VERIFICATION SURVEY OF BUILDING T012 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

T. J. VITKUS AND J. R. MORTON

Prepared for the
Office of Environmental Restoration
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ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
Environmental Survey and Site Assessment Program
Environmental and Health Sciences Division

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OF
BUILDING T012
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

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TABLE OF CONTENTS

LIST OF FIGURES

PAGE

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

μR/h	microroentgens per hour
AEC	Atomic Energy Commission
BKG	background
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
D&D	Decontamination and Decommissioning
DOE	Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EM	Environmental Restoration and Waste Management
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
ESSAP	Environmental Survey and Site Assessment Program
ETEC	Energy Technology Engineering Center
ft	feet
ha	hectare
HMRFSR	Heavy Metal Reflected Fast Spectrum Reactor
m	meter
m^2	square meter
M&O	Management and Operation
MDC	minimum detectable concentration
NaI	sodium iodide
NIST	National Institute of Standards and Technology
ORISE	Oak Ridge Institute for Science and Education
PIC	pressurized ionization chamber
SNAP	Systems for Nuclear and Auxiliary Power
SRE	Sodium Reactor Experiment
SSFL	Santa Susana Field Laboratory
ZnS	zinc sulfide

VERIFICATION SURVEY
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VENTURA COUNTY, CALIFORNIA

INTRODUCTION

Rockwell International's Rocketdyne Division operates the Santa Susana Field Laboratory (SSFL). The Energy Technology Engineering Center (ETEC) is that portion of the SSFL, operated for the Department of Energy (DOE), which performs testing of equipment, materials, and components for nuclear and energy related programs. Contract work for the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (ERDA), predecessor agencies to the DOE, began in the early 1950's. Specific programs conducted for AEC/ERDA/DOE involved the engineering, development, testing, and manufacturing operations of nuclear reactor systems and components. Other SSFL activities have also been conducted for the National Aeronautics and Space Administration, the Department of Defense, and other government related or affiliated organizations and agencies. Some activities have been licensed by both the Nuclear Regulatory Commission and by the State of California Radiological Health Branch of the Department of Health Services.

Numerous buildings and land areas became radiologically contaminated as a result of the various operations which included ten reactors, seven criticality test facilities, fuel fabrication, reactor and fuel disassembly, laboratory work, and on-site storage of nuclear material. Potential radioactive contaminants identified at the site are uranium (in natural and enriched isotopic abundances), plutonium, Am-241, fission products (primarily Cs-137, and Sr-90 present as mixed fission products that have not been separated), activation products (tritium [H-3], Co-60, Eu-152, Eu-154, Ni-63, Pm-147, and Ta-182). Chemical contaminants, mainly chlorinated organic solvents, have also been identified in groundwater, primarily as a result of rocket engine testing.

Decontamination and decommissioning (D&D) of contaminated facilities began in the late 1960's and continues as the remaining DOE program operations at ETEC have been terminated, effective September 30, 1995. As part of this D&D program, Rockwell/Rocketdyne performed decommissioning and final status surveys of a number of the facilities that supported the various nuclear-related ETEC operations conducted during the latter part of the 1950's and continued through to the present. Environmental management of DOE contaminated properties continues under the termination clause of the existing Management and Operation (M&O) contract. Surplus sodium facilities have been included in the current Environmental Restoration and Waste Management (EM) Program for stabilization and eventual clean-up.

Most recently, D&D activities and final status surveys have been completed for Building T012. Operations began in Building T012 in 1962. Experiments were conducted using three Systems for Nuclear and Auxiliary Power (SNAP) critical assembly machines. A majority of the tests were directed at determining criticality of various configurations and conditions. Clad reactor fuel elements were stored in the fuel storage tubes within Room 109 and operations continued intermittently until 1968, when the fuel was shipped to the Source and Special Nuclear Material Storage Vault (T064) and the Building T012 facility was placed in stand-by mode. Later operations included modifications of the critical assembly machine for use in the Heavy Metal Reflected Fast Spectrum Reactor (HMRFSR) project during 1969 and 1970. Critical experiments were performed using fabrications of highly enriched uranium rods and foil used to simulate reactor fuel elements. Fuel materials were stored and assembled in the critical test cell. These fuel materials were later returned to the original supplier in 1972 and the facility was deactivated. From 1979 to 1992, a modification allowed the facility to be used by ETEC Quality Assurance in performance of x-ray machine and source radiography. Rockwell performed a radiological survey of Building T012 and its surrounding areas in 1985. Subsequent D&D efforts were performed and a final status survey was completed in 1996 (Rockwell 1996).

