Peer Review of the

ROCKWELL INTERNATIONAL SANTA SUSANA FIELD LABORATORY'S ENVIRONMENTAL MONITORING PROGRAM

Conducted By:

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EXECUTIVE SUMMARY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

I. INTRODUCTION

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

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

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

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

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

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

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

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

II. SSFL SITE HISTORY AND SOURCES OF RADIOACTIVITY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

III. LICENSING AND REGULATION OF RADIOACTIVE MATERIALS AT SSFL

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

LOWER LIMITS OF DETECTION FOR ENVIRONMENTAL SAMPLES

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

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

IV. RADIOLOGICAL MEASUREMENTS AND QUALITY ASSURANCE

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

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

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

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

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

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

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

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

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

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

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

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

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

V. REVIEW OF EFFLUENT AND ENVIRONMENTAL MONITORING RESULTS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

APPENDIX A

RECOMMENDATION FOR ENHANCEMENT OF RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM AT SSFL

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

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

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

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

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

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

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

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

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

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

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

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

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

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

APPENDIX B

REVIEW OF EPA DEMPSEY REPORT

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

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

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

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

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

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

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

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

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

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

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

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

2. Comments on soil procedure for gross activity measurements:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

   Response: It is true that washing of vegetation samples could remove radioactivity deposited from atmospheric emissions. SSFL has stated that the purpose for sampling of vegetation was to monitor potential uptake from soil. For this purpose the vegetation should have been washed. In retrospect soil uptake was not a likely mechanism for vegetation uptake at most locations where soil samples were collected and measurement of unwashed vegetation would have been an additional method for evaluating airborne releases in addition to soil. The vegetation sampling was discontinued because the site was in the process of being decommissioned and it was recognized that there was no longer a need for monitoring the uptake of radioactivity from soil.

5. Comment: "Part of a good environmental program involves checking other pathways to man thorough which radionuclides might travel. One of these is through meat samples obtained from feral species... This is not being done."

   Response: A good monitoring program is one that is based on an analysis of pathways for transport of radioactivity in the environment and ultimately the pathways for exposure of man. Environmental monitoring programs should be designed to monitor critical radionuclides and critical exposure pathways. Critical is used in the context of being the most important with respect to exposure of man. Environmental monitoring programs should be periodically reviewed and updated to reflect the information gained from past results. For example if analysis of soil samples indicated that atmospheric deposition could result in significant uptake by animals from forage and that these animals are a source of meat for people in the area, then samples of these animals should be analyzed. At the SSFL site there were no indications that feral species should be monitored since no elevated levels of radioactivity have been detected in environmental samples and hunting is not allowed onsite. Subsequent to the release of the Dempsey Report SSFL analyzed portions of a deer and rabbits obtained as a result of road kills near the site. No radioactivity associated with SSFL operations were detected in these samples.

6. Comment: Exception was taken to the method of draping a bag of air filters over the germanium detector instead of placing them in a Marinelli beaker and counting for 10,000 seconds instead of 36000 seconds as stated

   Response: This appeared to be point of miscommunication between the laboratory and Mr. Dempsey. The filters were draped over the counter for a preliminary view of the filters and the count time was in excess of 3600 seconds which is normally used. There was a typo in the procedure which indicated a count of 36000 seconds instead of 3600. A printout of this count was provided as a courtesy to Mr. Dempsey for his review and did not constitute the final count where the filters are placed in a marinelli beaker for counting.

7. Comment: "The laboratory also provides thermoluminescent dosimetry for the facility and offsite areas. Certain questionable practices are alluded to in the environmental report. data...is normalized to a 1000-ft altitude by using a adjustment factor equal to 15 mR/1000 ft....Also in both the calendar year 1987 and the unpublished calendar year 1988 SSFL environmental reports. comparisons ...by the State of California and a DOE intercomparison report were 'not available' for inclusion...This leads me to think that the SSFL dosimetry program may not compare favorably with the other groups."

   Response: I have not previously encountered the normalization technique used for making altitude corrections to dose rates; however, there is a technical basis for making such a correction. This data was derived from data presented in "Environmental Radioactivity," by Merrill Eisenbud in 1963. Although "experts" can debate the relative merits of making such a correction. it seems like a moot point since the original data is included in the report. The comment about the failure to include State of California and DOE data and the implication that it was not included because it would not agree with others is presumptuous of Mr. Dempsey. In fact the SSFL TLD results are generally higher than the State of California's by up to 25-40 per cent and this information has been published in previous reports. In reviewing the difference between dose rates at monitoring locations (at locations with elevated radiation levels compared to background) and control stations, the State data and SSFL show reasonably good agreement.

