RI/RD85-123

ROCKETDYNE DIVISION
ENVIRONMENTAL MONITORING
AND
FACILITY EFFLUENT
ANNUAL REPORT
DE SOTO AND
SANTA SUSANA FIELD LABORATORIES SITES
1984

Rockwell International

Rocketdyne Division
6633 Canoga Avenue
Canoga Park, CA, U.S.A. 91304

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7.0 ENVIRONMENTAL MONITORING PROGRAM QUALITY CONTROL

This section describes the quality assurance (QA) elements that are incorporated into the Rocketdyne radiological analysis program to ensure that data produced are as meaningful as possible.

The following elements of quality control are used for the Rocketdyne program:

1. Reagent Quality – Reagent-grade chemicals and certified grade counting gas used.
2. Laboratory Ventilation – Room air supply is controlled to minimize temperature variance and dust incursion.
3. Laboratory Contamination – Periodic laboratory contamination surveys for fixed and removable surface contamination are performed. Areas are cleaned routinely and decontaminated when necessary.
4. Control Charts – Background and reference source control charts for counting equipment are maintained to evaluate stability and response characteristics.
5. Laboratory Intercomparisons – Rocketdyne participates in the DOE EML-QAP.
6. Calibration Standards – Counting standard radioactivity values are traceable to the NIST primary standards.

7.1 PROCEDURES

Procedures followed include sample selection; sample collection; packaging, shipping, and handling of samples for off-site analysis; sample preparation and analysis; the use of radioactive reference standards; calibration methods and instrument QA; and data evaluation and reporting.

7.2 RECORDS

Records generally cover the following processes: field sample collection and laboratory identification coding; sample preparation method; radioactivity measurements (counting) of samples, instrument backgrounds, and analytical blanks; and data reduction and verification.

Quality control records for laboratory counting systems include the results of measurements of radioactive check sources, calibration sources, backgrounds, and blanks, as well as a complete record of all maintenance and service.

Records relating to overall laboratory performance include the results of analysis of interlaboratory cross-check samples and other quality control analyses; use of standard (radioactive) reference sources; and calibration of analytical balances.

7.3 QUALITY ASSURANCE

Rocketdyne participates in the DOE Quality Assessment Program (QAP) operated by the Environmental Measurements Laboratory (EML) in New York for radiological analyses. During 1993, two sets of

samples were distributed: QAP XXXVIII and QAP XXXIX. A summary of results is shown in Table 7-1. While these comparisons involve sample types, geometries, and analyses that are not part of the routine procedures at the Rocketdyne laboratory, review of these results and those of the other laboratories shows a similar quality in most cases. In this summary, the values shown are the average ratios of the analytical result determined by each laboratory relating to the reference result (EML). Ideally, these should equal that of the reference laboratory, 1.00.

Table 7-1. Summary of QAP-XXXVIII and -XXXIX Results (Sheet 1 of 2)

Laboratory Identifier	Number of Results	Result Compared to Reference		
		Unweighted		
		Minimum	Average	Maximum
YP	8	0.21	0.82	1.09
HC	2	0.69	0.83	0.97
PI	14	0.17	0.89	2.12
MI	37	0.45	0.89	1.89
AW	26	0.45	0.90	1.20
BP	35	0.52	0.91	1.12
CA	29	0.45	0.93	1.27
ML	50	0.51	0.94	1.57
SR	58	0.08	0.95	1.45
SC	36	0.55	0.95	1.64
IE	50	0.43	0.96	1.19
EC	74	0.26	0.97	2.23
HA	33	0.20	0.97	1.50
BC	17	0.62	0.97	1.14
BA	38	0.73	0.97	1.27
AU	77	0.00	0.98	2.48
EN	61	0.10	0.99	2.30
NL	7	0.64	0.99	1.39
ST	36	0.32	0.99	1.49
TN	58	0.42	0.99	1.39
LH	76	0.49	0.99	1.36
EML (reference)	91	1.00	1.00	1.00
WI	11	0.91	1.00	1.12
HS	67	0.76	1.00	1.28
IN	40	0.75	1.00	1.28
GA	60	0.50	1.00	1.29
OR	68	0.44	1.00	1.53
BR	37	0.65	1.00	1.56
SK	33	0.84	1.01	1.18
OS	37	0.06	1.01	1.78
NC	8	0.84	1.02	1.16
EP	48	0.54	1.02	1.47
GE	68	0.23	1.02	1.84
BL	64	0.41	1.02	2.85
BN	35	0.77	1.02	2.58
SA	12	0.91	1.03	1.11
OL	32	0.85	1.03	1.23
LL	55	0.85	1.03	1.38
WA	83	0.56	1.03	1.80
FN	45	0.34	1.03	2.31
FL	46	0.71	1.03	2.03
AP	44	0.57	1.03	3.01
RI	56	0.25	1.04	2.53
AS	82	0.56	1.05	1.78
AN	77	0.42	1.05	2.42
EE	52	0.19	1.05	2.27
UY	36	0.44	1.05	3.48
AE	33	0.65	1.06	1.44
ET	68	0.63	1.06	1.57
SE	21	0.60	1.06	1.57
AR	80	0.24	1.06	4.76
NA	34	0.58	1.07	2.00

Table 7-1. Summary of QAP-XXXVIII and -XXXIX Results (Sheet 2 of 2)

Laboratory Identifier	Number of Results	Result Compared to Reference		
		Unweighted		
		Minimum	Average	Maximum
UK	41	0.49	1.07	3.56
RG	10	0.93	1.08	1.14
UC	35	0.32	1.08	3.55
RE	58	0.49	1.09	1.50
RF	19	0.90	1.09	1.97
CC	38	0.65	1.09	2.86
NR	5	0.96	1.10	1.25
TM	79	0.52	1.10	2.26
IS	75	0.41	1.10	3.55
LW	12	0.99	1.11	1.25
MA	6	0.91	1.11	1.29
BQ	20	0.81	1.11	2.40
TO	69	0.53	1.11	2.24
TI	66	0.04	1.11	15.5
BX	76	0.37	1.13	3.28
IR	5	1.02	1.15	1.22
CP	49	0.36	1.17	3.62
PA	18	0.25	1.18	3.32
HR	14	0.36	1.19	2.28
AG	30	0.33	1.19	16.5
BE	69	0.56	1.20	5.03
SS	4	1.10	1.22	1.44
LA	58	0.10	1.26	9.66
CL	35	0.56	1.31	2.57
HL	23	0.62	1.34	4.48
Rocketdyne	50	0.03	1.43	7.73
DC	39	0.00	1.44	9.68
PC	42	0.20	1.48	11.7
AT	23	0.52	1.49	5.89
HI	21	0.83	1.50	2.41
LM	24	0.78	1.50	3.88
BM	58	0.02	1.55	21.9
WS	3	1.11	1.68	2.77
ES	73	0.57	1.69	28.7
RA	47	0.34	1.91	17.2
WN	58	0.68	1.94	51.6
EG	53	0.31	2.16	55.0
NJ	25	0.58	2.23	29.1
OI	17	0.86	2.50	13.9
IT	78	0.53	14.4	1040
AC	71	0.06	14.8	974
WP	62	0.00	16.3	940
OA	58	0.45	19.4	1040
KA	29	0.85	36.5	1030
WV	57	0.04	198.	10100
Minimum		0.00	0.82	0.97
Average	Total	0.51	4.17	160
Maximum	4147	1.11	198.	10100

APPENDIX A

NPDES PERMIT CA0001309

The Board has notified the discharger and interested agencies and persons of its intent to renew waste discharge requirements for this discharge and has provided them with an opportunity to submit their written views and recommendations.

The Board, in a public hearing, heard and considered all comments pertaining to the discharge and to the tentative requirements.

This Order shall serve as a National Pollutant Discharge Elimination System permit pursuant to Section 402 of the Federal Water Pollution Control Act, or amendments thereto, and shall take effect at the end of 10 days from the date of its adoption, provided the Regional Administrator, EPA, has no objections.

IT IS HEREBY ORDERED, that Rockwell International Corporation, Rocketdyne Division, in order to meet the provisions contained in Division 7 of the California Water Code and regulations adopted thereunder, and the provisions of the Federal Water Pollution Control Act and regulations and guidelines adopted thereunder, shall comply with the following:

A. Effluent Limitations

7. The discharge shall be limited to filtered domestic wastewater and industrial wastewater only, as proposed.
8. The discharge of an effluent in excess of the following limits is prohibited:

Constituent	Units	Discharge Limitations Maximum
Total dissolved solids	mg/L	950
	lb/day*	1,267,680
BOD_5 20°C	mg/L	30
	lb/day*	40,035
Oil and grease	mg/L	15
	lb/day*	20,020
Chloride	mg/L	150
	lb/day*	200,160
Sulfate	mg/L	300
	lb/day*	400,320
Fluoride	mg/L	1.0
	lb/day*	1,340
Boron	mg/L	1.0
	lb/day*	1,340
Surfactants (as MBAS)	mg/L	0.5
	lb/day*	667
Residual chlorine	mg/L	0.1

*Based on a total waste flow of 160 million gal per day.

9. The daily discharge rate shall be obtained from the following calculation for any calendar day:

$$\text{Daily discharge rate} = \frac{8.34}{N} \sum_{1}^{N} Q_i \, C_i$$

in which N is the number of samples analyzed in any calendar day. Q_i and C_i are the flow rate (MGD) and the constituent concentration (mg/L), respectively, which are associated with each of the N grab samples that may be taken in any calendar day. If a composite sample is taken, C_i is the concentration measured in the composite sample and Q_i is the average flow rate occurring during the period over which samples are composited.

10. The pH of wastes discharged shall at all times be within the range 6.0 to 9.0.

11. The temperature of wastes discharged shall not exceed 100°F.

12. Wastes discharged shall not contain visible oil or grease, and shall not cause the appearance of grease, oil or oily slick, or persistent foam in the receiving waters or on channel banks, walls, inverts, or other structures.

13. Wastes discharged shall not cause the formation of sludge deposits.

14. Neither the disposal nor any handling of waste shall cause pollution or nuisance.

15. Wastes discharged shall not damage flood control structures or facilities.

16. This discharge shall not cause a violation of any applicable water quality standard for receiving waters adopted by the Regional Board or the State Water Resources Control Board as required by the Federal Water Pollution Control Act and regulations adopted thereunder. If more stringent applicable water quality standards are promulgated or approved pursuant to Section 303 of the Federal Water Pollution Control Act, or amendments thereto, the Board will revise and modify this Order in accordance with such more stringent standards.

17. Wastes discharged shall not increase the natural turbidity of the receiving waters at the time of discharge.

18. Oil, oily material, chemicals, refuse, and other wastes shall not be stored or placed where they could be picked up by rainfall and discharged to surface waters.

19. The wastes discharged shall not contain phenols, mercaptans, or other substances in concentrations that would impart taste, odors, color, foaming or other objectionable characteristics to receiving waters.

20. The wastes discharged shall not cause receiving waters to contain any substance in concentrations toxic to human, animal, plant, or fish life.

21. Radioactivity shall not exceed the limits specified in Title 17, Chapter 5, Subchapter 4, Group 3, Article 3, Section 30269 of the California Administrative Code.

22. Domestic wastes discharged to watercourses shall at all times be adequately disinfected. For the purpose of these requirements, the wastes shall be considered adequately disinfected if the median number of coliform organisms at some point in the treatment process does not exceed 2.2 per 100 milliliters and the number of coliform organisms does not exceed 23 per 100 milliliters in more than one sample within any 30-day period. The median value shall be determined from samples taken on seven sampling days each week, at least one sample per sampling day, collected at a time when wastewater flow and characteristics are most demanding on the treatment facilities and disinfection procedures.

23. Domestic wastes discharged to watercourses shall have received treatment equivalent to that of a filtered wastewater.

    Filtered wastewater means an oxidized, coagulated, clarified wastewater that had been passed through natural undisturbed soils or filter media, such as sand or diatomaceous earth, so that the turbidity as determined by an approved laboratory method does not exceed an average operating turbidity of 2 turbidity units and does not exceed 5 turbidity units more than 5 percent of the time during any 24-hour period.

    Nothing herein shall be construed to prevent the use of any alternative treatment process(es) provided that they can be demonstrated to the satisfaction of the Executive Officer to achieve compliance with the effluent limitations and requirements.

24. The average final effluent concentrations shall not exceed 15 percent by weight of the average sewage treatment plant influent concentrations of BOD_5 20°C and suspended solids during periods of discharge.

25. Wastes discharged shall not contain heavy metals, arsenic, or cyanide in concentrations in excess of the mandatory limits contained in the current California Department of Health Drinking Water Standards.

26. The toxicity of the effluent shall be such that in a standard 96-hour static or flow-through bioassay in undiluted effluent at least 90 percent of test organisms shall survive at least 90 percent of the time with no single test producing 70 percent of survival.

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APPENDIX B

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APPENDIX C

STATUS OF NEPA COMPLIANCE ACTIVITIES—FY 1993

STATUS OF NEPA COMPLIANCE ACTIVITIES
Fiscal Year 1993

Item	Level/ DOE No.	NEPA Determination for:	Remarks/Action
1	CX ET-EM-93-01	MSOP Treatability Studies	DOE-OAK approved 12/17/92, DRF-2235
2	CX	Space Station Assembly Support	DOE-ETEC approved 12/07/92, DRF 2171
3	CX ET-NE-93-02	Demonstrating a Retrofitted, Post-combustion NOx Removal System on a Natural Gas Fired Heater – Cannon Digester	DOE-OAK approved 05/25/93, DRF-0925
4	CX ET-NE-93-03	NOx Removal Catalyst Demonstration System on a Pressurized Natural Gas Fired Heater - SRI	DOE-OAK approved 05/25/93, DRF-1225
5	CX ET-EM-93-04	Environmental Site Characterization at ETEC	DOE-OAK approved 07/28/93, DRF-1267
6	CX ET-NE-93-05	Natural Gas Engine Emissions Control Systems Test	DOE-OAK approved 07/28/93, DRF-1266
7	CX ET-NE-93-06	Removal and Cleaning of the Few Tube Test Model Steam Generator	DOE-OAK approved 08/02/93, DRF-1297
8	CX ET-NE-93-07	Electromagnetic (EM) Pump Test	DOE-OAK approved 09/23/93, DRF-1613
ADM – Action Description Memorandum, CX – Categorical Exclusion, EA – Environmental Assessment, EIS Environmental Impact Statement			

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APPENDIX D

ACRONYMS

ACM	asbestos–containing materials
ALARA	As Low As Reasonably Achievable
ANL	Argonne National Laboratory
AOC	Areas of Concern
ASL	above sea level
ATIR	Air Toxics Inventory Report
BOD	biological oxygen demand
$BOD_5$20°C	biological oxygen demand, 5–day at 20°C
B/100	Building 100 at SSFL
CAA	Clean Air Act
CARB	California Air Resources Board
CEM	Continuous Emission Monitoring
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CO	carbon monoxide
CRWQCB	California Regional Water Quality Control Board
CTC	Clemson Technical Center
CWA	Clean Water Act
CX	Categorical Exclusion
D&D	decontamination and decommissioning
DCG	Derived Concentration Guide
DHS	Department of Health Services
DL	detectable limit
DOE	Department of Energy
DOE–OAK	Department of Energy – Oakland Office
DOE–SF	Department of Energy–San Francisco Office
DS104	Building 104 at De Soto site
DTSC	Cal–EPA Department of Toxic Substances Control
EA	Environmental Assessment
EIS	Environmental Impact Statement
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
ETEC	Energy Technology Engineering Center
FONSI	Finding of No Significant Impact
GWRC	Groundwater Resources Consultants, Inc. (Tucson, AZ)
HAR	Hydrogeological Assessment Report
HEPA	high–efficiency particulate air

HMET	Hazardous Materials Elimination Team
HRS	Hazard Ranking System
HSWA	Hazardous and Solid Waste Amendments of 1984
HWMF	Hazardous Waste Management Facility
ICP	Inductively Coupled Plasma
LLD	lower limit of detection
MBAS	methylene blue active substances
MCL	Maximum Contamination Level
MGD	million gallons per day
MPC	maximum permissible concentration. air, or water
MSOP	Molten Salt Operation Program
MSTF	Molten Salt Test Facility
MWD	Metropolitan Water District
NASA	National Aeronautics and Space Administration
ND	not detected
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NIST	National Institute of Standards and Technology
NOD	Notice of Deficiency
NOI	Notice of Intent
NOV	Notice of Violation
NOx	oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NSPS	New Source Performance Standards
ODS	ozone depleting substance
PAH	polynucleararomatic hydrocarbon
PA/SI	Preliminary Assessment/Site Investigation
PCB	polychlorinated biphenyl
PCE	perchloroethene
QA	quality assurance
QAP	Quality Assessment Program
QC	quality control
QUAP	Quality Assessment Plan
R&D	research and development
RCP	Radiological Characterization Plan
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RHB	Radiologic Health Branch
RIHL	Rockwell International Hot Laboratory

RMDF	Radioactive Materials Disposal Facility
RMMA	Radioactive Materials Management Areas
ROC	reactive organic compound
ROD	Record of Decision
ROV	Report of Violation
RWQCB	Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SBP1	Sodium Disposal Facility Burn Pit 1
SBP2	Sodium Disposal Facility Burn Pit 2
SCP	Site Characterization Plan
SCTI	Sodium Component Test Installation
SNAP	Systems for Nuclear Auxiliary Power
SPCC	Spill Prevention Control and Countermeasure
SPTF	Sodium Pump Test Facility
SRE	Sodium Reactor Experiment
SRI	Stanford Research Institute
SSFL	Santa Susana Field Laboratory
SSME	Space Shuttle Main Engine
SWPPP	Storm Water Pollution Prevention Plan
STL–IV	Systems Test Laboratory, Area IV
SVOC	semi–volatile organic compound
SWMU	Solid Waste Management Unit
TCE	trichloroethylene
TLD	thermoluminescent dosimeter
TPCA	Toxic Pits Cleanup Act
TSDF	Treatment, Storage, and Disposal Facility
USEPA	United States Environmental Protection Agency
UST	underground storage tank
UV	ultraviolet
VCAPCD	Ventura County Air Pollution Control District
VCEHD	Ventura County Environmental Health Division
VCPWA	Ventura County Public Works Agency
WDR	Waste Discharge Requirement

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By
J. D. Moore

APPROVED: R J Tuttle

R. J. TUTTLE
Manager
Radiation and
Nuclear Safety

Rockwell International
Rocketdyne Division
6633 Canoga Avenue
Canoga Park, California 91304

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FIGURES

I. INTRODUCTION

In a Rockwell International Corporation organizational realignment, effective on 1 October 1984, the Energy Systems Group was merged with Rocketdyne Division and is no longer a separate organization. Annual Reports will hereafter reflect this change. Environmental and facility effluent radioactivity monitoring at the Rocketdyne Division of Rockwell International (California operations) is performed by the Radiation and Nuclear Safety Group of the Health, Safety, and Environment Department. Soil, vegetation, and surface water are routinely sampled to a distance of 10 miles from Division sites. Ground water from site supply water wells and other test wells is periodically sampled to measure radioactivity in these waters. Continuous ambient air sampling and direct radiation monitoring by thermoluminescent dosimetry are performed at several onsite and offsite locations for measuring airborne radioactivity concentrations and site ambient radiation levels. Radioactivity in emissions discharged to the atmosphere from nuclear facilities is continuously sampled and monitored to ensure that amounts released to unrestricted areas are below appropriate limits and to identify processes that may require additional engineering safeguards to minimize radioactivity in such discharges. In addition, selected nonradioactive chemical constituent concentrations in surface water discharged to unrestricted areas are determined. The environmental radioactivity reported herein is attributed to natural sources and to fallout of radioactive material from past atmospheric testing of nuclear devices.