DOE's Office of Environmental Restoration, Northwestern Area Programs is responsible for oversight of a number of remedial actions that have been or will be conducted at the SSFL. It is the policy of DOE to perform independent (third party) verification of remedial action activities conducted within Office of Environmental Restoration programs. The purpose of these independent verifications is to

confirm that remedial actions have been effective in meeting established and supplemental guidelines and that the documentation accurately and adequately describes the radiological conditions at the site.

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) was designated as the organization responsible for this task at SSFL, and was requested to verify the current radiological status of Building T012.

SITE DESCRIPTION

The SSFL is located in the Simi Hills of southeastern Ventura County, California, approximately 47 kilometers (29 miles) northwest of downtown Los Angeles (Figure 1). The site is comprised of approximately 1,090 hectares (ha [2,700 acres]) and is divided into four administrative areas (Areas I through IV) and a Buffer Zone. DOE operations were conducted in Rockwell International-owned facilities located within the 117 ha Area IV. The ETEC portion of Area IV consists of government-owned buildings occupying 36 ha.

Building T012, located on B Street, has 120 square meters (m^2) of floor space (Figure 2). In 1986, an unattached operations and control building and the connecting walkway that were considered part of the complex were demolished in order to allow for adjacent construction. The remaining structure has a single floor and consists of three rooms. The critical cell (Room 110) has four-foot thick walls with a 1/4-inch steel liner and a mat-type concrete floor and the equipment room has concrete walls and a concrete floor. Located in the west section of the equipment room is the fuel storage area, which is bounded by a concrete shield containing 1% boron by weight. Within the shield there are 110 cadmium-plated tubes. Figure 3 shows the building's floor plan.

OBJECTIVES

The objectives of the verification survey were to provide independent document reviews and measurement and sampling data for use by the DOE in determining the radiological status of the facility and whether or not the facility meets the guideline requirements for release without radiological restrictions.

DOCUMENT REVIEW

ESSAP reviewed Rockwell's final radiological status survey report (Rockwell 1996). Procedures and methods used were reviewed for adequacy and appropriateness. Final status survey data were reviewed for accuracy, completeness, and compliance with guidelines. Additional review of procedures and supporting documentation referenced in the survey report was performed at SSFL at the time of the verification survey.

PROCEDURES

During the period of July 29 through 31, 1996, ESSAP performed a verification survey of Building T012 at the Santa Susana Field Laboratory. The survey was in accordance with a site-specific survey plan submitted to and approved by DOE and the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 1996a, 1995a and b). This report summarizes the procedures and results of the survey.

REFERENCE GRID

Measurement and sampling locations were referenced to the existing 1 m × 1 m reference grid established during the final status surveys. Measurement and sampling data from any ungridded surfaces, such as upper walls and ceilings, were referenced to the floor or lower wall grid coordinates or to prominent building features.

SURFACE SCANS

Surface scans for alpha, beta, and gamma activity were performed on 100 percent of floor and lower wall surfaces and 5 percent of upper surfaces using ZnS, gas proportional, and NaI scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators. Areas of elevated direct radiation identified by scans were marked for further investigation.

SURFACE ACTIVITY MEASUREMENTS

Single point measurements to determine total alpha and total beta surface activity levels were performed on 41 randomly selected grid blocks on the floor, lower walls, and upper surfaces of Building T012 using gas proportional detectors coupled to ratemeter-scalers. A smear sample for the determination of removable activity was obtained from each direct measurement location. Measurement and sampling locations are shown in Figures 4 through 6.

EXPOSURE RATE MEASUREMENTS

ESSAP measured exposure rates at three locations at one meter above the surface using a pressurized ionization chamber (PIC). Measurement locations are shown in Figures 4 to 6. Background exposure rates measured by Rockwell in an area having similar construction as Building T012 and in which site history indicates that radiological materials have not been used, were used for comparison (Rockwell 1996).

