an aerial survey by the EG&G Energy Measurements group is valid; however, the survey should not be conducted until final decon-

tamination is complete and all radioactivity has been shipped offsite. The presence of radioactive material stored for shipment would interfere with aerial measurements and decrease the sensitivity for identifying any remaining surface contamination.

A review of specific problems identified by Dempsey relating to laboratory practices or environmental monitoring techniques follows:

1. Comment: "Gross activity is not a good method for assessing environmental radioactivity."

   Response: I agree that gross radioactivity measurements are not recommended and are of limited value for assessing radioactivity since these techniques do not identify or quantify individual radionuclides. This is especially true for soil samples where the natural radioactivity levels are high and there can be large variations depending on the losses of radon isotopes and radon daughters during sample preparation. As discussed in my review, gross activity measurements can be useful for screening samples or comparing with background or control samples. Although a single measurement is not very useful, a series of measurements over a long period of time provides information that will indicate if environmental levels have increased significantly.

2. Comments on soil procedure for gross activity measurements:

   a. Comment: "soils are heated...for 8 hours at 500°C...this temperature is sufficient to volatilize most man-made radionuclides of concern including Cs-137 and Sr-90."

      Response to a: Although Cs-137 is known to volatilize at temperatures near or in excess of 800°C, losses from volatilization in soil and vegetation are not expected to be significant at 500°C. A recent letter in a recent Health Physics Newsletter (April 1990) presented data that shows Cs-137 is retained in woodash even after combustion at temperatures in excess of 870-1100°C. The DOE Environmental Monitoring Laboratory manual recommends ashing at approximately 480°C to limit the possibility of volatilization. Subsequent tests of volatilization of Cs-137 from SSFL soil samples were conducted by SSFL staff. These tests showed that there were no significant losses of Cs-137 after heating for 8 hours at 500°C. To my knowledge there is no problem with volatilization of Sr-90 even at temperatures in excess of 800°C. Volatilization of technetium in soil could be a problem; however this is not a likely environmental contaminant at SSFL.

   b. Comment: "soil is sieved through a Coors crucible to obtain a uniform particle size...it is common practice that if one wants to obtain a uniform particle size, soil is ground in a machine designed for this purpose."

      Response to b: The SSFL method is designed to remove rocks and other non soil material, and I find no problem with the technique.

c. Comment: "two grams of soil are used in a planchet for counting . Because of absorption of the alpha and beta activity within the soil, the procedure has highly variable results. The procedure attempts to make a correction for this but it is not adequate."

Response to c: The variability of results is more likely related to the low counting efficiency for a 2 gram sample and the poor counting statistics. Since all samples contain 2 grams the self absorption factor would be the same for all samples. The relative concentrations reported for soil should be valid. There is some question as to accuracy of the efficiency used to calculate concentrations. This would affect the magnitude of the concentration but not affect accuracy on a relative basis. This means that SSFL results can be compared with each other; however, these results would probably not compare well with analyses provided by other organization.

d. Comment: "the environmental report states that samples are to be counted in a stainless steel planchet, but the current SSFL procedure states that a copper planchet is called for. This makes a difference in counting and calibration."

Response to d: Laboratory operations should be carried out in accordance with approved procedures. Stainless steel planchets were substituted for copper planchets due to their unavailability. The procedure should have been updated to accommodate the change to stainless steel planchets. Since the planchet dimensions are the same and thick samples are being counted, the change to stainless steel would not significantly affect counting efficiencies. The differences referred to would be most important in counting thin beta samples where backscatter significantly affects the counting efficiency. Since backscatter is a function of the atomic number (Z), the difference between copper ($Z = 29$) and stainless steel ($Z = 26$) would be negligible.

e. Comment: "Spike samples have apparently never been prepared and run through this procedure to provide internal quality control."

Response to e: The analysis of internal quality control would improve the program. Such samples would also provide information regarding the suitability of current preparation and calibration techniques.