Work in nuclear energy research and development in what has become the Rocketdyne Division of Rockwell International Corporation began in 1946. Rocketdyne is currently working on the design, development, fabrication, and testing of components and systems for central station power plants, on the decladding of irradiated nuclear fuel, and on the Decontamination and Disposition of Facilities (D&D) program.

The administrative and scientific research facilities associated with these efforts are located at the De Soto site in Canoga Park, California (Figure 1), approximately 23 miles northwest of downtown Los Angeles. This level

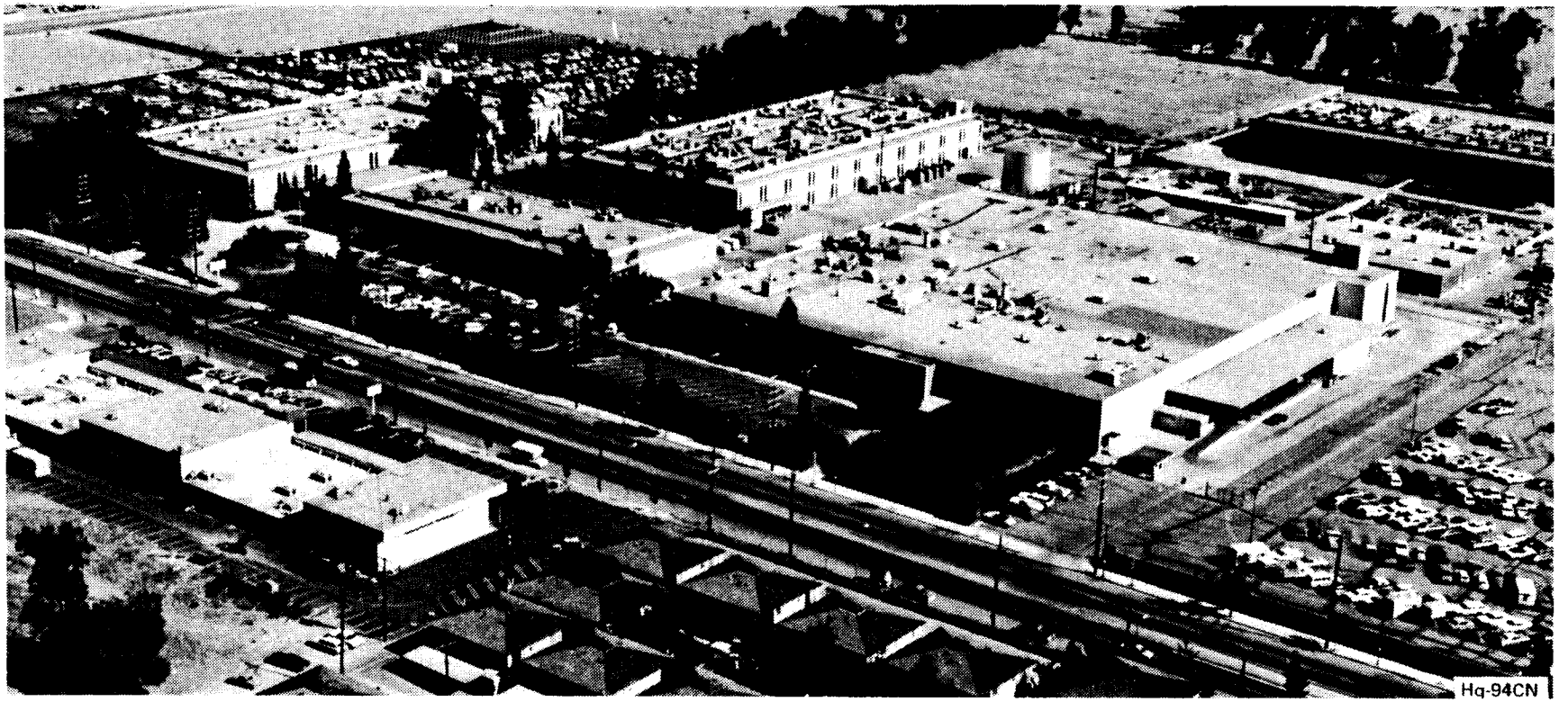

Figure 1. Rocketdyne Division – De Soto Site

site, typical of the San Fernando Valley floor, is at an altitude of 875 ft above sea level. Several nuclear research programs, licensed by the State of California, are conducted here. These include Building 104 analytical chemistry and applied nuclear research laboratories and the gamma irradiation facility containing approximately 35 kCi of ^{60}Co. The 290-acre Santa Susana Field Laboratories (SSFL) site (Figure 2) is located in the Simi Hills of Ventura County, approximately 30 miles northwest of downtown Los Angeles. The SSFL site, situated in rugged terrain typical of mountain areas of recent geological age, is underlain by a sandstone bedrock unit called the upper cretaceous Chatsworth formation. The site may be described as an irregular plateau sprinkled with outcroppings above the more level patches and with peripheral eroded ravines. Elevations of the site vary from 1650 to 2250 ft above sea level. The surface mantle consists of unconsolidated gravel, sand, silt, and clay. Both Department of Energy (DOE) and Rockwell International owned facilities, shown in Figure 3, share this site. The SSFL site also contains facilities in which nuclear operations licensed by the U.S. Nuclear Regulatory Commission and the State are conducted. The licensed facilities include: (1) the Rockwell International Hot Laboratory (RIHL), Building 020; (2) the Nuclear Materials Development Facility (NMDF), Building 055; (3) a former neutron radiography facility containing the defueled L-85 nuclear examination and research reactor, Building 093; and (4) several X-ray and radioisotope industrial radiography inspection facilities. The location of these sites in relation to nearby communities is shown in Figure 4. Much of the land surrounding the De Soto site is used for light industry and other commercial uses and for residential apartments and single-family dwellings. Most of the land surrounding the SSFL site is barren, with some minor cattle grazing on the southern portion and some orchard farming at the eastern boundary. At greater distances, residences and some light industries become prevalent. Within 30 km of the SSFL site, there is no significant agricultural land use and, except for the Pacific Ocean about 20 km south, no significant body of water reserved for recreational use. There are four major reservoirs within 50 km of the site, which provide most of the greater Los Angeles domestic water supply. The nearest of these is more than 16 km distant.

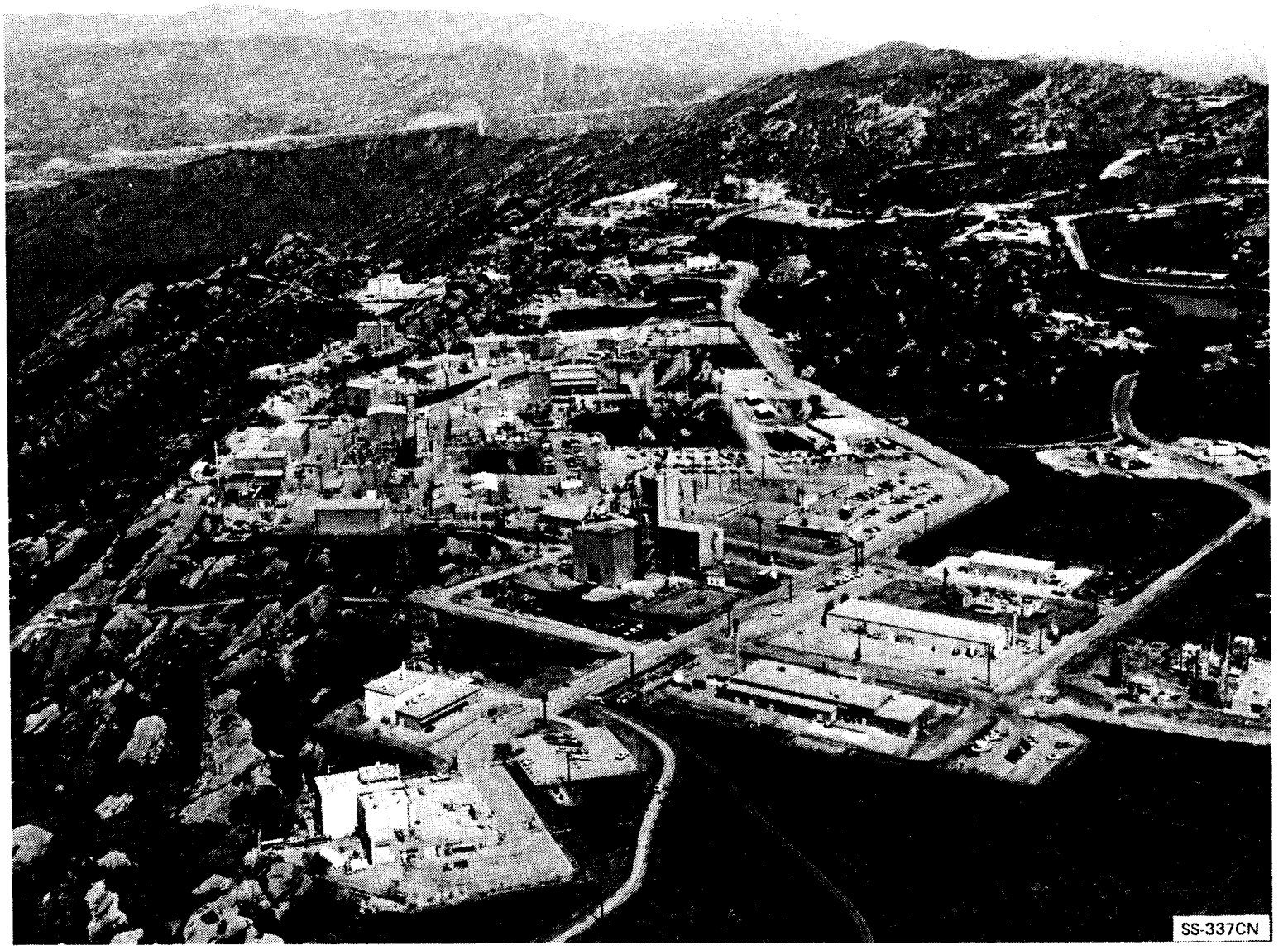

Figure 2. Rocketdyne Division — Santa Susana Field Laboratories Site

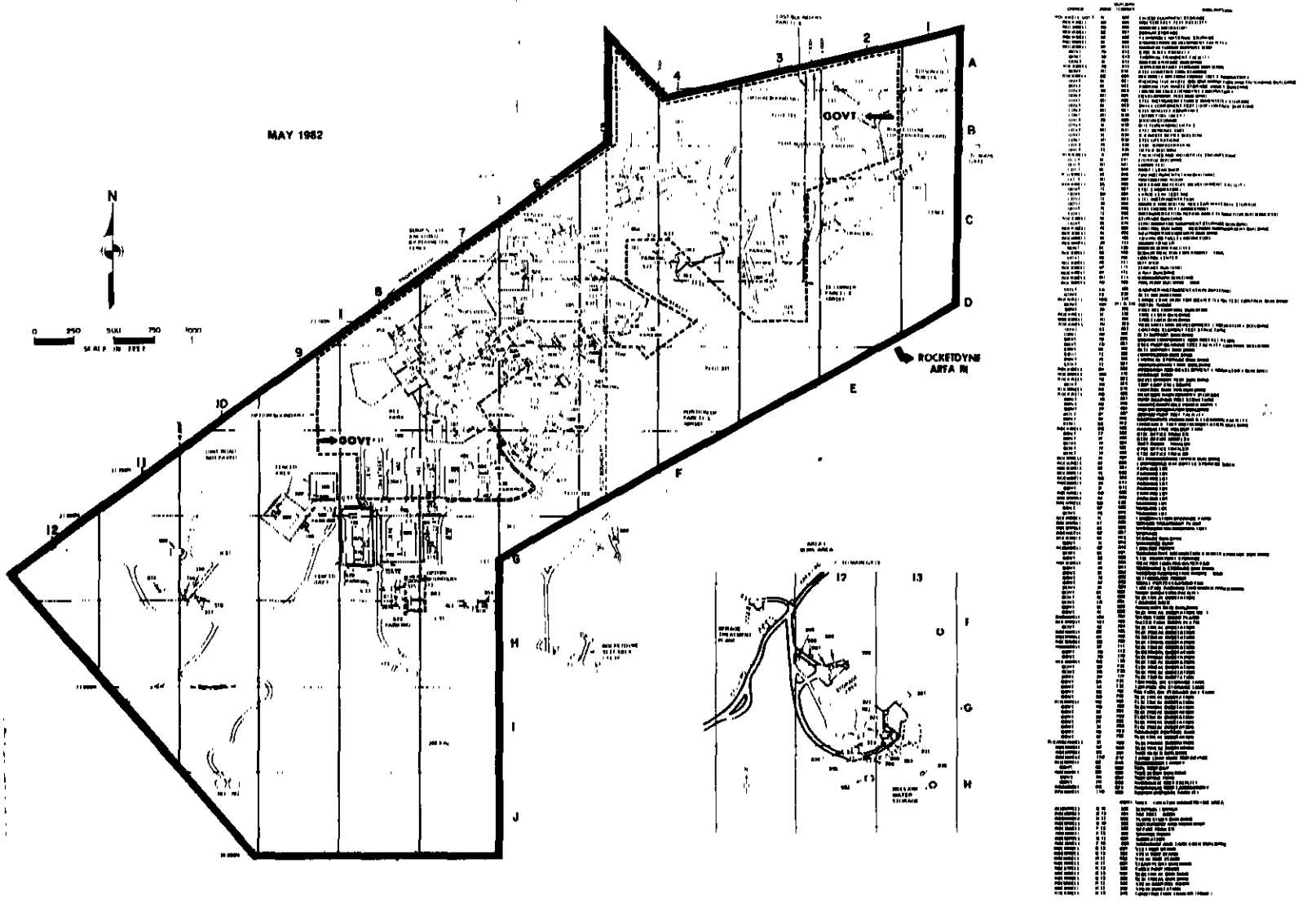

Figure 3. Map of Santa Susana Field Laboratories Site Facilities

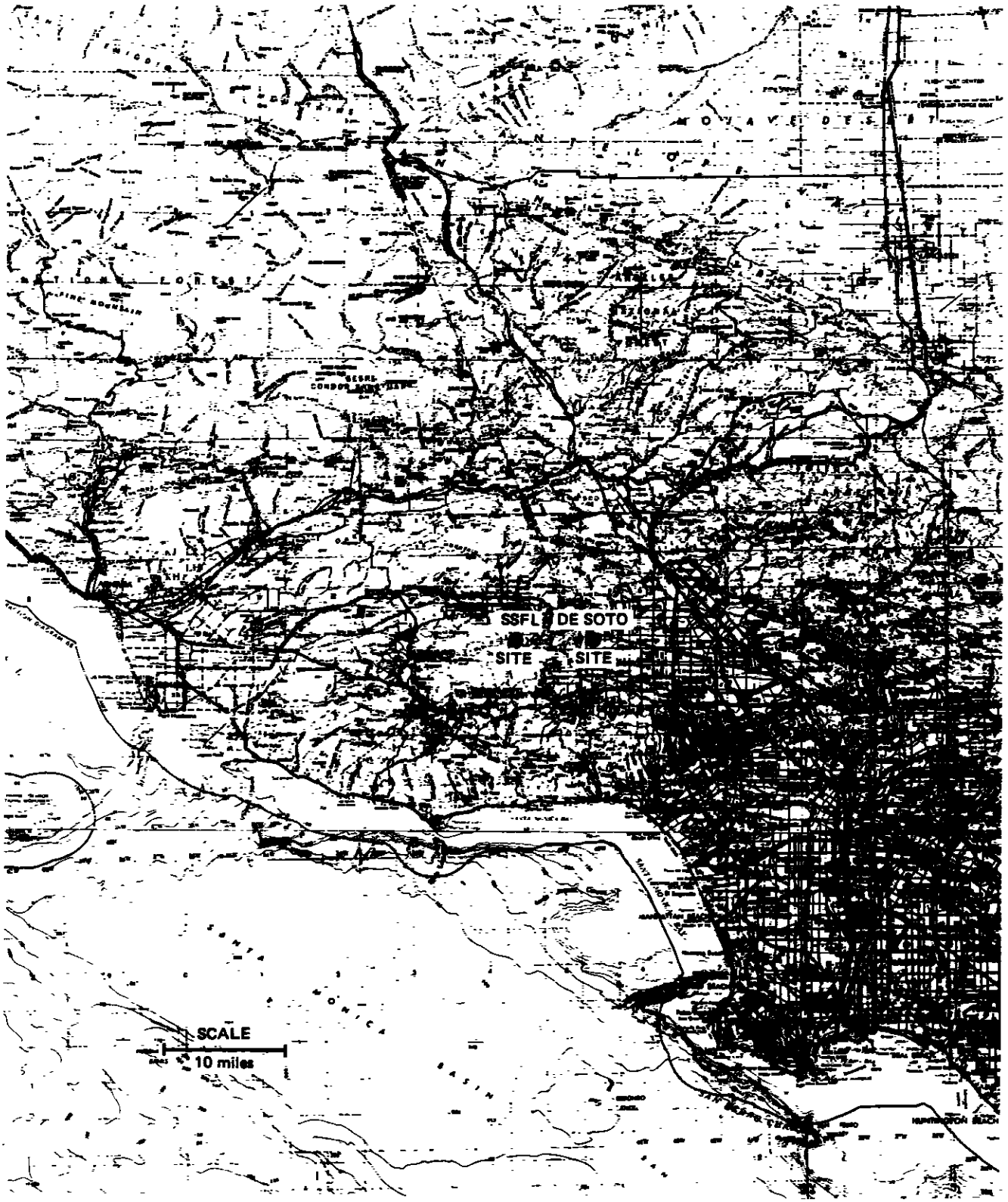

Figure 4. Map of General Los Angeles Area

Included within the SSFL site is an 82-acre government-optioned area where DOE contract activities are conducted, primarily by the nonnuclear Energy Technology Engineering Center (ETEC). The major operational nuclear installation within the DOE optioned area is the Radioactive Material Disposal Facility (RMDF), Buildings 021 and 022. This facility is used for storage of irradiated fuel and for packaging radioactive wastes generated as a result of the D&D program and fuel decladding operations. Several deactivated nuclear reactor and support facilities, all within the optioned area, are affected by the D&D program.