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and survey data were returned to ORISE's ESSAP laboratory in Oak Ridge, TN for analysis and interpretation. Smears were analyzed for gross alpha and gross beta activity using a low-background gas proportional counter. Sample analysis was performed in accordance with the ORISE/ESSAP Laboratory Procedures Manual (ORISE 1995c). Smear data and direct measurement data were converted to units of disintegrations per minute per 100 square centimeters (dpm/100 cm^2). Exposure rates were reported in units of microroentgens per hour (μR/h).

Additional information regarding major instrumentation, sampling equipment, and analytical procedures is provided in Appendices A and B.

FINDINGS AND RESULTS

DOCUMENT REVIEW

Overall, Rockwell's final radiological survey procedures were appropriate for detection of residual contamination. The survey report data provided adequate documentation of Building T012's radiological status relative to the DOE's guidelines for release for unrestricted use (DOE 1990). Comments identified by ESSAP were provided to the DOE in a September 9, 1996 correspondence (ORISE 1996b).

SURFACE SCANS

Surface scans for alpha, beta, and gamma activity on floor, lower wall, and upper surfaces identified one location of elevated direct alpha radiation on a door hinge at the entrance to the critical cell. All remaining scans were comparable to ambient background levels.

SURFACE ACTIVITY LEVELS

Results of total and removable activity are summarized in Table 1. Total activity levels ranged from less than 34 to 170 dpm/100 cm^2 and less than 230 to 480 dpm/100 cm^2 for alpha and beta, respectively.

Removable activity was less than the minimum detectable concentrations of 9 dpm/100 cm^2 for gross alpha and 15 dpm/100 cm^2 for gross beta.

EXPOSURE RATES

Exposure rates are summarized in Table 2. The Rockwell-determined average background exposure rate was 14 µR/h. ESSAP's verification exposure rates ranged from 12 to 15 µR/h.

COMPARISON OF RESULTS WITH GUIDELINES

A summary of the DOE guidelines for residual radioactive material is included as Appendix C. The primary contaminants of concern for Building T012 are uranium and mixed fission and activation products. The applicable surface contamination guidelines for uranium are as follows (DOE 1990 and 1993):

Total Activity

5,000 α dpm/100 cm^2, average in a 1 m^2 area

15,000 α dpm/100 cm^2, maximum in a 100 cm^2 area

Removable Activity

1000 α dpm/100 cm^2

The guidelines for beta-gamma emitters are:

Total Activity

5,000 β-γ dpm/100 cm^2, average in a 1 m^2 area

15,000 β-γ dpm /100 cm^2, maximum in a 100 cm^2 area

Removable Activity

1,000 β-γ dpm/100 cm^2

All surface activity levels were less than the respective total and removable surface activity guidelines.

The DOE's exposure rate guideline is 20 μR/h above background, however Rockwell has elected to use a more restrictive guideline of 5 μR/h above background. Exposure rates at 1 meter above the surface were within these guidelines.

SUMMARY

During the period of July 29 through 31, 1996 the Environmental Survey and Site Assessment Program performed verification activities for Building T012 at the Santa Susana Field Laboratory located in Ventura County, California. Verification activities included document reviews, surface scans, surface activity measurements, and exposure rate measurements.

The results of the independent verification survey demonstrate that surface activity for all areas was below applicable total and removable guidelines. In addition, exposure rates were comparable to background levels and satisfied both the DOE and the more restrictive exposure rate guideline that Rockwell has elected to use. The findings, therefore, support Rockwell's final status survey conclusion that the radiological conditions of Building T012 satisfy the DOE guidelines for release without radiological restrictions.