3. Comment: "the procedure is to evaporate the water to dryness and count for gross alpha and beta radioactivity. I inspected the samples and found that alpha and beta self-absorption is, again, likely to be a problem."

Response: There appears to be some misconceptions with respect to this point. Self-absorption is considered in the calibrations. For beta counting of water samples, efficiencies are determined from relationships determined by counting different thicknesses of KCl. The beta activity is provided by K-40 which is present in natural potassium. It is recognized that the average beta energy is somewhat higher than expected from natural beta emitters in water. This would result in higher efficiencies and different self-absorption factors. For alpha particles the soil ef-

ficiencies for 2 gram samples are used for water samples. This represents a sample with infinite thickness compared to the alpha range. The SSFL water samples are rich in dissolved salts, and evaporation gives a thick deposit that is also normally infinitely thick compared to the alpha particle range. Although the methodology for calibration and self-absorption could be improved, the problems are not serious enough to negate the validity of the data for the purpose of identifying increased radioactivity levels.

4. Comment: "If past operations at Rocketdyne had produced airborne contamination and it settled on the surface of the vegetation instead of being absorbed through the roots, it is washed off before counting. Or it may have been volatilized during ashing at 500°C. Even so, I do not think the reasons were good enough to stop vegetation sampling."

   Response: It is true that washing of vegetation samples could remove radioactivity deposited from atmospheric emissions. SSFL has stated that the purpose for sampling of vegetation was to monitor potential uptake from soil. For this purpose the vegetation should have been washed. In retrospect soil uptake was not a likely mechanism for vegetation uptake at most locations where soil samples were collected and measurement of unwashed vegetation would have been an additional method for evaluating airborne releases in addition to soil. The vegetation sampling was discontinued because the site was in the process of being decommissioned and it was recognized that there was no longer a need for monitoring the uptake of radioactivity from soil.

5. Comment: "Part of a good environmental program involves checking other pathways to man thorough which radionuclides might travel. One of these is through meat samples obtained from feral species... This is not being done."

   Response: A good monitoring program is one that is based on an analysis of pathways for transport of radioactivity in the environment and ultimately the pathways for exposure of man. Environmental monitoring programs should be designed to monitor critical radionuclides and critical exposure pathways. Critical is used in the context of being the most important with respect to exposure of man. Environmental monitoring programs should be periodically reviewed and updated to reflect the information gained from past results. For example if analysis of soil samples indicated that atmospheric deposition could result in significant uptake by animals from forage and that these animals are a source of meat for people in the area, then samples of these animals should be analyzed. At the SSFL site there were no indications that feral species should be monitored since no elevated levels of radioactivity have been detected in environmental samples and hunting is not allowed onsite. Subsequent to the release of the Dempsey Report SSFL analyzed portions of a deer and rabbits obtained as a result of road kills near the site. No radioactivity associated with SSFL operations were detected in these samples.

6. Comment: Exception was taken to the method of draping a bag of air filters over the germanium detector instead of placing them in a Marinelli beaker and counting for 10,000 seconds instead of 36000 seconds as stated

   Response: This appeared to be point of miscommunication between the laboratory and Mr. Dempsey. The filters were draped over the counter for a preliminary view of the filters and the count time was in excess of 3600 seconds which is normally used. There was a typo in the procedure which indicated a count of 36000 seconds instead of 3600. A printout of this count was provided as a courtesy to Mr. Dempsey for his review and did not constitute the final count where the filters are placed in a marinelli beaker for counting.

7. Comment: "The laboratory also provides thermoluminescent dosimetry for the facility and offsite areas. Certain questionable practices are alluded to in the environmental report. data...is normalized to a 1000-ft altitude by using a adjustment factor equal to 15 mR/1000 ft....Also in both the calendar year 1987 and the unpublished calendar year 1988 SSFL environmental reports. comparisons ...by the State of California and a DOE intercomparison report were 'not available' for inclusion...This leads me to think that the SSFL dosimetry program may not compare favorably with the other groups."