8. Comment: "SSFL or Rocketdyne has not collected soil or water samples to be analyzed for tritium."

   Response: Although tritium has been detected in two locations, the concentrations are very low. There has been no evidence of migration from the area where it was produced. The analysis of soil samples for tritium is of little value since tritium in soil will reflect the values observed with water. If there is not sufficient water to collect a sample, it is unlikely that tritium contamination of ground water would be a significant pathway for exposure. Since a detailed study of pollutants in groundwater is being carried out. it would be useful to analyze for tritium since it may provide information regarding site hydrology. In view of the limited source term for tritium from the reactors. the exclusion of tritium from the routine

monitoring program was a reasonable decision. Most environmental monitoring programs are not designed to analyze for every potential radionuclide. A sound program is based on the source term and potential for a pathway to man. There is no evidence that tritium was produced in sufficient quantities to be considered as a significant contributor to offsite doses even if there were subsurface migration to offsite groundwater.

9. Comment: "The lack of a meteorological tower onsite was mentioned as a concern (quote by Dempsey from DOE report). Better AIRDOS information could be generated with a closer-to-site or onsite met tower."

Response: The local topography is quite complex with hills and valleys. There are so many uncertainties associated with AIRDOS for a site with complex terrain like SSFL that it is unlikely that a site meteorological tower would be useful. In addition, the atmospheric emissions from the SSFL are so low that errors of several orders of magnitude would not be significant with respect to assessing doses from airborne releases. There are no significant sources of airborne radioactivity that would threaten the environment or the local population. This concern may have been valid when reactors and criticality assemblies represented significant source terms for airborne radioactivity. At this point in time I do not believe that a meteorological tower could be justified in terms of cost and need.

APPENDIX C

REVIEW OF THE BERGER REPORT, "REVIEW OF SURPLUS FACILITIES RADIOLOGICAL MONITORING SAINT SUSANA FIELD LABORATORIES VENTURA COUNTY, CALIFORNIA"

In September 1989 Oak Ridge Associated Universities conducted an onsite review at the SSFL site. This review was requested by the DOE to assess the capability of the SSFL radiological monitoring program to identify, characterize, and decommission areas associated with past and present DOE activities. The assessment was performed by Mr. James Berger and Dr. Clayton Weaver of ORAU. Both individuals are highly qualified and have been associated with close out surveys at DOE and NRC regulated sites to assess the efficacy of the licensees or contractors activities and radiological measurements.

The Berger report noted that the overall capabilities at SSFL in terms of staff, equipment, and procedures were adequate to perform the necessary radiological monitoring in support of site decommissioning. The report did note that there were several areas where improvements would strengthen the program. A list of seventeen recommendations were made to improve the program. I have reviewed these recommendations and will provide my assessment as to the need to implement the recommendations.

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

I concur with this recommendation. The cross training of staff is particularly important in view of the limited number of employees in the Radiation and Nuclear Safety Group. Based on my observations it appears that the current staffing is not adequate to meet all the current demands and suggested program improvements such as procedure development.

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

The SSFL facilities are not adequate to support the chemical separations that would be necessary for preparing samples for analysis of low energy beta emitters. This function should be contracted to a laboratory with the equipment and expertise necessary for these complex analyses.

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

I concur with this recommendation. During my review of the laboratory I noted the need for additional procedures and periodic review and updating of current procedures. Although some guidance with respect to survey techniques are given in Survey Plans for specific facilities, generic procedures for operation of survey instruments should be available for all instrumentation. These procedures should specify instrument checks, calibration frequency, and guidance for using the equipment for various types of surveys.

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

This recommendation is currently being implemented. Prior to the Berger review, the necessary programs were obtained and staff attended training in the use of RESRAD.

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

This recommendation should be implemented in conjunction with Item 4. Specific nuclidic analyses should be performed if gross alpha or gross beta levels exceed a screening level. The screening level should be based on dose considerations using RESRAD and information regarding the most likely radioisotopes based on initial surveys and historical information. Gamma ray spectrometry should be used to the fullest extent possible. The need for other radionuclidic analyses can be based on the results of gamma analyses. For example if there are elevated levels of Cs-137 near the guidelines established in recommendation 4, it would normally be necessary to analyze for Sr-90 since both are fission products likely to be present together.

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

This is considered good practice so that survey locations are unambiguous and can be relocated if necessary.

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

It was not clear to me why this particular recommendation was made. Previous decontamination projects and surveys by SSFL personnel have been reviewed by DOE, NRC, and contractors and were found to be acceptable.

Item 8. Develop a list of equipment detection capabilities.

This was presumably recommended to ensure that instrumentation being used is capable of demonstrating compliance with regulatory limits or guidelines. The equipment operating procedures would be an appropriate location to list an instrument's particular capabilities.