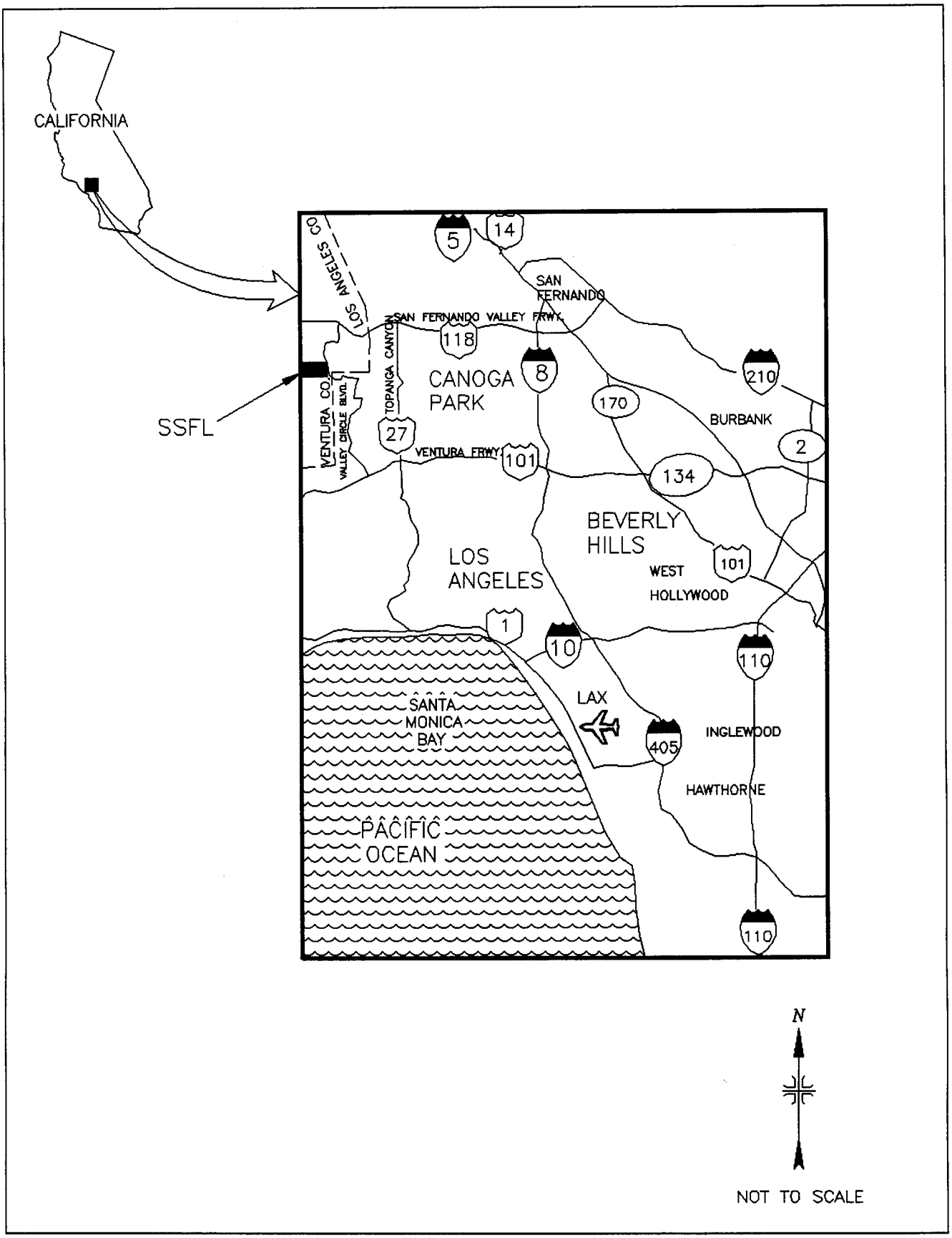


FIGURE 1: Los Angeles, California Area – Location of the Santa Susana Field Laboratory Site