   Response: I have not previously encountered the normalization technique used for making altitude corrections to dose rates; however, there is a technical basis for making such a correction. This data was derived from data presented in "Environmental Radioactivity," by Merrill Eisenbud in 1963. Although "experts" can debate the relative merits of making such a correction. it seems like a moot point since the original data is included in the report. The comment about the failure to include State of California and DOE data and the implication that it was not included because it would not agree with others is presumptuous of Mr. Dempsey. In fact the SSFL TLD results are generally higher than the State of California's by up to 25-40 per cent and this information has been published in previous reports. In reviewing the difference between dose rates at monitoring locations (at locations with elevated radiation levels compared to background) and control stations, the State data and SSFL show reasonably good agreement.

8. Comment: "SSFL or Rocketdyne has not collected soil or water samples to be analyzed for tritium."

   Response: Although tritium has been detected in two locations, the concentrations are very low. There has been no evidence of migration from the area where it was produced. The analysis of soil samples for tritium is of little value since tritium in soil will reflect the values observed with water. If there is not sufficient water to collect a sample, it is unlikely that tritium contamination of ground water would be a significant pathway for exposure. Since a detailed study of pollutants in groundwater is being carried out. it would be useful to analyze for tritium since it may provide information regarding site hydrology. In view of the limited source term for tritium from the reactors. the exclusion of tritium from the routine

monitoring program was a reasonable decision. Most environmental monitoring programs are not designed to analyze for every potential radionuclide. A sound program is based on the source term and potential for a pathway to man. There is no evidence that tritium was produced in sufficient quantities to be considered as a significant contributor to offsite doses even if there were subsurface migration to offsite groundwater.

9. Comment: "The lack of a meteorological tower onsite was mentioned as a concern (quote by Dempsey from DOE report). Better AIRDOS information could be generated with a closer-to-site or onsite met tower."

Response: The local topography is quite complex with hills and valleys. There are so many uncertainties associated with AIRDOS for a site with complex terrain like SSFL that it is unlikely that a site meteorological tower would be useful. In addition, the atmospheric emissions from the SSFL are so low that errors of several orders of magnitude would not be significant with respect to assessing doses from airborne releases. There are no significant sources of airborne radioactivity that would threaten the environment or the local population. This concern may have been valid when reactors and criticality assemblies represented significant source terms for airborne radioactivity. At this point in time I do not believe that a meteorological tower could be justified in terms of cost and need.

APPENDIX C

REVIEW OF THE BERGER REPORT, "REVIEW OF SURPLUS FACILITIES RADIOLOGICAL MONITORING SAINT SUSANA FIELD LABORATORIES VENTURA COUNTY, CALIFORNIA"

In September 1989 Oak Ridge Associated Universities conducted an onsite review at the SSFL site. This review was requested by the DOE to assess the capability of the SSFL radiological monitoring program to identify, characterize, and decommission areas associated with past and present DOE activities. The assessment was performed by Mr. James Berger and Dr. Clayton Weaver of ORAU. Both individuals are highly qualified and have been associated with close out surveys at DOE and NRC regulated sites to assess the efficacy of the licensees or contractors activities and radiological measurements.

The Berger report noted that the overall capabilities at SSFL in terms of staff, equipment, and procedures were adequate to perform the necessary radiological monitoring in support of site decommissioning. The report did note that there were several areas where improvements would strengthen the program. A list of seventeen recommendations were made to improve the program. I have reviewed these recommendations and will provide my assessment as to the need to implement the recommendations.

Item 1: Evaluate staffing requirements relative to the current and anticipated workload. Actively pursue staff replacements as determined appropriate. Initiate plans for replacement of laboratory head. Cross-train staff in key activities to provide backup capabilities.