Licensed programs conducted during 1984 included: (1) the operation of the RIHL for nuclear reactor fuel decladding and reactor system component examination and the fabrication of sealed radiation sources and (2) the continued decommissioning and dismantling of a nuclear fuel research and development facility formerly used for the fabrication of experimental test reactor fuel involving plutonium and uranium.

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

Occasional gamma-spectral analyses of bulk samples such as soil, water, and air confirm that the major radionuclides present are those of the naturally occurring thorium and uranium decay chains, plus other natural radionuclides such as the primordial ^{40}K, and ^{7}Be, produced by cosmic ray interactions in the atmosphere.

In addition to environmental monitoring, work area air and atmospheric emissions are continuously monitored or sampled, as appropriate. This provides a direct measure of the effectiveness of engineering controls and allows remedial action to be taken before a significant release of hazardous material can occur.

Environmental sampling stations located within the boundaries of the De Soto and SSFL sites are referred to as "onsite" stations; those located outside these boundaries are referred to as "offsite" stations. The De Soto and SSFL sites are sampled monthly to determine the concentration of radioactivity in typical surface soil, native vegetation, and water. Soil is sampled onsite (SSFL) and offsite semiannually for plutonium analysis. Similar offsite environmental samples, except for plutonium analysis, are obtained quarterly. Continuous ambient air sampling provides information concerning long-lived airborne particulate radioactivity. Onsite ambient radiation monitoring utilizing thermoluminescent dosimetry (TLD) measures environmental radiation levels at the De Soto and SSFL sites and also at several offsite locations.

Nonradioactive wastes discharged to unrestricted areas are limited to liquids released to sanitary sewage systems and to surface water drainage systems. No intentional releases of any liquid pollutants are made to unrestricted areas. Sanitary sewage from all DOE and Rocketdyne facilities at the SSFL site is treated at an onsite sewage plant. The plant outfall drains into retention pond R-2A, located toward the southern portion of SSFL. The surface water drainage system of SSFL, which is composed of catch ponds and open drainage ditches, also drains to retention pond R-2A. Water from the pond may be reclaimed as industrial process water or released, as necessary, offsite into Bell Creek, a tributary of the Los Angeles River. The pond is periodically sampled for radioactivity and sampled at discharge for both radioactive and nonradioactive pollutants as required by the discharge permit issued to Rocketdyne Division by the California Regional Water Quality Control Board.

This report summarizes environmental monitoring results for 1984. The sampling and analytical methods used in the environmental monitoring program

for radioactive materials are described in Section III. A comparison of 1984 radioactivity results with results from previous years appears in Appendix A, with a summary of the Environmental Monitoring Quality Control Program in Appendix B. Appendix C shows regulatory limits on nonradioactive pollutants in water released from the site. References are listed in Appendix D.

II. SUMMARY AND EVALUATION OF ENVIRONMENTAL MONTORING RESULTS

All radioactivity levels observed in environmental samples for 1984 show close agreement with radioactivity levels measured during recent years and reported in previous issues of this report. Local environmental radioactivity levels, which result from both primordial and man-made radionuclides and showed the presence of fallout from past atmospheric testing of nuclear devices, have decreased to generally constant levels during the past several years. These levels are now due mainly to the primordial radionuclides. The local effects of foreign atmospheric nuclear tests, which had been readily observable in daily ambient airborne radioactivity levels, were not evident in 1984. The long-term effect of airborne radioactivity on surface sample radioactivity levels also has not been discernable in recent years. The continuing relative constancy in environmental radioactivity levels is due primarily to the dominance of naturally occurring radionuclides in the environment.

The results of this environmental monitoring indicate that there are no significant sources of unnatural radioactive material in the vicinity of the Rocketdyne sites. Additionally, identical results obtained for onsite and offsite samples further indicate that there is no contribution to general environmental radioactivity that is attributable to nuclear operations at Rocketdyne. Potentially significant exposure pathways to the general public resulting from Rocketdyne nuclear operations are limited to the atmospheric discharge of radioactive materials for which the only exposure pathways to people result from whole body external exposure and from inhalation exposure to released materials, and to direct radiation exposure of individuals and the general public beyond the site boundary. No discharge of liquid radioactive wastes is made to the environment. All such materials are processed for disposal at regulated disposal sites.

The maximum individual annual exposures estimated for persons at the fence-line boundary and also at the residence nearest the SSFL site are negligible compared with natural radiation and all applicable guidelines. The estimates of exposure due to inhalation at the boundary (ranging from 0.002 to

2.9 μrem) and the nearest residence (0.001 to 0.9 μrem) were derived from the AIRDOS-EPA calculated concentrations at those locations and incorporated the dose conversion factor appropriate for radionuclides in process at each nuclear facility. This inhalation exposure estimate is the sum of contributions calculated for the measured releases from each facility. The external radiation exposure estimates for the hypothetical maximally exposed individual at the fence-line boundary (1 mrem) and at the nearest residence (0.04 mrem) were determined by calculating the unattenuated exposure expected at the boundary and nearest residence on the basis of the single highest onsite TLD measurement, with the assumption that the RIHL is the source of the exposure using actual point-to-point distances in the calculation. This exposure estimate is very conservative in that a direct unattenuated line of sight does not exist between the assumed source and any offsite individual, as it does for the TLD location. The topography of the SSFL site surrounding the nuclear facilities and out to the site boundary is extremely irregular. Hills and rock outcroppings shield the offsite areas, significantly reducing offsite exposures from onsite sources.

Similarly for the De Soto site, internal dose estimates at the boundary (0.04 to 19 μrem) and at the nearest residence (0.01 to 5 μrem) are not significantly different from zero. Estimates of the external radiation exposure at the De Soto boundary (7 $\pm$ 11 mrem) and at the nearest residence (2 $\pm$ 3 mrem) are based on the difference between the single highest onsite TLD measurement and the average of offiste measurements. The difference more likely results from random variability in the measurements than from actual radiation exposure.

Supply water at the SSFL site is monitored at two locations. This water consists of ground water from deep wells on the site blended with potable water from Ventura County Water District 17. In addition, shallow ground water is periodically sampled at a standpipe adjacent to the basement level of a deactivated SNAP reactor test facility (Building 059). These samples are evaluated to detect the transfer of activation product radioactivity from the underground reactor test vault containment and into the surrounding soil. None

has been detected. Therefore, these analyses serve as a measure of radioactivity naturally present in the ground water.

Quality assurance measures incorporated into the environmental monitoring program include participation in Department of Energy (DOE) sponsored programs such as the Environmental Dosimeter Intercomparison Program and the DOE Environmental Measurements Laboratory Quality Assessment Program (EML-QAP). Results for the 1984 TLD intercomparison show good agreement between the measured and the delivered exposures. Participation in two EML-QAP sample analysis sets (QAP XXI and XXII) was done in 1984. Analysis of the results indicates that accuracy in measuring radioactivity in the sample media provided for the intercomparison improved with the second sample set for the year; however, additional work is required to develop counting standards that are more representative of the types of samples and analyses addressed in the quality assessment program. In addition to participation in these programs, laboratory analyses of split and replicate samples are routinely used to evaluate the reproducibility of sample radioactivity measurements of water and soil gross radioactivity. Control charts of radiation counting system background levels and radiation response are maintained. These data are periodically evaluated to determine the correlation between sample sets and in background trends.

III. ENVIRONMENTAL MONITORING RESULTS

A. RADIOACTIVE MATERIALS – 1984

The average radioactivity concentrations in local soil, vegetation, surface water, and ambient air for 1984 are presented in Tables 1 through 6. The data shown for gross alpha activity in samples that are generally thick compared with the range of the alpha particles represent a marked change in the manner of calculating and reporting them, compared with prior reports. This change reflects the gradual changes in the monitoring program from monitoring to measurement. Previously, alpha count rate data had been converted to alpha activity concentrations by use of an efficiency factor for a thin electroplated source, and the results were monitored for changes from prior values. This resulted in artificially low numerical values for the alpha activity in several sample media. Starting in this report, the alpha activity concentrations for these media will be reported based on an efficiency factor derived from a sample with distributed alpha activity that is thick relative to the alpha particle range. For monitoring purposes, this has no effect. However, the values reported will more closely represent the actual alpha activity existing in the environment. In calculating the average concentration values, all values, including negative values, were included. This method of non-censored data averaging, recommended by DOE Order 5484.1, affords a better estimate of the central value and dispersion of the data. All limits of error reported in the tables are for one standard deviation (1σ). In most cases, these show the dispersion of the measured values about the mean. These two changes in data interpretation result in noticeable differences in the data shown in the historical comparisons. It must be recognized that these differences do not reflect changes in environmental radioactivity but are merely consequences of the evolution of the monitoring program.

To achieve much higher detection sensitivity for plutonium than gross alpha measurements can provide, soil samples are collected and sent to an independent testing laboratory for specific analysis for plutonium. In this

TABLE 1

SOIL PLUTONIUM RADIOACTIVITY DATA--1984

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

[a]Offsite location

analysis, the individual soil samples are leached with acid, and the leachate is treated chemically to separate and concentrate any plutonium present in the sample. In this way, minute quantities of plutonium, such as that distributed globally by testing of nuclear weapons, can be detected and quantitatively measured by alpha spectroscopy. The results are shown in Table 1. Alpha spectroscopy permits identification of $^{239}Pu + ^{240}Pu$, predominantly from weapons tests, and ^{238}Pu, from the destructive reentry of a Transit satellite over the Indian Ocean in April 1964.

The maximum radioactivity level detected for a single sample from the annual set is reported because of its significance in indicating the occurrence of a major episode or an area-wide incident of radioactive material deposition. None of the maximum observed values, which, as the tables show, occurred randomly during the year, shows a great increase over the average values beyond inherent variability. The ambient air sampling data show no greatly increasing or decreasing trends for most of the year and can be

described as generally constant, with some increase in local airborne radioactivity levels occurring during the second and third quarters and a subsequent decrease toward the end of the year.

The results observed for gross radioactivity in soil (Table 2) and vegetation (Table 3) show no significant difference between onsite and offsite samples. Table 2 shows no significant variation in soil plutonium concentrations for the 1984 sample sets.

For comparison with the plutonium present as a result of fallout from nuclear weapons tests and failure at launch of a radioisotope-powered satellite, published data from soil tests in nearby Burbank, California, in 1970-71 show a plutonium concentration of approximately 2×10^{-9} μCi/g for ^{239}Pu + ^{240}Pu and approximately 0.06×10^{-9} μCi/g for ^{238}Pu. The data in Table 2 show no significant increases in onsite soil plutonium relative to the Burbank values.

The detected gross radioactivity in soil and vegetation is due to various naturally occurring radionuclides present in the environment and to radioactive fallout of dispersed nuclear weapons materials and fission product radioactivity produced by past atmospheric tests of nuclear weapons. No atmospheric nuclear weapons tests were announced during 1984. Naturally occurring radionuclides include ^{7}Be, ^{40}K, ^{87}Rb, ^{147}Sm, and the uranium and thorium series (including radon and daughters). The specific radioactive composition of local area surface soil has been determined to be predominantly ^{40}K, natural thorium, and natural uranium, both in secular equilibrium with daughter nuclides, with less than 1% fission-produced radionuclides, principally ^{137}Cs. Radioactivity in aged fallout consists primarily of the fission produced ^{90}Sr-^{90}Y, ^{137}Cs, and ^{147}Pm, and also ^{234}U and ^{239}Pu. Gamma spectrometric analysis of composited ambient air samples collected during 1984 detected only the cosmogenic radionuclide ^{7}Be, plus additional natural radionuclides of terrestrial origin, the natural uranium and thorium series and ^{40}K, plus the fission product ^{137}Cs. Relative amounts of these radio-

TABLE 2

SOIL RADIOACTIVITY DATA--1984

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

[a]Maximum value observed for single sample

TABLE 3

VEGETATION RADIOACTIVITY DATA--1984

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

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

nuclides were approximately 54% ^{40}K, 40% ^{7}Be, 6% natural uranium series, 0.9% natural thorium series, and 0.6% attributed to ^{137}Cs. The value for ^{7}Be is representative for the mixture only at the time of measurement since the physical half-life is extremely short compared with those of the other radionuclides detected.

Supply water is sampled monthly at De Soto and at two widely separated SSFL site locations. The average supply water radioactivity concentration for each site is presented in Table 4. Supply water used at the De Soto site is supplied by the Los Angeles Department of Water and Power. Supply water used at the SSFL site is obtained partly from Ventura County Water District No. 17, which also supplies nearby communities, and is distributed on the site by the same piping system previously used when all facility supply water was obtained from onsite wells. Two onsite water wells (wells 5 and 13) were operated during 1984 to reduce the consumption of Ventura County water. The well water proportion in the blend averaged about 54% for the year, for a total well water consumption of about 3.2×10^5 m^3 (8.5×10^7 gal). Pressure for the water system is provided by elevated storage tanks.

A shallow standpipe, placed during construction of a modification to a now deactivated SNAP reactor test facility, is being used for sampling of ground water adjacent to the underground reactor test vault. The well is periodically sampled for the purpose of detecting any transfer of activation product radioactivity from the containment to the soil bed. Radioactivity in samples taken during 1984 averaged 1×10^{-8} μCi/ml beta with no alpha activity detected. Gamma spectrometric analysis has not identified any specific unnatural radionuclides in the water; thus, this activity is attributed to dissolved radioelements of natural origin in the soil bed.

A recent hydrogeoligic study at SSFL describes two ground water systems at the site: a shallow, unconfined system of alluvial surface mantle on the Burro Flats area and along the major drainage channels, and a deeper ground water system in the fractured Chatsworth sandstone. Alluvium along the major

TABLE 4

SUPPLY WATER RADIOACTIVITY DATA--1984

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

[a]Maximum value observed for single sample

surface drainage systems may store and transmit ground water to the underlying Chatsworth Formation through fractures. Water levels in the alluvium respond to recharge resulting from surface flows and may vary considerably between wet and dry periods. The alluvium, composed of a heterogeneous mixture of gravel, sand, silt, and clay, has an estimated hydraulic conductivity ranging from 0.1 to 1000 gal/day$\cdot$ft^2.

The Chatsworth Formation is composed of well-consolidated, massively bedded sandstones with interbedded layers of siltstone and claystone. The layer may be as thick as 6,000 ft at the SSFL site. The direction of ground water flow in the formation is probably radially offsite toward the surrounding lowlands and is probably controlled by fracture zones.

The hydrogeologic environment at the SSFL site is a dynamic system. Ground water is recharged at the site, moves through the aquifers, and discharges to the surface or to other aquifers down-gradient of the site. The ground water system is recharged by precipitation and by unlined ponds and drainage channels. Because of the meager rainfall in the area and the relatively large variability in annual precipitation, ground water recharge may vary greatly from year to year. Specific pathways of possible contaminant transport are difficult to predict on the basis of on-site well data. The most likely pathways are along fracture zones that trend offsite.

As discussed earlier, surface waters discharged from SSFL facilities and the sewage plant outfall drain southward into Rocketdyne retention pond R-2A. When full, the pond may be drained into Bell Creek, a tributary of the Los Angeles River in the San Fernando Valley, Los Angeles County. Pursuant to the requirements of Los Angeles Regional Water Quality Control Board Resolution 66-49 of 21 September 1966, a sampling station for evaluating environmental radioactivity in Bell Canyon was established in 1966. It is located approximately 2.5 miles downstream from the southern Rockwell International Corporation boundary. Samples, obtained and analyzed monthly, include stream bed mud, vegetation, and water. Average radioactivity concentrations in Retention Pond R-2A and Bell Creek samples are presented in Table 5.