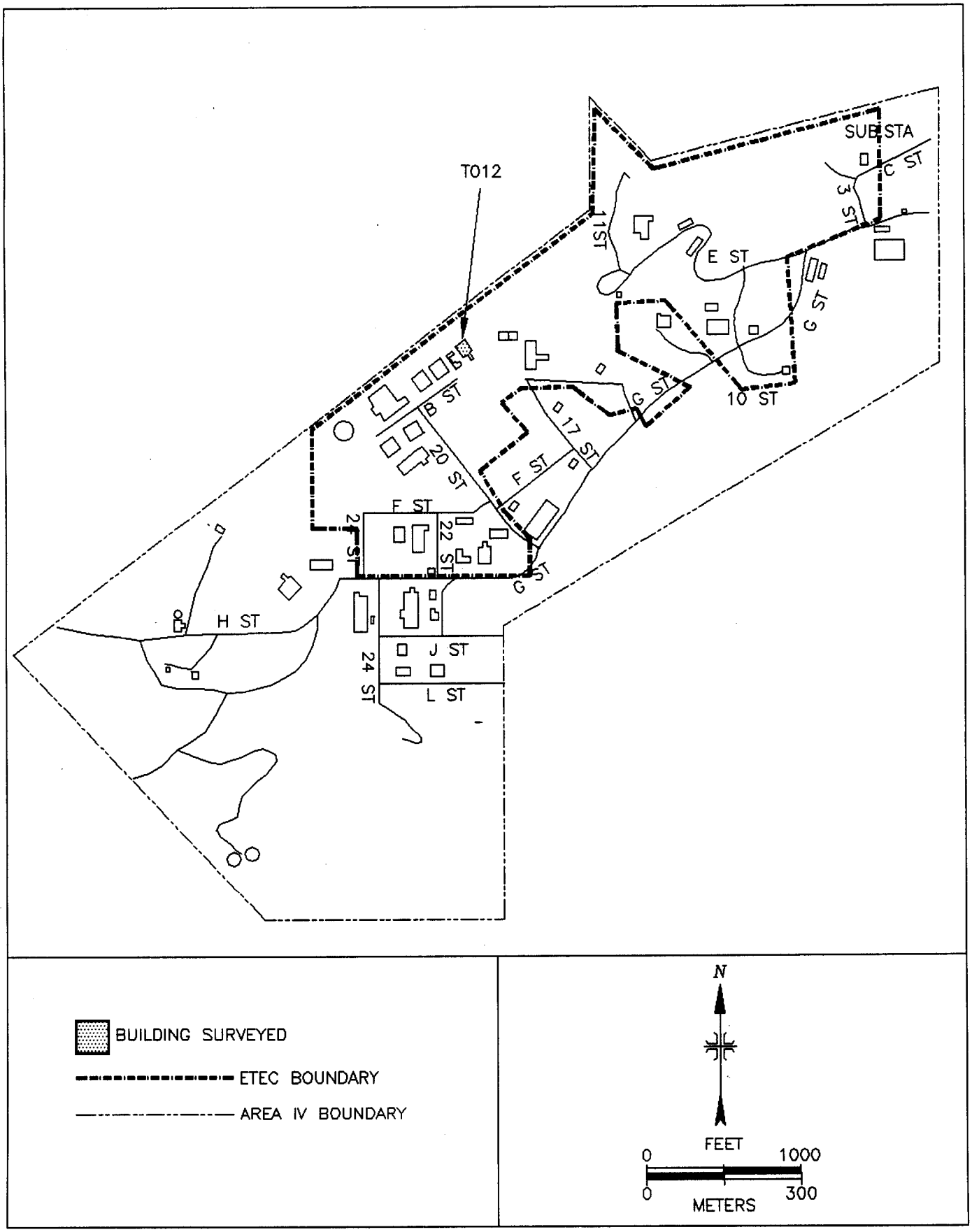
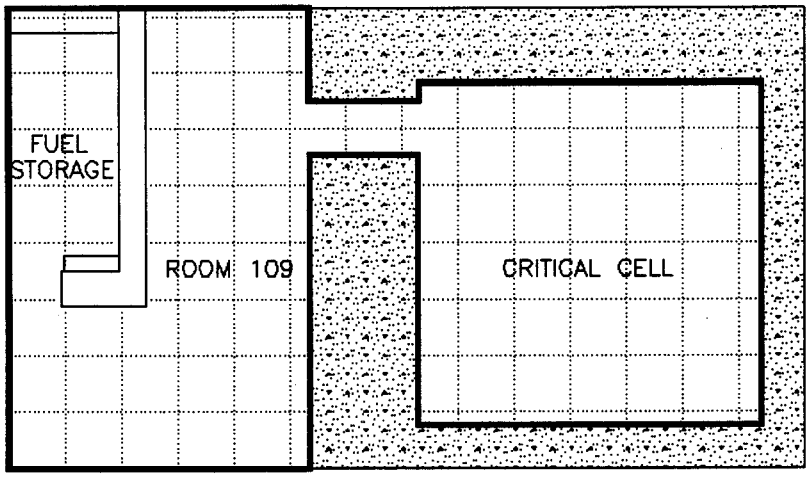