I concur with this recommendation. The cross training of staff is particularly important in view of the limited number of employees in the Radiation and Nuclear Safety Group. Based on my observations it appears that the current staffing is not adequate to meet all the current demands and suggested program improvements such as procedure development.

Item 2: Evaluate potential low-energy beta analytical needs to determine whether acquisition of a liquid scintillation would be cost effective.

The SSFL facilities are not adequate to support the chemical separations that would be necessary for preparing samples for analysis of low energy beta emitters. This function should be contracted to a laboratory with the equipment and expertise necessary for these complex analyses.

Item 3. Develop additional detailed procedures, covering aspects of the monitoring program such as monitoring surveys and measurement of surface activity and exposure rates. Finalize revisions of procedures, as appropriate, and establish a regular schedule for procedure review and update.

I concur with this recommendation. During my review of the laboratory I noted the need for additional procedures and periodic review and updating of current procedures. Although some guidance with respect to survey techniques are given in Survey Plans for specific facilities, generic procedures for operation of survey instruments should be available for all instrumentation. These procedures should specify instrument checks, calibration frequency, and guidance for using the equipment for various types of surveys.

Item 4. Develop guidelines for residual concentrations of radionuclides in soils at SSFL. It is suggested that the DOE RESRAD program be used for this purpose.

This recommendation is currently being implemented. Prior to the Berger review, the necessary programs were obtained and staff attended training in the use of RESRAD.

Item 5: Use gross alpha and gross beta soil analysis only for screening purposes: develop radionuclide specific analyses for evaluating soil contamination levels.

This recommendation should be implemented in conjunction with Item 4. Specific nuclidic analyses should be performed if gross alpha or gross beta levels exceed a screening level. The screening level should be based on dose considerations using RESRAD and information regarding the most likely radioisotopes based on initial surveys and historical information. Gamma ray spectrometry should be used to the fullest extent possible. The need for other radionuclidic analyses can be based on the results of gamma analyses. For example if there are elevated levels of Cs-137 near the guidelines established in recommendation 4, it would normally be necessary to analyze for Sr-90 since both are fission products likely to be present together.

Item 6. Implement referencing of surveys to state and/or USGS grid systems.

This is considered good practice so that survey locations are unambiguous and can be relocated if necessary.

Item 7. Review surface gamma scanning procedures for improved identification of "hot spots" and small areas of contamination.

It was not clear to me why this particular recommendation was made. Previous decontamination projects and surveys by SSFL personnel have been reviewed by DOE, NRC, and contractors and were found to be acceptable.

Item 8. Develop a list of equipment detection capabilities.

This was presumably recommended to ensure that instrumentation being used is capable of demonstrating compliance with regulatory limits or guidelines. The equipment operating procedures would be an appropriate location to list an instrument's particular capabilities.

Item 9. Modify drying/ashing procedure for soil to reduce the peak temperature to 450°C. Also, evaluate possible effects of temperature on loss of other potential contaminants.

Although there is not likely to be a problem with ashing soil at 500°C, reduction of the ashing temperature to 450°C would decrease any chances of volatilization and not otherwise affect soil measurements. Test have been performed that show Cs-137 is not volatilized at 500°C. To my knowledge no other radionuclides that would volatilize (e.g. Tc-99, I-129) are expected to be present in soil at the SSFL site.

Item 10. Evaluate the use of alternate photopeaks for gamma spectrometry of certain radionuclides.

This has been evaluated by SSFL staff and the current practice for identifying radionuclides from characteristic photopeaks is acceptable. Certain photopeaks such as the 93 keV photopeak from Th-234 cannot be easily used due to limitations in the gamma spectral reduction software with respect to resolution of doublets. Specific recommendations with respect to using alternate photopeaks for U-235 are considered when the data is reviewed.

Item 11. Obtain a simulated soil matrix standard for gamma spectrometer calibration.

I concur with this recommendation since actual soil efficiencies may be ten per cent lower than those obtained with the solid standard that is currently used for calibrations.