Comparison of the radioactivity concentrations in water from the ponds and from Bell Creek with that of the supply water shows no significant differences in either alpha or beta activity. Similar comparisons between onsite and offsite soil and vegetation samples and those of Bell Creek show no significant differences.

The SSFL site surface water and the ambient air radioactivity concentration guide values selected for each site are the most restrictive limits for those radionuclides currently in use at Rocketdyne facilities. Radioactivity concentration guide values are those concentration limits adopted by DOE, NRC, and the State of California as maximum permissible concentrations (MPCs). The

TABLE 5

BELL CREEK AND RETENTION POND RADIOACTIVITY DATA--1984

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

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

MPC values are dependent on the radionuclide and its behavior as a soluble or an insoluble material. For comparison with results of environmental and effluent monitoring, the single lowest MPC value for the various radionuclides present is selected rather than a derived MPC for the mixture. Accordingly, for SSFL site surface water, the guide values of 5×10^{-6} μCi/ml alpha activity corresponding to ^{239}Pu and 3×10^{-7} μCi/ml beta activity corresponding to ^{90}Sr are appropriate. These values are established in 10 CFR 20, California Administrative Code Title 17, and DOE Order 5480.1.

Ambient air sampling for long-lived particulate alpha and beta radioactivity is performed continuously by automatic sequential samplers located at the De Soto and SSFL sites. Air is drawn through Type A/E glass fiber filter media, which are analyzed for retained long-lived radioactivity after a minimum 120-h decay period that eliminates naturally occurring short-lived particulate radioactivity. The average concentrations of ambient air alpha and beta radioactivity for 1984 are presented for the various sampler locations in Table 6.

The guide value of 6×10^{-14} μCi/ml for SSFL site ambient air alpha activity is due to work with unencapsulated plutonium. The value of 3×10^{-11} μCi/ml for beta activity is due to the presence of ^{90}Sr in fission products in irradiated nuclear fuel at the SSFL site. The guide value of 3×10^{-12} μCi/ml for De Soto ambient air alpha activity is due to work with unencapsulated uranium (including depeleted uranium). The guide value of 3×10^{-10} μCi/ml is for ^{60}Co, for which the ambient air beta activity guide is appropriate since it is the most restrictive limit for any beta-emitting radionuclide in use at the De Soto site. Guide value percentages are not presented for soil or vegetation data since none have been established.

Monitoring of ambient radiation is performed with thermoluminescent dosimeters. Each dosimeter set uses two calcium fluoride (CaF_2:Mn) low background, bulb-type chip dosimeters. The dosimeter sets are placed at locations on or near the perimeters of the De Soto and SSFL sites. Each dosimeter,

TABLE 6

AMBIENT AIR RADIOACTIVITY DATA--1984

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

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

sealed in a light-proof energy compensation shield, is installed in a polyethylene container mounted about 1 m above ground at each location. The dosimeters are exchanged and evaluated quarterly. Fifteen onsite TLD monitoring locations were used during the year. Five additional dosimeter sets, placed at locations up to 10 miles from the sites, are similarly evaluated to determine the local area offsite ambient radiation level, which averaged 11 μR/h for 1984. The quarterly and annual radiation exposures and the equivalent absolute and altitude-adjusted annual exposures, and exposure rates determined for each dosimeter location are presented in Tables 7 and 8.

Table 7 shows that radiation exposures and equivalent annual exposure rates monitored onsite are nearly identical to levels monitored at five widely separated offsite locations. These data reflect natural background radiation from cosmic radiation, radionuclides in the soil, radon and thoron in the atmosphere, and radioactive fallout from atmospheric nuclear device tests. Locally, the natural background radiation level as measured by these dosimeters is about 100 mR/year. The small variability observed in the data is attributed to differences in elevation and geologic conditions at the various dosimeter locations. The altitude range for the dosimeter locations is from about 875 ft ASL (above sea level) at the De Soto site to a maximum of about 1900 ft ASL for one of the SSFL dosimeters. When normalized to a specific altitude by adjusting the measured value by an altitude adjustment factor equal to 15 mR per 1000 ft elevation difference, derived radiation exposures for all locations are essentially identical. The 1984 averaged exposure values adjusted to 1000 ft ASL are 100 $\pm$ 6 mR for the De Soto site, 104 $\pm$ 7 mR for the SSFL site, and 101 $\pm$ 9 mR for the offsite control dosimeters.

During the 4-year period 1977 through 1980, a steady increase was observed in the TLD readings for all locations. Although the increases were variable from year to year and between locations, averaged over 4 years, the increases were in the range of 14 to 17 mR per year. The values for 1984 show a slight decrease from the previous year's results and continue the downward trend, begun in 1981, toward the earlier observed values.

TABLE 7

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

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

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

During 1984, Rocketdyne participated in the Seventh International Environmental Dosimeter Intercomparison Project sponsored by the U.S. Department of Energy and the U.S. Nuclear Regulatory Commission. This project involves exposure of sets of TLDs to ambient radiation typical of environmental monitoring and also well-controlled exposures to calibrated radioisotope sources. A shipping control set is shielded during most of the project and provides a measure of apparent exposure during shipment. The Rocketdyne measurements of the various exposures are shown in Table 8.

TABLE 8

COMPARISON OF EXPOSURE MEASUREMENTS IN THE SEVENTH INTERNATIONAL ENVIRONMENTAL DOSIMETER INTERCOMPARISON PROJECT

Type of Exposure	Delivered Exposure (mR)	Measured Exposure (mR)
Field	76 ± 6	74 ± 12
Laboratory (^{60}Co)	80 ± 4	88 ± 15
Laboratory (^{137}Cs)	75 ± 4	84 ± 15
Control	6.5[a]	18 ± 3[b]

[a]Exposure during intercomparison project duration only
[b]Exposure during intercomparison plus shipping

Supplementary measurements of ambient radiation levels with high-pressure ion chamber (HPIC) monitors are made at two locations at the SSFL site. The HPIC values for 1984 were equivalent to annual exposures of 112 mR for the Building 207 monitor and 110 mR for the Building 363 monitor. These values are in good agreement with the TLD results for the year.

For independent monitoring of radiation levels in this area, the Radiologic Health Section of the State of California Department of Health Services provides packages containing lithium fluoride (LiF) chip dosimeters for placement with the packets used for the bulb dosimeters. The state dosimeters are returned to the Radiologic Health Section in Sacramento for evaluation. Data

for these TLDs, placed at eight Rocketdyne dosimeter locations, both onsite and offsite, are presented in Table 9 for 1984. Considering the total independence of these measurements and the use of different thermoluminescent materials, the agreement is remarkably good and attests to the quality of both sets of measurements.

TABLE 9

DE SOTO AND SSFL SITES--STATE OF CALIFORNIA
AMBIENT RADIATION DOSIMETRY DATA--1984

TLD Location	Quarterly Exposure (mR)				Annual Exposure (mR)	Equivalent Exposure at 1000 ft ASL	
	Q-1	Q-2	Q-3	Q-4		(mR)	(μR/h)
De Soto DS-2	28	28	26	24	106	108	12
DS-6	35	31	26	22	114	116	13
DS-8	38	27	25	25	115	117	13
Mean value	34	29	26	24	112	114	13
SSFL SS-3	35	36	a	27	131[b]	119	14
SS-6	a	33	14	28	100[b]	88	10
SS-7	26	31	27	24	108	96	11
Mean value	31	33	21	26	113	101	12
Offsite OS-1	35	28	25	25	113	115	13
OS-5	36	27	36	24	123	124	14
Mean value	36	28	31	25	118	120	14

[a]Dosimeter damaged during deployment interval
[b]Annualized value

B. NONRADIOACTIVE MATERIALS--1984

Processed wastewater and most collected surface runoff discharged from the SSFL site flows to Rocketdyne retention pond R-2A. Water samples from the pond are analyzed for various constituents, as required by the Regional Water Quality Control Board, for each discharge to Bell Canyon. Such discharges are normally done only as a result of excessive rainfall runoff; however, during 1984, most discharges were due to desilting and control valve replacement operations. During rainfall-caused releases, the NPDES permit concentration limits for turbidity and for suspended and settleable solids do not apply. The results of analyses for each discharge for 1984 are presented in Table 10.

TABLE 10

NONRADIOACTIVE CONSTITUENTS IN WASTEWATER DISCHARGED TO UNRESTRICTED AREAS--1984
(Analysis Results for Wastewater Discharged from Pond R-2A to
Bell Creek on Date Indicated - Sample Station W-12)
(Sheet 1 of 2)

	March 13		June 5		June 12		June 19		June 26		July 2		July 9		July 16	
	Result	% of Guide	Result	% of Guide	Result	% of Guide	Result	% of Guide	Result	% of Guide	Result	% of Guide	Result	% of Guide	Result	% of Guide
Total dissolved solids (mg/l)	527	55.5	542	57.0	518	54.5	582	61.2	543	57.2	510	53.7	528	55.6	529	55.7
Chloride (mg/l)	59	39.3	65	43.3	64	42.7	75	50.0	59	39.3	53	35.3	51	34.0	47	31.3
Sulfate (mg/l)	116	38.7	151	50.3	140	46.7	141	47.0	143	47.7	141	47.0	155	51.7	148	49.3
Suspended solids[b] (mg/l)	17	11.3	14	9.3	9.0	6.0	8.3	5.5	16.5	11.0	139	92.7	22	14.7	7	4.7
Settleable solids[b] (mg/l)	0.1	33.3	<0.1	<33.3	0.1	33.3	<0.1	<33.3	<0.1	<33.3	0.8	266.7	<0.1	<33.3	<0.1	<33.3
BOD_5 (mg/l)	23	38.3	11	18.3	3	5.0	4	6.7	4	6.7	2	3.3	2	3.3	3	5.0
Oil and grease (mg/l)	2	13.3	3	20.0	1.1	7.3	0.6	4.0	0.4	2.7	1	6.7	2	13.3	3	20.0
Turbidity[b] (TU)	11	-	6	-	4.3	-	4.0	-	9.8	-	30	-	14	-	5	-
Chromium (mg/l)	<0.001	<10.0	<0.001	<10.0	<0.001	<10.0	0.006	60.0	0.01	100.0	0.009	90.0	0.003	30.0	0.015	150.0
Fluoride (mg/l)	0.5	50.0	0.4	40.0	0.3	30.0	0.3	30.0	0.4	40.0	0.4	40.0	0.4	40.0	0.3	30.0
Boron (mg/l)	0.4	40.0	0.2	20.0	0.3	30.0	0.2	20.0	0.2	20.0	0.3	30.0	0.2	20.0	0.3	30.0
Residual chlorine (mg/l)	<0.04	<40.0	<0.04	<40.0	<0.04	<40.0	<0.04	<40.0	<0.04	<40.0	<0.04	<40.0	<0.04	<40.0	< 0.04	<40.0
Fecal Coliform (MPN/100 ml)	<2	<8.7	<2	<8.7	<2	<8.7	<2	<8.7	<2	< 8.7	<2	<8.7	<2	<8.7	<2	<8.7
Surfactants (MBAS)	<0.01	<2.0	0.01	2.0	0.055	11.0	0.05	10.0	0.07	14.0	0.01	2.0	0.02	4.0	0.06	12.0
pH	8.5		8.8		8.2		8.2		8.0		8.2		7.7		7.8	
Rainfall (cm)	0		0		0		0		0		0		0		0	
Estimated Rainfall Runoff (m^3)	0		0		0		0		0		0		0		0	
Release Volume (m^3)	9,084		4,164		1,968		2,536		1,930		6,434		6,434		6,434	

TABLE 10

NONRADIOACTIVE CONSTITUENTS IN WASTEWATER DISCHARGED TO UNRESTRICTED AREAS--1984
(Analysis Results for Wastewater Discharged from Pond R-2A to
Bell Creek on Date Indicated - Sample Station W-12)
(Sheet 2 of 2)

	July 23		July 30		August 6		December 9[a]		December 18[a]	
	Result	% of Guide	Result	% of Guide	Result	% of Guide	Result	% of Guide	Result	% of Guide
Total dissolved solids (mg/l)	562	59.2	462	48.6	506	53.3	270	28.4	330	34.7
Chloride (mg/l)	51	34.0	46	30.7	48	32.0	34	22.7	37	24.7
Sulfate (mg/l)	194	64.7	136	45.3	150	50.0	87	29.0	110	36.7
Suspended solids[b] (mg/l)	210	140.0	77	51.3	55	36.7	39	26.0	33	22.0
Settleable solids[b] (mg/l)	0.1	33.3	1.0	333.3[§]	0.3	100.0	<0.1	<33.3	<0.1	<33.3
BOD_5 (mg/l)	2	3.3	3	5.0	3	5.0	2	3.3	3	30.0
Oil and grease (mg/l)	1	6.7	1	6.7	<1	<6.7	2	23.3	3	20.0
Turbidity[b] (TU)	125	-	88	-	42	-	42	-	38	-
Chromium (mg/l)	0.014	140.0	<0.001	<10.0	0.007	70.0	NA		NA	
Fluoride (mg/l)	0.5	50.0	0.7	70.0	0.5	50.0	0.3	30.0	0.3	30.0
Boron (mg/l)	<0.2	<20.0	0.4	40.0	0.3	30.0	0.5	50.0	0.3	30.0
Residual chlorine (mg/l)	<0.04	<40.0	<0.04	<40.0	<0.04	<40.0	<0.04	<40.0	<0.04	<40.0
Fecal Coliform (MPN/100 ml)	<2	<8.7	<2	<8.7	<2	<8.7	NA		NA	
Surfactants (MBAS)	<0.01	<2.0	0.04	8.0	<0.01	<2.0	0.02	4.0	0.02	4.0
pH	7.7		8.4		8.0		8.1		8.2	
Rainfall (cm)	0		0		0		4.75		10.36	
Estimated Rainfall Runoff (m^3)	0		0		0		121,120		208,175	
Release Volume (m^3)	6,434		6,434		1,817		15,140		9,462	

[†]Resampled July 26
Result = 20% of limit

[§]Resampled July 31
Result = 33% of limit

[a]Rainfall-related discharge
[b]Not applicable to discharges containing rainfall runoff during or immediately after periods of rainfall
[c]Attributed to unknown cause
[d]Attributed to pond desilting operations
NA constituents not analyzed

IV. ENVIRONMENTAL MONITORING PROGRAM

A. DESCRIPTION

A program of soil and vegetation sample collection and analysis for radioactivity was begun in 1952 in the Downey, California, area where the nuclear research and development work of the predecessor company to Rocketdyne was initially located. Environmental sampling was subsequently extended to the then proposed Sodium Reactor Experiment (SRE) site in the Simi Hills in May 1954. In addition, sampling was begun in the Burro Flats area, southwest of SRE, where other nuclear installations were planned and are currently in operation. The Downey area survey was terminated when nuclear activities were relocated to Canoga Park in 1955. The primary purpose of the environmental monitoring program is to survey environmental radioactivity adequately to ensure that Rocketdyne nuclear operations do not contribute significantly to environmental radioactivity. The locations of sampling stations are shown in Figures 5 through 7 and listed in Table 11.

B. SAMPLING AND SAMPLE PREPARATION

1. Soil

Soil is analyzed for radioactivity to monitor for any significant increase in radioactive deposition by fallout from airborne radioactivity. Since soil is naturally radioactive and has been contaminated by atmospheric testing of nuclear weapons, a general background level of radioactivity exists. The data are monitored for increases beyond the natural variability of this background. For most radionuclides, gross alpha and beta radioactivity measurements are adequate for this purpose. Chemically specific analyses are performed for plutonium.