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

Although there is not likely to be a problem with ashing soil at 500°C, reduction of the ashing temperature to 450°C would decrease any chances of volatilization and not otherwise affect soil measurements. Test have been performed that show Cs-137 is not volatilized at 500°C. To my knowledge no other radionuclides that would volatilize (e.g. Tc-99, I-129) are expected to be present in soil at the SSFL site.

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

This has been evaluated by SSFL staff and the current practice for identifying radionuclides from characteristic photopeaks is acceptable. Certain photopeaks such as the 93 keV photopeak from Th-234 cannot be easily used due to limitations in the gamma spectral reduction software with respect to resolution of doublets. Specific recommendations with respect to using alternate photopeaks for U-235 are considered when the data is reviewed.

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

I concur with this recommendation since actual soil efficiencies may be ten per cent lower than those obtained with the solid standard that is currently used for calibrations.

Item 12. Develop a chain-of-custody procedure.

To my knowledge there have not been any specific problems identified as a result of not having such a procedure. DOE guidance for quality assurance does specify that chain-of-custody procedures should be developed. I would prefer the development of a system for identifying and tracking samples through the sampling and analytical process rather than chain-of-custody procedure. Chain-of-custody generally refers to a legalistic term for tracking of samples to ensure samples are always within protective custody. This is generally not necessary unless the sample results are to be used for legal action. The tracking procedure should implement a system for logging samples that are sent offsite for analysis to ensure that sample results are received in a timely manner.

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

This is particularly important if new personnel are hired or individuals with limited health physics background are used in radiological surveys. Most of the current operational health physics staff are very experienced and would be "grandfathered" with respect to meeting training and qualification requirements.

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

There should be internal audits or audits by individuals who do not have responsibilities in this area. Scheduling of audits by DOE and other external agencies should not be a Rockwell responsibility. The number of audits should be limited since comprehensive audits require a substantial commitment of management time. Operations at SSFL are not so complex as to require audits by many different agencies.

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

I agree and have made specific recommendations in this regard in the body of my report. It should be noted that there are not many sources for obtaining quality control samples. This could be done inhouse, but generally this requires verification of the sample homogeneity and concentration after preparation. Sample verification could not be done inhouse.

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

This recommendation appears to go far beyond what is necessary to ensure that the site is properly decommissioned and safe for unrestricted use. Specifically, the characterization of the surface and subsurface over the entire SSFL site would be a monumental undertaking. It would appear that more detail should be provided by ORAU as to the scope of this characterization. It is my understanding that Rockwell intends to carry out a systematic survey of the surface with respect to surface radioactivity levels. The need for specific characterization of subsurface soil would be dictated by the survey results. An aerial survey by the EG&G survey group is being considered as a final survey after all radioactive material has been shipped offsite.

Item 17. Conduct additional investigations of questionable conditions identified at the remediated area of the T064 facility.

It is my understanding that decontamination activities have not been completed at this facility. The questionable conditions referred to in the Berger report will be corrected prior to final decommissioning.

ATTACHMENT 1

LIST OF DOCUMENTS REVIEWED

1. Rockwell International, "Nuclear Operations at Rockwell's Santa Susana Field Laboratory-A Factual Perspective," Facility Report N001ER000017.

2. Rockwell International, "Radiological Environmental Program Sampling Procedures, Analysis Procedures, and Radioactivity Measurement Methods," Number N001DWP00008, 7-9-84.

3. Rockwell International, "Radiological Environmental Program Quality Assurance," Number N001DWP000009, 10-3-84.

4. Rockwell International and Atomics International, "Environmental Monitoring and Facility Effluent Annual Reports Desoto and Santa Susana Field Laboratories Sites" 1969-1988.

5. Rockwell International, "Environmental Monitoring and Facility Effluent Annual Reports Desoto and Santa Susana Field Laboratories Sites" 1989 Draft Report, RI/RD90-132.

6. U.S. Department of Energy, "Environmental Survey, Preliminary Report, DOE Activities at Santa Susana Field Laboratories, Ventura County, California," DOE, Washington, D.C., February 1989.

7. U.S. Environmental Protection Agency, Memorandum from Gregg Dempsey to Daniel M. Shane, "Site Visit to Santa Susana Field Laboratory Operated by Rockwell Rocketdyne," July 28, 1989 and "Report on Environmental Samples Collected at the Rocketdyne Santa Susana Field Laboratory, July 1989," dated November 8, 1989.

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ATTACHMENT 2

LIST OF INDIVIDUALS CONTACTED

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2. M.R. Davis, Vice President, Human Resources and Communications, Rockwell International.

3. J.D. Moore, Retired Employee Rockwell International, Formerly Laboratory Manager.

4. F.H. Badger, Health Physicist, Rockwell International.

5. J.H. Wallace, Health Physicist, Rockwell International.

6. V.B. Saba, Respiratory Protection Specialist, Rockwell International.

7. G.M. Watson, Instrumentation Technician, Rockwell International.