Item 12. Develop a chain-of-custody procedure.

To my knowledge there have not been any specific problems identified as a result of not having such a procedure. DOE guidance for quality assurance does specify that chain-of-custody procedures should be developed. I would prefer the development of a system for identifying and tracking samples through the sampling and analytical process rather than chain-of-custody procedure. Chain-of-custody generally refers to a legalistic term for tracking of samples to ensure samples are always within protective custody. This is generally not necessary unless the sample results are to be used for legal action. The tracking procedure should implement a system for logging samples that are sent offsite for analysis to ensure that sample results are received in a timely manner.

Item 13. Initiate an auditable program of training and qualification of personnel in radiological monitoring procedures.

This is particularly important if new personnel are hired or individuals with limited health physics background are used in radiological surveys. Most of the current operational health physics staff are very experienced and would be "grandfathered" with respect to meeting training and qualification requirements.

Item 14. Develop and implement a program to assure periodic comprehensive audits of radiological monitoring activities, related to decommissioning. This program would include internal audit and audits by Rockwell, DOE, and external agencies.

There should be internal audits or audits by individuals who do not have responsibilities in this area. Scheduling of audits by DOE and other external agencies should not be a Rockwell responsibility. The number of audits should be limited since comprehensive audits require a substantial commitment of management time. Operations at SSFL are not so complex as to require audits by many different agencies.

Item 15. Initiate a program to include quality control samples for evaluating performance of commercial analytical laboratories.

I agree and have made specific recommendations in this regard in the body of my report. It should be noted that there are not many sources for obtaining quality control samples. This could be done inhouse, but generally this requires verification of the sample homogeneity and concentration after preparation. Sample verification could not be done inhouse.

Item 16. Implement a program to systematically characterize the radiological status of the entire SSFL Area IV site. This characterization should include evaluations of surface activity levels on structures and in surface and subsurface soils. The findings should be compared to applicable guidelines, including site-specific guidelines for soil, as established by DOE's Surplus Facilities Management Program.

This recommendation appears to go far beyond what is necessary to ensure that the site is properly decommissioned and safe for unrestricted use. Specifically, the characterization of the surface and subsurface over the entire SSFL site would be a monumental undertaking. It would appear that more detail should be provided by ORAU as to the scope of this characterization. It is my understanding that Rockwell intends to carry out a systematic survey of the surface with respect to surface radioactivity levels. The need for specific characterization of subsurface soil would be dictated by the survey results. An aerial survey by the EG&G survey group is being considered as a final survey after all radioactive material has been shipped offsite.

Item 17. Conduct additional investigations of questionable conditions identified at the remediated area of the T064 facility.

It is my understanding that decontamination activities have not been completed at this facility. The questionable conditions referred to in the Berger report will be corrected prior to final decommissioning.

ATTACHMENT 1

LIST OF DOCUMENTS REVIEWED

1. Rockwell International, "Nuclear Operations at Rockwell's Santa Susana Field Laboratory-A Factual Perspective," Facility Report N001ER000017.

2. Rockwell International, "Radiological Environmental Program Sampling Procedures, Analysis Procedures, and Radioactivity Measurement Methods," Number N001DWP00008, 7-9-84.

3. Rockwell International, "Radiological Environmental Program Quality Assurance," Number N001DWP000009, 10-3-84.

4. Rockwell International and Atomics International, "Environmental Monitoring and Facility Effluent Annual Reports Desoto and Santa Susana Field Laboratories Sites" 1969-1988.

5. Rockwell International, "Environmental Monitoring and Facility Effluent Annual Reports Desoto and Santa Susana Field Laboratories Sites" 1989 Draft Report, RI/RD90-132.

6. U.S. Department of Energy, "Environmental Survey, Preliminary Report, DOE Activities at Santa Susana Field Laboratories, Ventura County, California," DOE, Washington, D.C., February 1989.