Surface soil types available for sampling range from decomposed granite to clay and loam. Samples are taken from the upper 1 cm of undisturbed ground

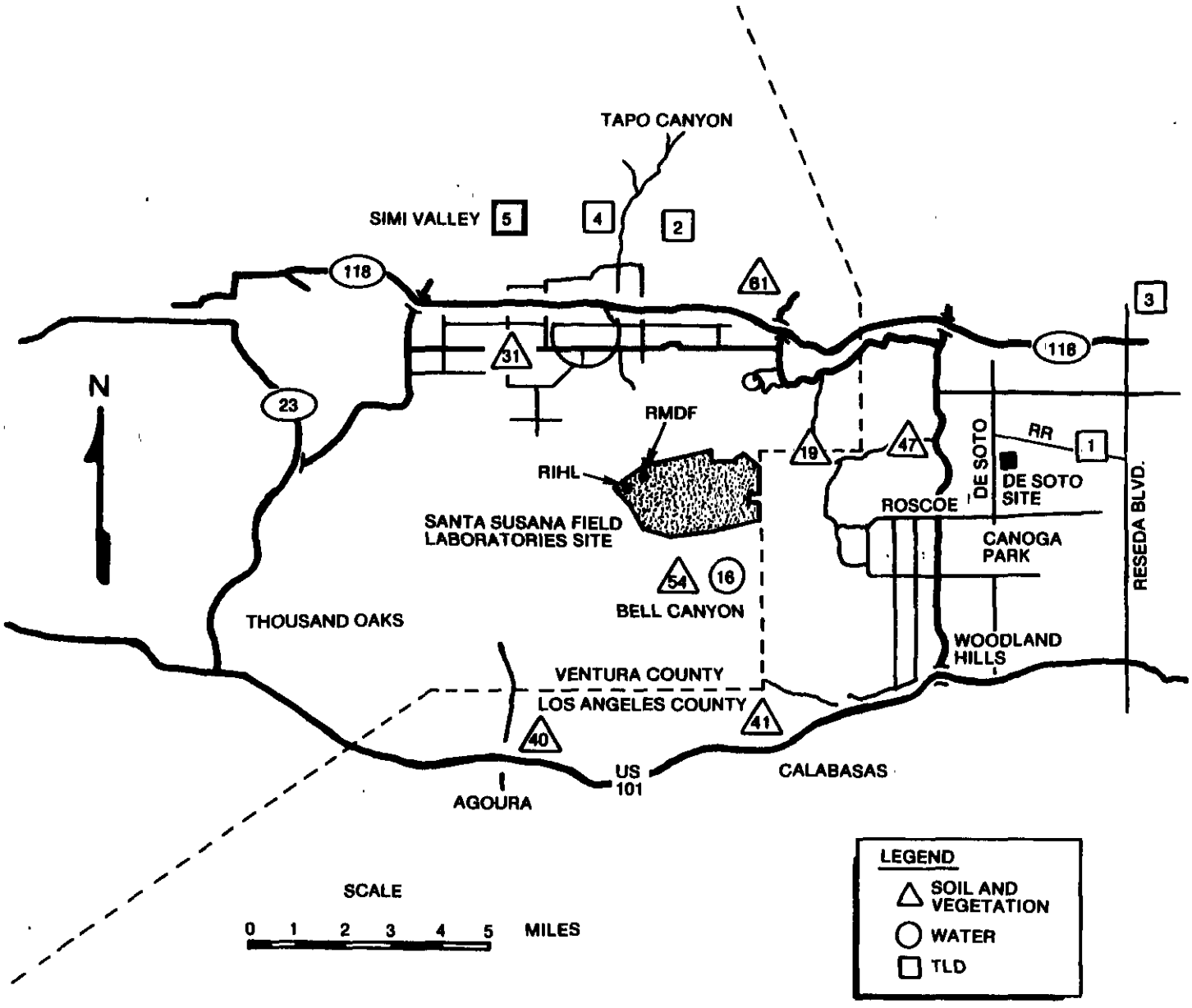

Figure 5. Map of Canoga Park, Simi Valley, Agoura, and Calabasas Sampling Stations

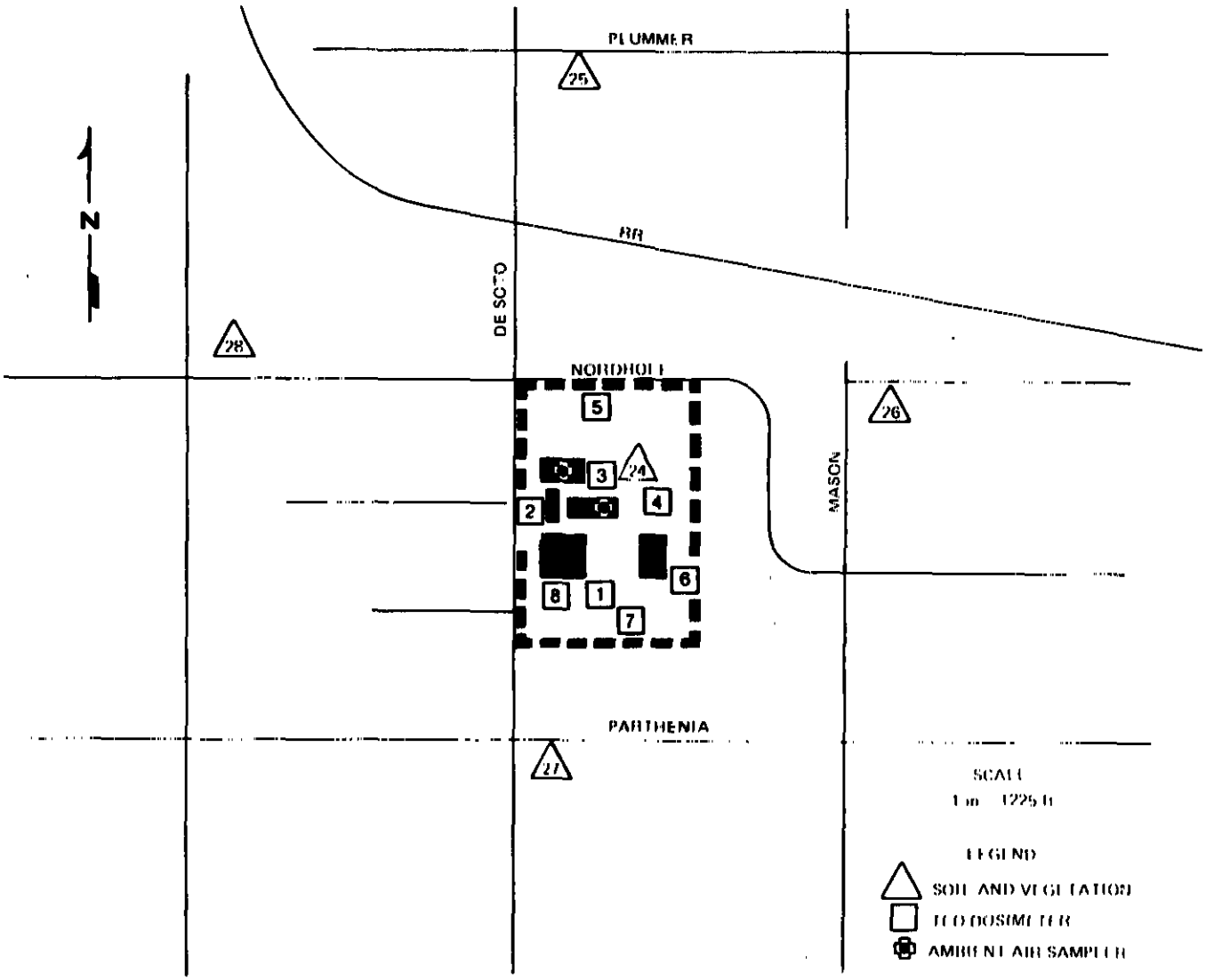

Figure 6. Map of De Soto Site and Vicinity Sampling Stations

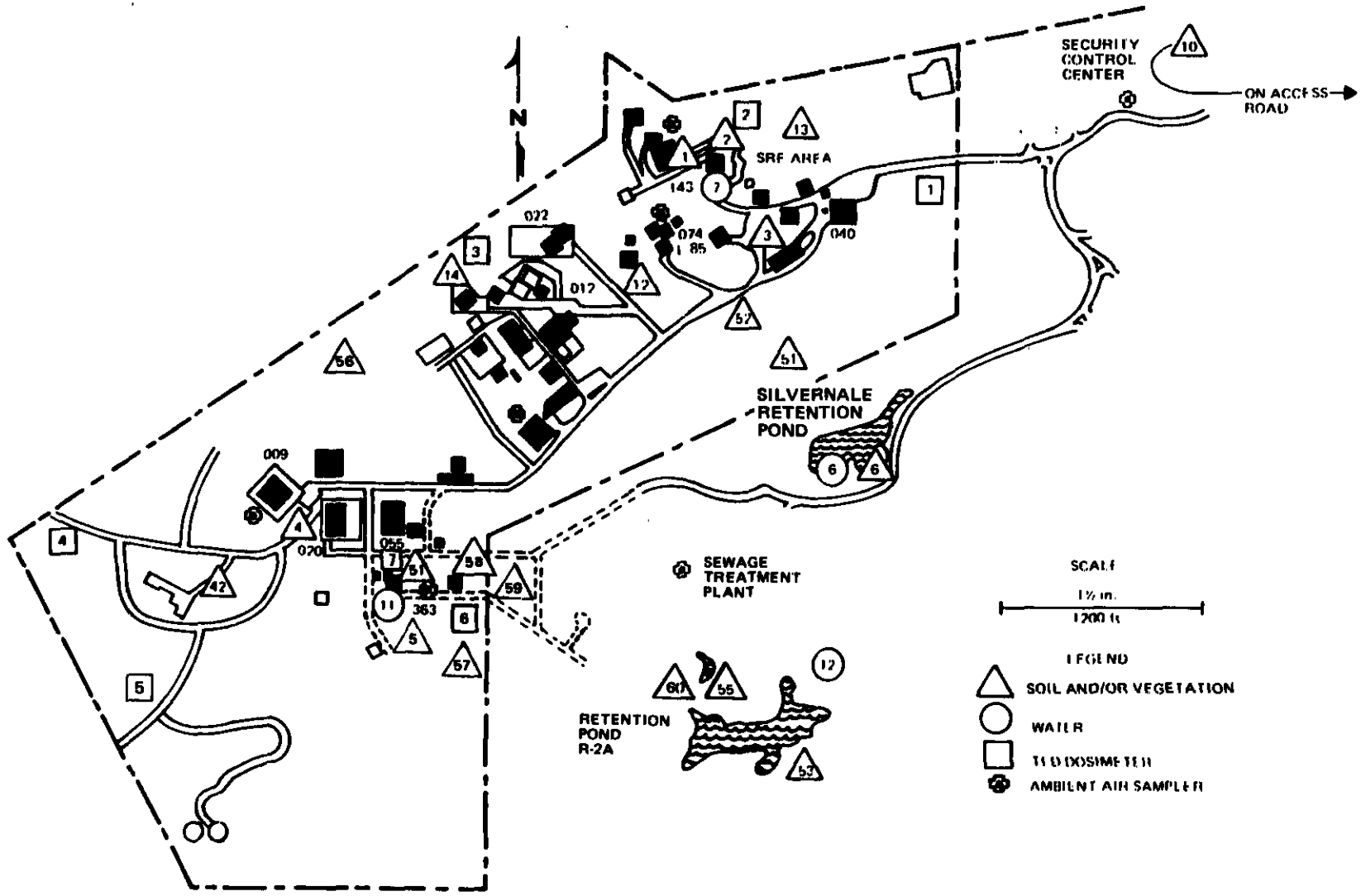

Figure 7. Map of Santa Susana Field Laboratories Site Sampling Stations

TABLE 11

SAMPLING LOCATION DESCRIPTION
(Sheet 1 of 4)

Station[a]		Frequency of Sampling[a]
SV-1	SSFL Site, Building 143, southeast side	(M)
SV-2	SSFL Site, Building 143, at perimeter drainage system	(M)
SV-3	SSFL Site, Building 064, north parking lot area	(M)
SV-4	SSFL Site, Building 020, at west fence	(M)
SV-5	SSFL Site, Building 363, east parking lot area	(M)
SV-6	Rocketdyne Site Interim Retention Pond, south side	(Q)
SV-10	SSFL Site Access Road, at upaer mobile home park entrance	(Q)
SV-12	SSFL Site, Building 093, at reactor building driveway	(M)
SV-13	SSFL Site, between SRE Water Retention Pond and former sodium cleaning facility	(M)
SV-14	SSFL Site, Building 028, upper parking lot area	(M)
SV-19	SSFL Site Entrance, Woolsey Canyon	(Q)
SV-24	De Soto Site, Building 104, east side	(M)
SV-25	De Soto Avenue and Plummer Street, southeast corner	(Q)
SV-26	Mason Avenue and Nordhoff Street, southeast corner	(Q)
SV-25	De Soto Avenue and Plummer Street, southeast corner	(Q)
SV-26	Mason Avenue and Nordhoff Street, southeast corner	(Q)
SV-27	De Soto Avenue and Parthenia Street, northeast corner	(Q)
SV-28	Canoga Avenue and Nordhoff Street, northwest corner	(Q)
SV-31	Simi Valley, Alamo Avenue and Sycamore Road, southeast corner	(Q)
SV-40	Agoura - Kanan Road and Ventura Freeway at Frontage Road	(Q)
SV-41	Calabasas - Parkway Calabasas and Ventura Freeway at Frontage Road	(Q)
SV-42	SSFL Site, Building 886, at old sodium disposal facility gate	(M)
SV-47	Chatsworth Reservoir Site North Boundary at north gate	(M)
SV-51	SSFL Site, Building 029, at driveway	(M)

[a]See Code at end of table

TABLE 11

SAMPLING LOCATION DESCRIPTION
(Sheet 2 of 4)

Station[a]		Frequency of Sampling[a]
SV-53	Rocketdyne Site Pond R-2A	(Q)
SV-54	Bell Creek at Ventura County Line	(M)
SV-55	Rocketdyne Site, Pond R-2A (Pond Bottom Mud), north side	(M)
SV-56	SSFL Site, F Street and 24th Street	(S)
S-57	SSFL Site, J Street, south of Building 055 exhaust stack	(S)
S-58	SSFL Site, Building 353, south of road	(S)
Sa-50	Rocketdyne Site Test Area CTL 4, entrance, east side	(S)
S-60	Rocketdyne Site, Pond R-2A, northwest side	(S)
S-61	Simi Valley, east end of Alamo Avenue	(S)
W-6	Rocketdyne Site Interim Retention Pond, south side	(M)
W-7	SSFL Site Supply Water, Building 003, outside faucet, north side	(M)
W-11	SSFL Site Supply Water, Building 363, washroom faucet	(M)
W-12	Rocketdyne Site, Pond R-2A, north side	(M)
W-16	Bell Creek at Ventura-Los Angeles County Line	(M)
A-1	De Soto Site, Building 102 roof	(D)
A-2	De Soto Site, Building 104 roof	(D)
A-3	SSFL Site, Building 009, west side	(D)
A-4	SSFL Site, Building 011, west side	(D)
A-5	Rocketdyne Site, Building 600, Sewage Treatment Plant, north side	(D)
A-6	Rocketdyne Site, Building 207, Security Control Center, north side	(D)
A-7	SSFL Site, Building 074, south side (L-85 Reactor Facility)	(D)
A-8	SSFL Site, Building 363, Box Shop at east side	(D)
A-9	SSFL Site, Building 363, west side	(D)
ONSITE-DE	SOTO - AMBIENT RADIATION DOSIMETER LOCATIONS (TLD)	
DS-1	De Soto Site, south of Building 102	(Q)

[a]See Code at end of table

TABLE 11

SAMPLING LOCATION DESCRIPTION
(Sheet 3 of 4)

Station[a]		Frequency of Sampling[a]
DS-2	De Soto Site, west boundary inside water supply enclosure (State of California TLD Location)	(Q)
DS-3	De Soto Site, Guard Post 1, Building 201	(Q)
DS-4	De Soto Site, northeast corner of storage yard fence	(Q)
DS-5	De Soto Site, north boundary at parking lot entry	(Q)
DS-6	De Soto Site, east boundary, southeast corner of fence (State of California TLD Location)	(Q)
DS-7	De Soto Site, south boundary in parking lot telephone pole stay	(Q)
DS-8	De Soto Site at Post 004, southwest corner of Building 101 (State of California TLD Location)	
ONSITE-SSFL (TLD)		
SS-1	SSFL Site, Building 114 on telephone pole	(Q)
SS-2	SSFL Site, SRE Retention Pond on pump motor control panel on boundary fence	(Q)
SS-3	SSFL Site, Electric Substation 719 on boundary fence (State of California TLD Location)	(Q)
SS-4	SSFL Site, west boundary on H Street	(Q)
SS-5	SSFL Site, southwest boundary at property line gate	(Q)
SS-6	SSFL Site, Building 854 (State of California TLD Location)	(Q)
SS-7	SSFL Site, Building 363, north side on HPIC monitor (State of California TLD Location)	(Q)
OFFSITE (TLD)		
OS-1	Offsite, San Fernando Valley, Chatsworth, approximately Oakdale Avenue and Lassen Street (State of California TLD Location)	(Q)
OS-2	Offsite, Simi Valley, approximately Tapo Canyon and Walnut Streets	(Q)
OS-3	Offsite, San Fernando Valley, Northridge, approximately Plummer Street and Vanalden Avenue	(Q)

[a]See Code at end of table

TABLE 11

SAMPLING LOCATION DESCRIPTION
(Sheet 4 of 4)

Station[a]		Frequency of Sampling[a]
OS-4	Offsite, Simi Valley, approximately Tapo Canyon and Walnut Streets	(Q)
OS-5	Offsite, Simi Valley, approximately Erringer Road and Highway 118 (State of California TLD Location)	(Q)
HPI-1	High-Pressure Ionization Chamber Ambient Radiation Monitor at Building 207, north side	(C)
HPI-2	High-Pressure Ionization Chamber Ambient Radiation Monitor at Building 363, north side	(C)
CODE		
SV	Soil and Vegetation Sample Station	
S	Soil Sample Station	
W	Water Sample Station	
A	Air Sampler Station	
TLD	Thermoluminescent Dosimeter	
D	Daily Sample	
M	Monthly Sample	
Q	Quarterly Sample	
S	Semiannual Sample	
C	Continuous	

[a]See Code above

surface for gross radioactivity analysis and to a depth of 5 cm for plutonium analysis. The soil samples are packaged in plastic containers and returned to the laboratory for analysis.

Sample preparation of soil for gross radioactivity determination consists of transferring the soils to Pyrex beakers and drying them in a muffle furnace at about 500°C for 8 h. After cooling, the soil is sieved to obtain uniform particle size. Two-gram aliquots of the sieved soil are weighed into copper planchets. The soil is wetted in the planchet with alcohol, evenly distributed to obtain uniform sample thickness, dried, and counted for alpha and beta radiation.

Soil plutonium analysis is performed using a chemically specific method by a certified independent testing laboratory according to the guidelines specified in U.S. NRC Regulatory Guide 4.5 titled "Measurements of Radionuclides in the Environment--Sampling and Analysis of Plutonium in Soil."

2. Vegetation

The analysis of vegetation, performed as an adjunct to the soil analysis, is done to determine the uptake of radioactivity by plants. These plants do not contribute to the human food chain, and there is no significant agriculture or grazing in the immediate neighborhood of either site.

Vegetation samples obtained in the field are of the same perennial plant types, wherever possible; these are usually sunflower or wild tobacco. Vegetation leaves are stripped from plants and placed in waxed cardboard containers for transfer to the laboratory for analysis. Ordinarily, plant root systems are not analyzed.