7. U.S. Environmental Protection Agency, Memorandum from Gregg Dempsey to Daniel M. Shane, "Site Visit to Santa Susana Field Laboratory Operated by Rockwell Rocketdyne," July 28, 1989 and "Report on Environmental Samples Collected at the Rocketdyne Santa Susana Field Laboratory, July 1989," dated November 8, 1989.

8. Rockwell International, "Radiological Survey Plan for SSFL," Number 154SRR000001, 9-25-85.

9. Groundwater Resources Consultants Inc., "Draft Investigation of Naturally Occurring Radionuclides in Rock, Soils and Groundwater Santa Susana Field Laboratory Ventura County, California," 8640M-77, April 26, 1990.

10. Rockwell International, Memorandum to J.T. Davis, DOE from R.J. Tuttle, "Modification in Rocketdyne Radiological Environmental Monitoring Program," February 9, 1990.

11. Rockwell International, Internal Letter from J.D. Moore to R.J. Tuttle, "Trip Report-Audit of United States Testing Company."

12. U.S. Department of Energy, "Review of Surplus Facilities Radiological Monitoring Santa Susana Field Laboratories Ventura County, California," James Berger, December 1990.

13. Rockwell International Laboratory Records for Environmental Monitoring, 1969-1990.

14. Rockwell International and Atomics International, Annual Reviews of Radiological Controls, 1975-1984.

15. U.S. Nuclear Regulatory Commission, "Environmental Impact Appraisal of Commercial Fuel Fabrication Facilities Canoga Park and Chatsworth, California," Sept. 1977.

16. Groundwater Resources Consultants Inc. "Area IV Radiological Investigation Report SSFL Laboratory," 8640M-76, March 23, 1990.

17. Atomics International, "Environmental Impact Assessment of Operations at AI Under SNM-21," 1976.

18. Rockwell International, Radiological Environmental Monitoring Program, Number N001SRR140094, 18-8-86

19. U.S. Department of Energy , Quality Assurance Program Results, 1988-1989.

20. Rockwell International, Internal Memo Summarizing Results of Investigation of Volatility of Cs-137 Heated to 500°C, September 1989.

21. U.S. Department of Energy, DOE Orders Series 5480.

22. Rockwell International, GEN-ZR-0015, "Chapman Report on Radiological Survey of Twenty Five Locations within Area IV of the SSFL," 10/10/1988.

23. U.S. Department of Energy, Chapter 0524, "Standards for Radiation Protection," March 30, 1977.

24. Rockwell International, "Survey of NMDF, Building 055 Decontamination and Deactivation," 12-19-1986

25. Oak Ridge Associated Universities, "Final Report 1987, Confirmatory Radiological Survey Nuclear Material Development Facility (Building T-055)," July 1987.

26. U.S. Nuclear Regulatory Commission, SNM-21 License for Rockwell International Activities at SSFL, Renewed June 1984.

27. State of California, License 0015-70 Broad Scope Radioactive Materials License, Amended March 11, 1988, Expires on Sept. 11, 1993.

28. Rockwell International, Internal Report GEN-ZR-0008, "Radiological Survey of ESG Salvage Yard (Old), Rocketdyne Barrel Storage Yard and New Salvage Yard."

ATTACHMENT 2

LIST OF INDIVIDUALS CONTACTED

1. R.J. Tuttle, Manager, Radiation and Nuclear Safety, Rockwell International.

2. M.R. Davis, Vice President, Human Resources and Communications, Rockwell International.

3. J.D. Moore, Retired Employee Rockwell International, Formerly Laboratory Manager.

4. F.H. Badger, Health Physicist, Rockwell International.

5. J.H. Wallace, Health Physicist, Rockwell International.

6. V.B. Saba, Respiratory Protection Specialist, Rockwell International.

7. G.M. Watson, Instrumentation Technician, Rockwell International.