Since the analysis is done to determine uptake only, and not fallout deposition, vegetation is first washed with tap water to remove soil, dust, and other foreign matter and then thoroughly rinsed with distilled water.

Washed vegetation is vacuum-dried in tared beakers at 100°C for 24 h for dry weight determination, then ashed in a muffle furnace at about 500°C for 8 h, producing a completely burned ash. One-gram aliquots of pulverized ash from each beaker are weighed into copper planchets. The vegetation ash is wetted in the planchet with alcohol, evenly distributed to obtain uniform sample thickness, dried, and counted for alpha and beta radiation. The dry/ash weight ratio is used for determining the equivalent dry weight gross radioactivity concentration value. The moisture content of the vegetation is about 80% of total plant weight.

3. Water

Surface and supply water samples are obtained monthly at the De Soto and SSFL sites and from Bell Creek. The water is drawn into 1-liter polyethylene bottles and transferred to the laboratory.

Five-hundred-milliliter volumes of water are evaporated to dryness in crystallizing dishes at about 90°C. The residual salts are redissolved into distilled water, transferred to planchets, dried under heat lamps, and counted for alpha and beta radiation.

4. Ambient Air

Air sampling is performed continuously at the De Soto and SSFL sites with continuous air samplers operating on 24-h sampling cycles. Airborne particulate radioactivity is collected on Type A/E glass fiber filter media, which are automatically changed daily at the end of each sampling period (midnight). The samples are counted for alpha and beta radiation following a minimum 120-h decay period. The volume of a typical daily ambient air sample is about 25 m^3.

Figure 8 is a graph of the weekly averaged long-lived alpha and beta ambient air radioactivity concentrations for the De Soto and SSFL sites during 1984. The daily data were mathematically smoothed in a moving weekly average

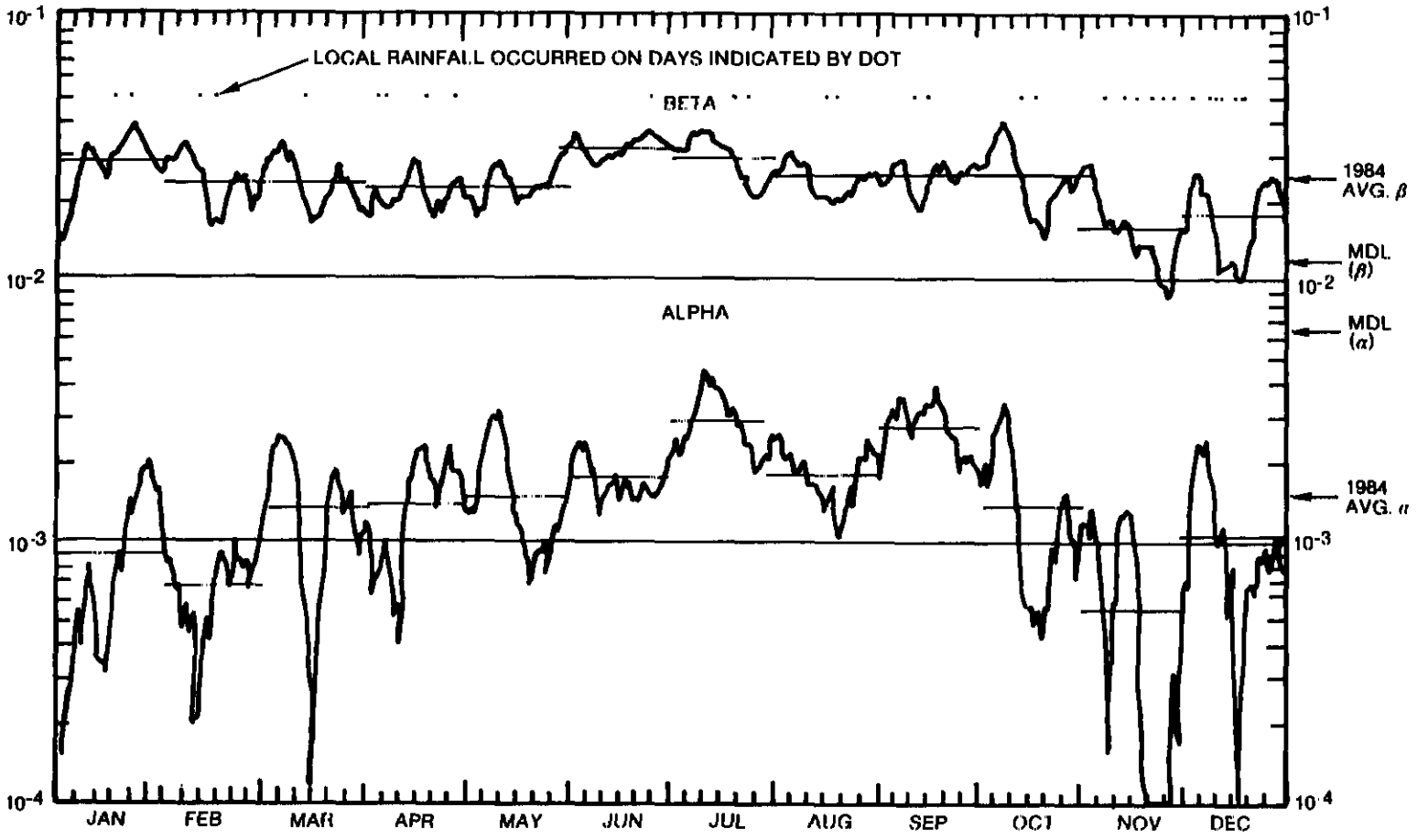

Figure 8. Weekly, Monthly, and Annual Averaged Long-Lived Airborne Radioactivity at the De Soto and Santa Susana Field Laboratories Sites — 1984

of daily data for the year. The average alpha and beta radioactivity concentrations for each month are indicated by horizontal bars. The graph shows small decreasing trends in airborne radioactivity during the first and fourth quarters, with a small increase in the summer; however, overall levels were generally constant for the year. Several transient peak concentration levels were observed within the general trend. This activity is attributed to naturally occurring airborne radioactive materials and, to a minor degree, to residual aged fallout from past foreign atmospheric tests of nuclear devices. Nuclides identified in air samples collected during 1984 include ^{7}Be, ^{137}Cs, and ^{40}K, plus several of the naturally occurring radionuclides from the uranium and thorium series. While the data for airborne alpha activity are nearly all below the minimum detection level for a single sample, averaging values from 9 daily air samples over 7 consecutive days and over calendar months reveals the long-term behavior of this activity, which for 1984 shows relatively constant levels with the exception of depressed airborne alpha radioactivity coincident with periods of rainfall.

C. COUNTING AND CALIBRATION

Environmental soil, vegetation, 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 background corrected or net beta radiation. The sample-detector configuration provides a nearly 2π geometry. The thin-window detector is continually purged with methane counting gas. A preset time mode of operation is used for all samples. The minimum detection levels shown in Table 12 are those for a single sample determined by using typical values for counting time, system efficiencies for detecting alpha and beta radiation, background count rates (approximately 0.05 cpm α and 1.0 cpm β), and sample size. For the table, the minimum statistically significant amount of radioactivity, irrespective of sample configuration, is taken as that amount equal in count rate to three times the standard deviation of the system background count rate.

TABLE 12

MINIMUM RADIOACTIVITY DETECTION LEVELS (MDLs)

Sample	Activity	Minimum Detection Level
Soil	α	$(2.3 \pm 1.4)\ 10^{-6}$ μCi/g
	β	$(2.3 \pm 1.2)\ 10^{-7}$ μCi/g
Vegetation	α	$(2.3 \pm 1.3)\ 10^{-6}$ μCi/g ash
	β	$(3.6 \pm 1.8)\ 10^{-7}$ μCi/g ash
Water	α	$(6.4 \pm 3.9)\ 10^{-9}$ μCi/ml
	β	$(6.4 \pm 3.2)\ 10^{-10}$ μCi/ml
Air	α	$(6.4 \pm 3.8)\ 10^{-15}$ μCi/ml
	β	$(1.3 \pm 0.6)\ 10^{-14}$ μCi/ml

Counting system efficiencies are determined routinely with Ra-D+E+F (with alpha absorber), ^{36}Cl, ^{230}Th, ^{235}U, and ^{239}Pu standard sources and with ^{40}K, in the form of standard reagent-grade KCl, which is used to simulate soil and vegetation samples, and with soil containing known amounts of fully enriched uranium.

Self-absorption standards for beta counting are made by dividing sieved KCl into samples that increase in mass by 200-mg increments, from 100 to 3000 mg. The samples are placed in copper planchets of the type used for environmental samples and are counted. The ratio of sample activity to the observed net count rate for each sample is plotted as a function of sample mass, and a smooth curve is drawn through these points. The correction factor (ratio) corresponding to the mass of environmental samples is then obtained from the graph. The product of the correction factor and the net sample count rate yields the sample activity (dpm). This method has been proven usable by applying it to various-sized aliquots of uniformly mixed environmental samples and observing that the resultant specific activities fell within the expected statistical counting error, showing the absence of any systematic bias.

Since the observed radioactivity in environmental samples is primarily the result of natural sources and weapons testing and is at such low concentrations, no effort is normally made to identify individual radionuclides. The detection of significant levels of radioactivity would lead to an investigation of the radioactive material involved, the sources, and the possible causes.

D. NONRADIOACTIVE MATERIALS

The Rocketdyne Division of Rockwell International Corporation has filed a Report of Waste Discharge with the California Regional Water Quality Control Board and has been granted a National Pollutant Discharge Elimination System permit to discharge wastewater, pursuant to Section 402 of the Federal Water Pollution Control Act. The permit, NPDES No. CA0001309, which became effective 27 September 1976, was renewed with minor changes effective 17 September 1984. This permit covers discharge of overflow and storm runoff from water reclamation retention ponds into Bell Creek. Discharge generally occurs only during and immediately after periods of heavy rainfall or during extended periods of rocket engine testing.

Only one of the retention ponds receives influent from the nuclear operating areas of the SSFL site. It is identified as retention Pond R-2A, Water Sample Station W-12 in Table 11.

The influent includes sewage treatment plant outfall and surface runoff water. Grab-type water samples taken at the retention pond prior to a discharge are analyzed by a California State certified analytical testing laboratory for nonradioactive chemical constitutents and for radioactivity. The specific constituents analyzed for, and their respective limitations in discharged wastewater, are presented in Appendix C. Wastewater originating from facilities located throughout the SSFL site is collected at the retention pond. The point of origin of small amounts of most nonradioactive constituents normally found in wastewater is difficult to determine; however, in the event of

excessive amounts of any of these materials in wastewater, the origin could be determined from the knowledge of facility operations involving their use. Thirteen offsite discharges of wastewater from pond R-2A occurred during 1984.

In addition to the wastewater discharge limitations, atmospheric pollutant discharge limitations were imposed by Ventura County Air Pollution Control District Permit 0271 on two natural-gas/oil-fired sodium heaters operated by ETEC. The limitations are 2.47 tons/year for reactive organic compounds, 215.21 tons/year for oxides of nitrogen, 16.41 tons/year for particulates, 106.26 tons/year for oxide of sulfur, and 24.87 tons/year for carbon dioxide. Based on fuel consumption records for this facility during 1984, there was essentailly no discharge to the atmosphere in comparison with the discharge limits. During 1985, the APCD permit will be renegotiated with Ventura County with the expectation of more restrictive pollutant discharge limitations.

V. EFFLUENT MONITORING PROGRAM

Effluents that may contain radioactive material are generated at Rocketdyne Division facilities as the result of operations performed under contract to DOE, under NRC Special Nuclear Materials License SNM-21, and under State of California Radioactive Material License 0015-70. The specific facilities are identified as Buildings 020, 021, 022, and 055 at the Santa Susana site, SSFL, and Building 104 (previously identified as 004) at the De Soto Facility.

A. TREATMENT AND HANDLING

Waste streams released to unrestricted areas are limited in all cases to atmospheric emissions. No contaminated liquids are discharged to unrestricted areas.

The level of radioactivity contained in all atmospheric emissions is reduced to the lowest value by passing the emissions through certified, high-efficiency particulate air (HEPA) filters. These emissions are sampled for particulate radioactive materials by means of continuously operating stack exhaust samplers at the points of release. In addition, stack monitors installed at Buildings 020, 022, and 055 provide automatic alarm capability in the event of the release of gaseous or particulate activity from Building 020 and particulate activity from Buildings 022 and 055. The HEPA filters used for filtering atmospheric emissions are at least 99.97% efficient for particles 0.3 m in diameter. Particle filtration efficiency increases for particles above and below this size.

The average concentration and total radioactivity in atmospheric emissions to unrestricted areas are shown in Table 13. The effectiveness of the air cleaning systems is evident from the fact that in most cases the atmospheric emissions are less radioactive than is ambient air. The total shows that no significant quantities of radioactivity were released in 1984.

TABLE 13

ATMOSPHERIC EMISSIONS TO UNRESTRICTED AREAS--1984

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

[a]Assuming all radioactivity detected is from Rocketdyne nuclear operations.
Guide: De Soto site: 3×10^{-12} μCi/ml alpha, 3×10^{-10} μCi/ml beta; 10 CFR 20 Appendix B.
SSFL site: 6×10^{-14} μCi/ml alpha, 3×10^{-11} μCi/ml beta, 3×10^{-12} μCi/ml beta (055 only); 10 CFR 20 Appendix B, CAC-17, and DOE Order 5480.1 Chapter XI.
[b]Averaged result for 7-day (202 m^3) De Soto continuous air sampler.
[c]Natural radioactivity contained in equivalent volume of air discharged through exhaust systems after filtration.
Note: All release points are at the stack exit.

B. FACILITY DESCRIPTIONS

1. De Soto Site

a. Building 104--California State Licensed Activities

Operations at Building 104 that may generate radioactive effluents consist of research studies in applied physics and physical chemistry. Only atmospheric emissions are released from the building to uncontrolled areas. Major quantities of radionuclides present in encapsulated form are limited to ^{60}Co. Small amounts of irradiated metallurgical samples and depleted uranium are used for research purposes.

2. Santa Susana Field Laboratories Site

a. Building 020--NRC and California State Licensed Activities

Operations at Building 020 that may generate radioactive effluents consist of hot cell examination and decladding of irradiated nuclear fuels and examination of reactor components. Only atmospheric emissions are released from the building to uncontrolled areas. The discharge may contain particulate material, as well as radioacive gases, depending on the operations being performed and the history of the irradiated fuel or other material. No radioactive liquid waste is released from the facility. Radioactive material handled in unencapsulated form in this facility includes the following radionuclides: Th, U, Pu, as constituents in the various fuel materials; and ^{137}Cs, ^{90}Sr, ^{85}Kr, and ^{147}Pm as mixed fission products.

b. Buildings 021 and 022--DOE Contract Activities

Operations at Buildings 021 and 022 that may generate radioactive effluents consist of the processing, packaging, and temporary storage of liquid and dry radioacive waste material for disposal. Only atmospheric emissions are

released from the building to uncontrolled areas. No radioactive liquid waste is released from the facility. Nuclear fuel material handled in encapsulated or unencapsulated form contains uranium and plutonium plus ^{137}Cs, ^{90}Sr, ^{85}Kr, and ^{147}Pm as mixed fission products.

c. Building 055--NRC and California State Licensed Activities

Operations at Building 055 that may generate radioactive effluents consist of converting UC waste to the oxide state and decommissioning and decontamination of the facility and equipment pending release for unrestricted use. Only atmospheric emissions are released from the facility to uncontrolled areas. No radioactive liquid waste is released from the facility.

The various fuel materials that have been used at the facility (depleted and enriched uranium and plutonium) contained the following radionuclides: U plus ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{241}Am. No irradiated fuel materials have been processed at the facility.

C. ESTIMATION OF GENERAL POPULATION DOSE ATTRIBUTABLE TO NUCLEAR OPERATIONS--1984

The Los Angeles basin is a semiarid region whose climate is controlled primarily by the semipermanent Pacific high-pressure cell that extends from Hawaii to the southern California coast. The seasonal changes in the position of this cell greatly influence the weather conditions in this area. During the summer months, the high-pressure cell is displaced to the north. This results in mostly clear skies with little precipitation. During the winter, the cell moves sufficiently southward to allow some Pacific lows with their associated frontal systems to move into the area. This produces light to moderate precipitation with northerly and northwesterly winds.

The release of airborne material at the De Soto site for summer season weather conditions would generally be under a subsidence inversion into an

atmosphere that is typical of slight neutral to lapse conditions. Nocturnal cooling inversions, although present, are relatively shallow in extent. During the summer, a subsidence inversion is present almost every day. The base and top of this inversion usually lie below the elevation of the SSFL site. Thus, any atmospheric release from the SSFL site under this condition would result in Pasquill Type D lofting diffusion conditions above the inversion and considerable atmospheric dispersion, prior to any diffusion through the inversion into the Simi or San Fernando Valleys. In the winter season, the Pacific high-pressure cell shifts to the south and the subsidence inversion is usually absent. The surface air flow is then dominated by frontal activity moving through the area to the east, resulting in high-pressure systems in the great basin region. Frontal passages through the area during winter are generally accompanied by precipitation. Diffusion characteristics are highly variable depending on the location of the front. Generally, a light to moderate southwesterly wind precedes these frontal passages, introducing a strong onshore flow of marine air and producing lapse rates that are slightly unstable. Wind speeds increase as the frontal systems approach, enhancing diffusion. The diffusion characteristics of the frontal passsage are lapse conditions with light to moderate northerly winds. Locally, average wind speeds for the various stability categories range from 0 to about 4.4 m/s with the greatest frequency occurring for winds from the north to northwest sectors. Local population distribution estimates projected for 1986, based on the 1980 federal census and on direct observation of nearby residences, for areas surrounding the SSFL site and out to 80 km for 16 sectors are shown in Figures 9-11.

The downwind concentration of radioactive material emissions to the atmosphere during 1984 from each of the three major Rocketdyne nuclear facilities has been calculated with the AIRDOS-EPA computer code using site-specific input data.

To determine the maximum radioactivity concentrations at the site boundary location nearest to each release point and at the nearest residence, a mean wind speed of 2.2 m/s for each stability class was assumed and

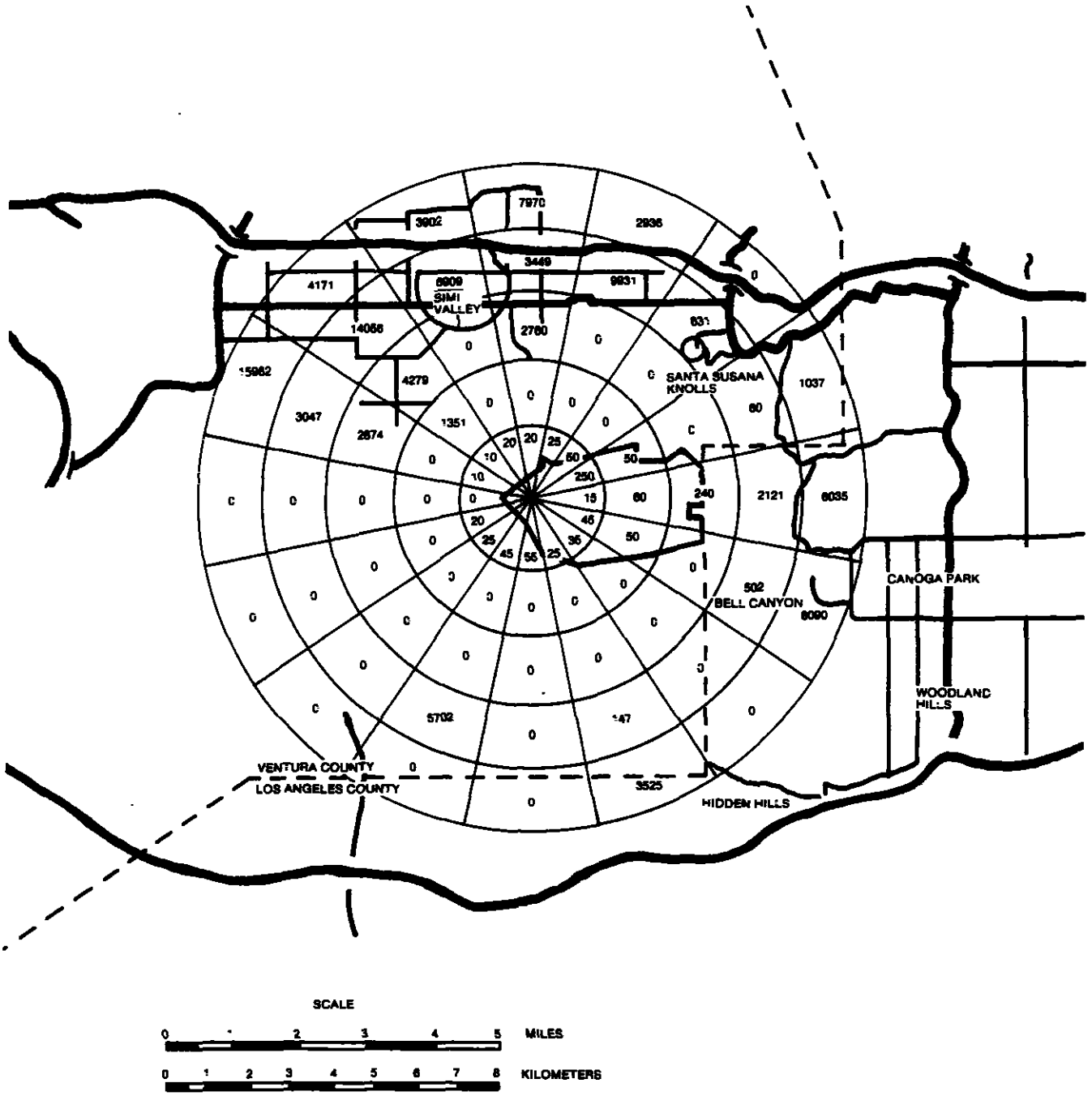

Figure 9. Santa Susana Field Laboratories Site Centered Demography to 8 km Distance

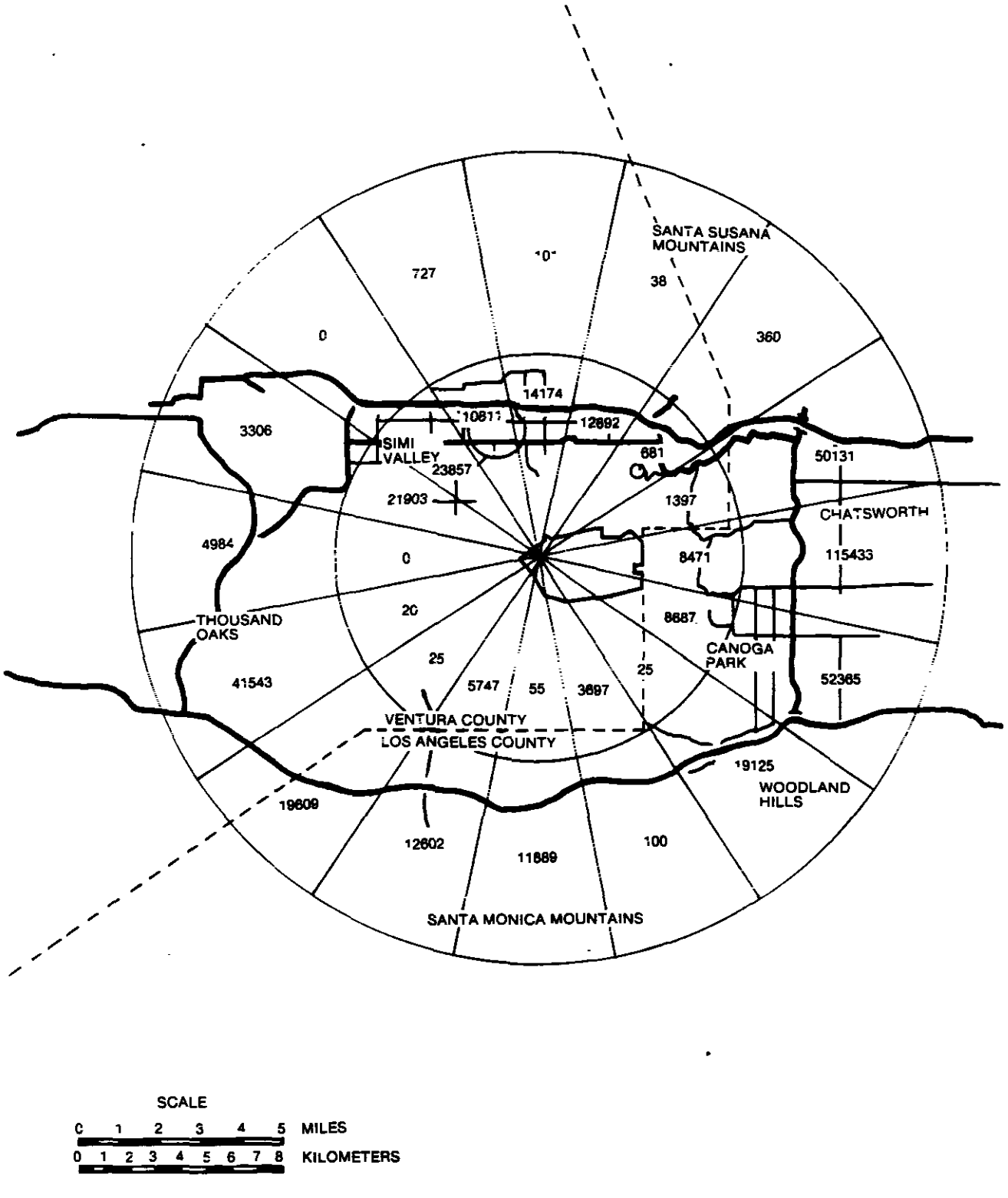

Figure 10. Santa Susana Field Laboratories Site Centered Demography to 16 km Distance

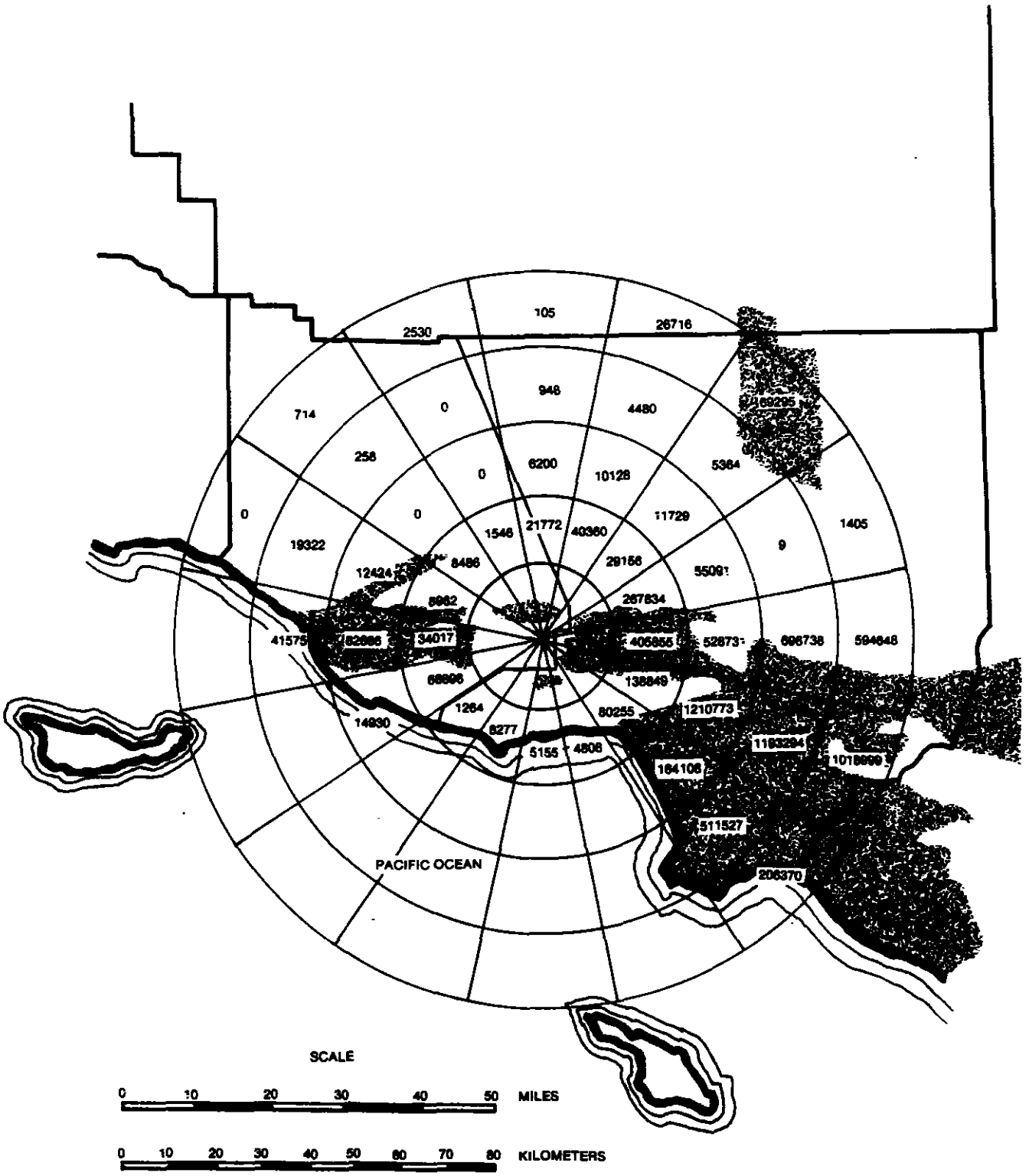

Figure 11. Santa Susana Field Laboratories Site Centered Demography to 80 km Distance (heavily populated areas are shown by shading)

used to evaluate the plume centerline (maximum) concentrations toward the sector in which those locations lie. The 80-km concentration was calculated for the greatest wind frequency, which is toward a northerly direction. The concentration estimates are shown in Table 14, and both internal and external radiation dose estimates are shown in Table 15. The internal dose calculations assume a constant unsheltered exposure throughout the year and therefore considerably overestimate the actual annual-averaged and doses. These are shown as ranges of estimated doses because of the great variability of dispersion calculations. The external dose calculations assume that differences in TLD readings represent true differences in local exposure. These differences are extrapolated to the boundary and nearest residence using an inverse square distance relation from an assumed source of radiation. However, these dose estimates are so small relative to the variability and uncertainty in the measurements that they probably do not represent real doses but are rather the result of the assumptions and the analysis process. In short, doses at the site boundaries and beyond are too small to be measurable.

TABLE 14

MAXIMUM CONCENTRATIONS OF ATMOSPHERIC EMISSIONS--1984

Facility	Release Rate (Ci/year)	Distance (m) to		Downwind Concentation ($\mu Ci/cm^3$)[a]		
		Boundary	Residence	Boundary	Residence	80 km
B/104	1.0×10^{-6}	200 W	315 SW	5.0×10^{-19}	1.3×10^{-19}	3.1×10^{-19}
B/020	4.5×10^{-6}	305 NW	1900 SE	4.7×10^{-19}	1.6×10^{-19}	0.21×10^{-19}
B/022	3.7×10^{-6}	350 NW	2300 SE	1.4×10^{-19}	0.7×10^{-19}	0.14×10^{-19}
B/055	1.0×10^{-6}	400 NW	1830 SE	2.4×10^{-19}	0.5×10^{-19}	0.05×10^{-19}

[a]Assume $\bar{u}$ = 2.2 m/s average wind speed, wind direction averaged for full year.

TABLE 15

MAXIMUM INDIVIDUAL ANNUAL DOSE--1984

Site	Internal Exposure (mrem)		External Dose (mrem)	
	Boundary	Residence	Boundary	Residence
De Soto	$(0.04 \text{ to } 19) \times 10^{-3}$	$(0.01 \text{ to } 5) \times 10^{-3}$	7 ± 11	2 ± 3
SSFL	$(0.002 \text{ to } 2.9) \times 10^{-3}$	$(0.001 \text{ to } 0.9) \times 10^{-3}$	1 ± 1.1	0.04 ± 0.04
Natural	80-130		100-120	

The general population man-rem dose estimates are calculated from the demographic distribution and the sector total inhalation intake (man-pCi/year) generated by AIRDOS-EPA, which uses release rate, wind speed, wind direction and frequency, inversion, lapse, and effective stack height parameters as input data. Population dose estimates centered on the SSFL site are presented in Table 16. Inhalation is the only significant exposure pathway likely to exist, with lung the critical organ for U and Pu, and bone for Sr. The doses reported for SSFL site emissions are summed for all release points and nuclides.

The estimated offsite doses are extremely low compared with the maximum permissible exposures recommended for the general population. These maximum permissible values are 3 rem/year for bone and 1.5 mrem/year for the lung for an individual. The general population values are one-third of the individual exposures. The maximum estimated internal and external exposures for 1984 at the De Soto and Santa Susana site boundaries to an individual and at the nearest residence are shown in Table 15. Estimated internal radiation doses due to atmospheric emission of radioactive materials from De Soto and the SSFL nuclear facilities are a small fraction of the recommended limits and are far below doses due to internal exposure to natural radioactivity in air.

TABLE 16

POPULATION DOSE ESTIMATES FOR ATMOSPHERIC EMISSIONS FROM SSFL FACILITIES--1984

22.5° Sector	Dose to Receptor Population Segment (man-rem)						
	0-8 km	8-16 km	16-32 km	32-48 km	48-64 km	64-80 km	Total
N	1.2×10^{-4}	2.9×10^{-7}	2.7×10^{-5}	4.8×10^{-6}	5.3×10^{-7}	4.6×10^{-8}	1.5×10^{-4}
NNW	5.5×10^{-5}	1.3×10^{-6}	1.2×10^{-6}	0	0	3.8×10^{-7}	5.8×10^{-5}
NW	1.5×10^{-4}	0	7.1×10^{-6}	0	9.9×10^{-8}	2.1×10^{-7}	1.6×10^{-4}
WNW	2.1×10^{-4}	1.2×10^{-5}	1.6×10^{-5}	1.4×10^{-5}	1.6×10^{-5}	0	2.7×10^{-4}
W	0	1.1×10^{-5}	3.6×10^{-5}	5.7×10^{-5}	2.1×10^{-5}	0	1.2×10^{-4}
WSW	2.1×10^{-7}	4.9×10^{-5}	3.8×10^{-5}	5.4×10^{-6}	1.0×10^{-6}	0	9.4×10^{-5}
SW	1.7×10^{-7}	1.7×10^{-5}	5.3×10^{-7}	0	0	0	1.8×10^{-5}
SSW	1.6×10^{-5}	1.2×10^{-5}	3.9×10^{-6}	0	0	0	3.2×10^{-5}
S	1.0×10^{-6}	2.5×10^{-5}	5.2×10^{-6}	0	0	0	3.1×10^{-5}
SSE	2.0×10^{-5}	2.5×10^{-7}	5.6×10^{-6}	0	0	0	2.6×10^{-5}
SE	5.2×10^{-7}	4.4×10^{-5}	8.9×10^{-5}	1.2×10^{-4}	2.7×10^{-4}	8.5×10^{-5}	6.1×10^{-4}
ESE	3.6×10^{-5}	9.5×10^{-5}	1.2×10^{-4}	6.7×10^{-4}	4.9×10^{-4}	3.3×10^{-4}	1.7×10^{-3}
E	3.5×10^{-5}	1.4×10^{-4}	2.4×10^{-4}	2.0×10^{-4}	1.9×10^{-4}	1.3×10^{-4}	9.2×10^{-4}
ENE	4.3×10^{-6}	4.1×10^{-5}	1.0×10^{-4}	1.3×10^{-5}	1.6×10^{-9}	2.0×10^{-7}	1.6×10^{-4}
NE	2.6×10^{-6}	4.0×10^{-7}	1.5×10^{-5}	3.9×10^{-6}	1.3×10^{-6}	1.3×10^{-5}	3.6×10^{-5}
NNE	5.9×10^{-5}	6.2×10^{-8}	3.0×10^{-5}	4.8×10^{-6}	1.5×10^{-6}	7.1×10^{-6}	1.0×10^{-4}
Total	7.0×10^{-4}	4.5×10^{-4}	7.3×10^{-4}	1.1×10^{-3}	9.9×10^{-4}	5.7×10^{-4}	4.5×10^{-3}

Average individual dose = 5.6×10^{-10} rem for the 80-km radius area total population.

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The external exposures, above background, are based on the greatest altitude-adjusted exposure measured by a single dosimeter compared with average adjusted offsite measurements. The mean adjusted value for five offsite dosimeters was 101 mrem with a maximum observed value of 109 mrem. Boundary exposures assume 100% occupancy, whereas the actual presence of persons at the boundary is rare or nonexistent. Review of the data indicates that these derived values are not statistically different from zero, as shown by the uncertainties being greater than the reported value, but result from assumptions in the analysis. These values are less than 2% of the permissible level of radiation in unrestricted areas of 500 mrem per year to any individual as specified in 10 CFR 20.105, CAC-17 Section 30268, and DOE Order 5480.1, Chapter XI, Part 4.b.

APPENDIX A

COMPARISON OF ENVIRONMENTAL RADIOACTIVITY DATA FOR 1984 WITH PREVIOUS YEARS

This section compares environmental monitoring results for calendar year 1984 with previous annual data.

The data presented in Tables A-1 through A-5 summarize past annual average radioactivity concentrations. These data show the effects of both the short-lived and long-lived radioactive fallout from nuclear weapons tests superimposed on the natural radioactivity inherent in the various sample types.

Over the considerable period of time that the environmental program has been in operation, evolutionary changes have been made in order to provide more effective data. In some cases, this is readily apparent in the data. For example, in Table A-1, a small but abrupt increase in the alpha activity reported for soil occurs in 1971. This increase, which is observed in both the onsite and the offsite samples, resulted from use of an improved counting system with a thinner sample configuration. The thinner sample increases the sensitivity of the detector to alpha-emitting radionuclides in the sample, thus producing a higher measured specific radiation.

Similarly, prior to 1971, gross activity in ambient air was measured, including both alpha and beta activity. In 1971, measurements were begun which allowed separate identification of these two types of radiation.

In 1984, recalibration of the alpha counting method for thick samples was achieved, resulting in determination of the absolute alpha activity in these samples rather than the relative values previously used for monitoring purposes. Comparison of the values for 1984 as determined by the relative method with those for prior years shows no significant difference.

The ambient radiation monitoring results continued a downward trend that appears to be real but unrelated to operations onsite. Independent measurements and intercomparisons support the values measured by the bulb-type dosimeters. With the exception of apparent changes resulting from improvements in analytical methods and interpretation of the data, the soil, vegetation, water, and air radioactivity results are notably constant over the past 20 years. In particular, environmental radioactivity data for the De Soto site show no reduction in the measured levels below those that had been observed during the fuel fabrication operations that were discontinued in 1982.

For all types of samples, the data indicate that there is no concentrated local source of unnatural radioactivity in the environment. Also, the similarity between onsite and offsite results further indicates that Rockwell operations contribute essentially nothing to general environmental radioactivity.

TABLE A-1

SOIL RADIOACTIVITY DATA--1965 THROUGH 1984

Year	Onsite Average (10^{-6} µCi/g ash)			Offsite Average (10^{-6} µCi/g ash)		
	Number of Samples	α	β	Number of Samples	α	β
1984[a]	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	0.50	23
1978	144	0.63	24	48	0.51	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	0.54	24
1973	144	0.57	25	48	0.51	24
1972	144	0.56	25	48	0.57	24
1971	144	0.55	25	48	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	0.42	28	48	0.39	24
1966	144	0.41	29	48	0.44	25
1965	144	0.46	36	142	0.47	29

[a]The change in alpha activity for 1984 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. This is discussed in detail in Part III, Section A. Values for 1984 using the prior method would be 0.65 for the onsite average and 0.66 for the offsite average.

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TABLE A-2

VEGETATION RADIOACTIVITY DATA--1965 THROUGH 1984

Year	Onsite Average (10^{-6} μCi/g ash)			Offsite Average (10^{-6} μCi/g ash)		
	Number of Samples	α	β	Number of Samples	α	β
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	0.56	162	142	0.61	138

[a]The change in alpha activity for 1984 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. This is discussed in detail in Part III, Section A. Values for 1984 using the prior method would be 0.21 for the onsite average and 0.21 for the offsite average.

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TABLE A-3

SSFL SITE SUPPLY WATER RADIOACTIVITY DATA--
1965 THROUGH 1984

Year	Number of Samples	Average α (10^{-9} μCi/ml)	Average β (10^{-9} μCi/ml)
1984[a]	24	3.53	2.9
1983	24	0.12	3.0
1982	24	0.14	3.0
1981	24	<0.24	2.8
1980	24	<0.22	2.4
1979	24	<0.23	2.8
1978	24	<0.26	3.0
1977	24	<0.25	2.5
1976	24	<0.25	2.0
1975	24	<0.24	2.3
1974	24	<0.24	2.7
1973	24	<0.26	3.4
1972	24	0.22	3.7
1971	24	0.28	4.9
1970	24	0.18	5.3
1969	24	0.11	5.0
1968	24	0.16	5.0
1967	24	0.13	6.1
1966	24	0.13	4.6
1965	24	0.22	6.0

[a]The change in alpha activity for 1984 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. This is discussed in detail in Part III, Section A. The value for 1984 using the prior method would be 0.15.

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TABLE A-4

BELL CREEK AND ROCKETDYNE DIVISION RETENTION POND
RADIOACTIVITY DATA--1966 THROUGH 1984

Year	Samples														
	Bell Creek Mud 54			Bell Creek Vegetation 54			Bell Creek Water 16			Interim Retention Pond Water 6			Final Retention Pond R-2A Water 12		
	Number of Samples	Average (10^{-6} µCi/g)		Number of Samples	Average (10^{-6} µCi/g ash)		Number of Samples	Average (10^{-9} µCi/ml)		Number of Samples	Average (10^{-9} µCi/ml)		Number of Samples	Average (10^{-9} µCi/ml)	
		α	β		α	β		α	β		α	β		α	β
1984[a]	12	20.8	24.	12	1.70	138.	12	4.15	2.9	12	2.07	4.6	12	0.15	4.2
1983	12	0.54	23.	12	0.12	136.	12	0.08	3.3	12	0.12	3.6	12	0.13	4.4
1982	12	0.64	25.	12	0.08	160.	12	0.03	3.3	12	0.17	3.9	12	0.11	3.9
1981	12	0.58	24.	12	<0.13	103.	12	<0.23	3.8	12	<0.23	4.3	12	<0.25	5.2
1980	12	0.51	23.	12	<0.18	150.	12	<0.22	2.9	12	<0.22	2.9	12	<0.22	3.9
1979	12	0.46	23.	12	<0.26	136.	12	<0.23	3.2	12	<0.25	3.1	12	<0.23	4.5
1978	12	0.42	23.	12	<0.26	156.	12	<0.24	2.5	12	<0.25	4.3	12	<0.25	4.6
1977	12	0.29	22.	12	<0.19	155.	12	<0.24	1.8	12	<0.24	4.3	12	<0.25	5.2
1976	12	0.38	23.	12	<0.17	164.	12	<0.25	2.2	12	<0.24	4.3	12	<0.28	4.4
1975	12	0.29	22.	12	<0.19	123.	12	<0.22	2.4	12	<0.24	4.2	12	<0.31	4.5
1974	12	0.32	22.	12	<0.16	142.	12	<0.21	2.5	12	<0.22	4.2	12	<0.21	4.5
1973	12	0.34	24.	12	<0.17	147.	12	<0.21	2.7	12	<0.23	4.5	12	<0.37	5.6
1972	12	0.32	22.	12	0.12	139.	12	0.20	2.5	12	0.22	5.3	12	0.22	5.5
1971	12	0.36	23.	12	0.19	128.	12	0.15	3.8	12	0.18	6.2	12	0.16	6.4
1970	12	0.44	24.	12	0.23	165.	12	0.15	3.7	12	0.15	6.9	12	0.12	7.4
1969	12	0.35	27.	12	0.28	166.	12	0.04	4.0	12	0.07	5.9	11	0.10	5.7
1968	11	0.32	24.	11	0.39	170.	8	0.05	4.6	11	0.23	8.1	12	0.33	7.7
1967	12	0.40	24.	12	0.38	180.	12	0.07	5.8	12	0.19	6.6	10	0.17	7.0
1966	3	0.39	25.	3	1.1	108.	3	0.75	2.5	9	0.11	5.8	8	1.1	6.3

[a]The change in alpha activity for 1984 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. This is discussed in detail in Part III, Section A. Values for 1984 using the prior method would be as follows:

Bell Creek mud: 0.55
Bell Creek vegetation: 0.09
Bell Creek water: 0.07
Interim Retention Pond: 0.07
Final Retention Pond: 0.002

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TABLE A-5

AMBIENT AIR RADIOACTIVITY CONCENTRATION DATA--1965 THROUGH 1984

Year	De Soto Site Average (10^{-12} µCi/ml)			SSFL Site Average (10^{-12} µCi/ml)		
	Number of Samples	α	β	Number of Samples	α	β
1984	712	0.0019	0.027	2461	0.0014	0.024
1983	644	0.0024	0.026	2328	0.0010	0.023
1982	727	0.0017	0.026	2347	0.0013	0.022
1981	704	<0.0069	<0.12	2518	<0.0068	<0.12
1980	685	<0.0065	<0.039	2342	<0.0064	<0.035
1979	697	<0.0066	<0.021	2519	<0.0065	<0.020
1978	713	<0.0084	<0.091	2402	<0.0072	<0.088
1977	729	<0.0066	<0.17	2438	<0.0066	<0.17
1976	719	<0.0067	<0.096	2520	<0.0065	<0.11
1975	709	<0.0063	<0.076	2450	<0.0060	<0.073
1974	663	<0.0056	<0.16	2477	<0.0057	<0.16
1973	715	<0.0075	<0.041	2311	<0.0072	<0.038
1972	708	0.0085	0.14	2430	0.0086	0.14
1971[a]	730	0.0087	0.30	2476	0.0086	0.33
1970	668	-	0.34	2434	-	0.36
1969	687	-	0.27	2364	-	0.26
1968	650	-	0.32	2157	-	0.32
1967	712	-	0.39	2400	-	0.41
1966	706	-	0.18	2205	-	0.17
1965	483	-	0.83	1062	-	0.21

[a]Ambient air alpha radioactivity values were included in the beta values and not reported separately prior to 1971.

APPENDIX B
ENVIRONMENTAL MONITORING PROGRAM QUALITY CONTROL

This section describes the quality assurance (QA) elements that are incorporated into the Rocketdyne program to ensure that data produced are as meaningful as possible.

PROCEDURES

Procedures followed include sample selection; sample collection; packaging, shipment and handling of samples for offsite analysis; preparation and analysis of samples; use of radioactive reference standards; calibration methods and instrument QA; and evalaution and reporting of data.

RECORDS

Records generally cover the following processes: field sample collection and laboratory identification coding; sample preparation method; radioactivity mesurements (counting) of samples, instrument backgrounds, and analytical blanks; and data reduction and verification.

Quality control records for laboratory counting systems include the results of measurements of radioactive check sources, calibration sources, backgrounds, and blanks, as well as a complete record of all maintenance and service.

Records relating to overall laboratory performance include the results of analysis of quality control samples such as analytical duplicates, interlaboratory cross-check samples and other quality control analyses; use of standard (radioactive) reference materials to prepare working standards; and calibration of analytical balances.

The following specific elements of quality control are used for the Rocketdyne program:

1) Reagent Quality--Reagent-grade chemicals and certified grade counting gas used.

2) Laboratory Ventilation--Room air supply is controlled to minimize temperature variance and dust incursion.

3) Laboratory Contamination--Periodic laboratory contamination surveys for fixed and removable surface contamination are performed. Areas are cleaned routinely and decontaminated when necessary.

4) Control Charts--Background and reference source control charts for counting equipment are maintained to evaluate stability and response characteristics.

5) Laboratory Intercomparisons--Rockwell participates in the DOE-EML Laboratory Quality Assessment Program, and also participates in the DOE Environmental Dosimeter Intercomparison Project.

6) Duplicate Samples--Duplicate samples are obtained monthly at randomly selected environmental sampling locations. Analytical data are statistically evaluated to determine the correlation coefficients for each media type for the annual sample set.

7) Calibration Standards--Counting standard radioactivity values are traceable to National Bureau of Standards primary standards.

APPENDIX C

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD CRITERIA FOR DISCHARGING NONRADIOACTIVE CONSTITUENTS FROM ROCKETDYNE DIVISION, SSFL

The discharge of an effluent in excess of the limits given in Table C-1 is prohibited.

TABLE C-1

NPDES NO. CA00-01309, EFFECTIVE 27 SEPTEMBER 1976

Constituent	Discharge Rate (lb/day)	Concentration Limit (mg/liter)		
	30-Day Average	30-Day Average	Maximum	Maximum[c]
Total dissolved solids	1,267,680	-	950	950
Chloride	200,160	-	150	150
Sulfate	400,320	-	300	300
Suspended solids[a]	66,720	50	150	-
Settleable solids[a]	-	0.1	0.3	-
BOD_5	26,690	20	60	30
Oil and grease	13,350	10	15	15
Chromium	6.67	0.005	0.01	-
Fluoride	1,340	-	1.0	1.0
Boron	1,340	-	1.0	1.0
Residual chlorine	-	-	0.1	0.1
Fecal coliform (MPN/100 ml)	-	-	23.0[b]	2.0
Surfactants (as MBAS)	667	-	0.5	0.5
pH			6.0 - 9.0	6.0 - 9.0

[a]Not applicable to discharges containing fainfall runoff during or immediately after periods of rainfall.
[b]Wastewater shall be considered adequately disinfected if the median number of coliform organisms does not exceed 23 per 100 ml.
[c]A new permit, NPDES No. CA0001309, Order 84-85, became effective on 17 September 1984 by order adopted by the California Regional Water Quality Control Board, Los Angeles Region.

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APPENDIX D

REFERENCES

1. DOE Order 5484.1

2. DOE Order 5480.1A

3. Code of Federal Regulations, Title 10, Part 20

4. California Radiation Control Regulations, California Administrative Code, Title 17, Public Health

5. California Regional Water Quality Control Board, Los Angeles Region, Order No. 74-379, NPDES No. CA0001309, Effective 27 September 1976

6. AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Doses to Man from Airborne Releases of Radionuclides, ORNL-5532

7. Estimates of Internal Dose Equivalent to 22 Target Organs for Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities, Volume III, ORNL/NURGE/TM-190

8. J. D. Moore, "Radiological Environmental Monitoring Program," N00105P000001, Rocketdyne Division, Rockwell International (9 July 1984)

9. J. D. Moore, "Radiological Environmental Monitoring Program Sampling Procedures, Analysis Procedures, and Radioactivity Measurement Methods," N001DWP000008, Rockwell International, Rocketdyne Division (9 July 1984)

10. J. D. Moore, "Radiological Environmental Monitoring Program Quality Assurance," N001DWP000009, Rocketdyne Division, Rockwell International (25 September 1984)

11. "*Investigation of Hydrogeolic Conditions - Santa Susana Field Laboratory*, Ventura County, California," Hargis & Associates, Inc., Tucson, Arizona (22 February 1985)

APPENDIX E

EXTERNAL DISTRIBUTION

1. Radiologic Health Section, Department of Health Services, California
2. Radiation Management, Health Services Department, Los Angeles County, California
3. Resources Management Agency, County of Ventura, California
4. U.S. Nuclear Regulatory Commission, Region V, Walnut Creek, California
5. U.S. Nuclear Regulatory Commission, Office of Inspection and Enforcement, Washington, D.C.
6. U.S. Department of Energy, San Francisco Operations Office
7. U.S. Department of Energy, Office of Operational Safety, EP-32, Technical Information Center

APPENDIX F

ALTERNATIVE UNITS FOR RADIOLOGICAL DATA

	In Non-SI Units	In SI Units	Conversion Factor From Non-SI to SI Units[a]
Activity Concentrations (Environmental)			
Airborne Particulates and Gas	pCi/m^3	Bq/m^3	3.70E - 02
Liquids (Water, Milk, etc.)	pCi/L	Bq/L	3.70E - 02
Solids (Soil, Sediment, Vegetation, Foodstuff, etc.)	pCi/kg	Bq/kg	3.70E - 02
Activity Concentrations (Effluent)			
Gas (Air)	(μCi/mL)[b]	Bq/m^3	3.70E + 10
Liquid	(μCi/mL)[b]	Bq/L	3.70E + 07
Exposure Rate (Environment)	μR/h	C/kg h	2.58E - 10
Absorbed Dose	mrad	Gy	1.00E - 05
Dose Equivalent	mrem	Sv	1.00E - 05
Dose Equivalent Rate (Commitment)	mrem/year	Sv/year	1.00E - 05

[a]To convert non-SI units to SI units, multiply the non-SI units by the conversion factor.

[b]Adopted because of established convention and use in maximum permissible concentration (MPC) tabulations.

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