FIGURE 2: Santa Susana Field Laboratory Area IV, Plot Plan – Location of Building T012



CELL SHIELDING

N

FEET
0 6
0 2
METERS

FIGURE 3: Building T012 – Floor Plan

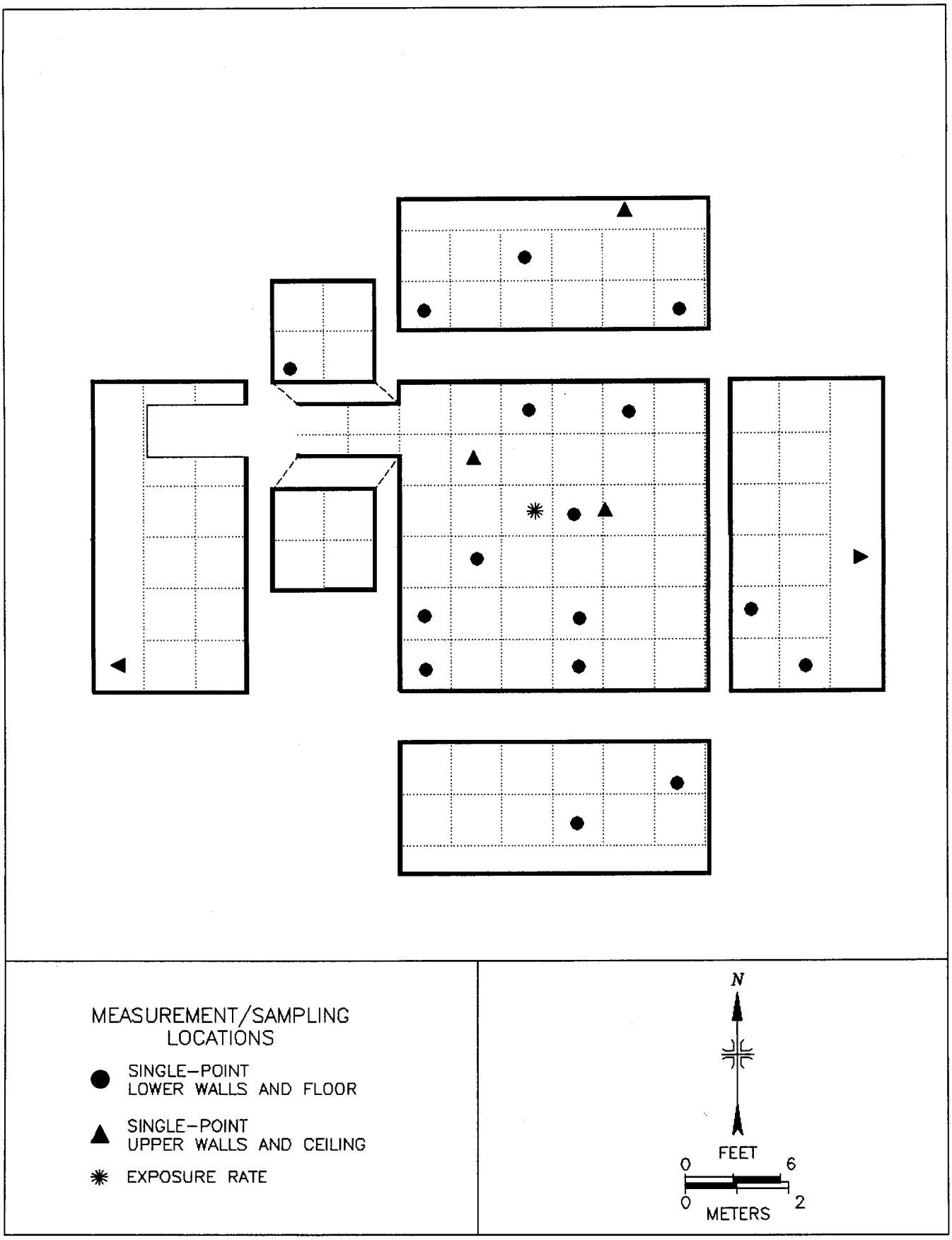


FIGURE 4: Building T012, Critical Cell – Measurement and Sampling Locations

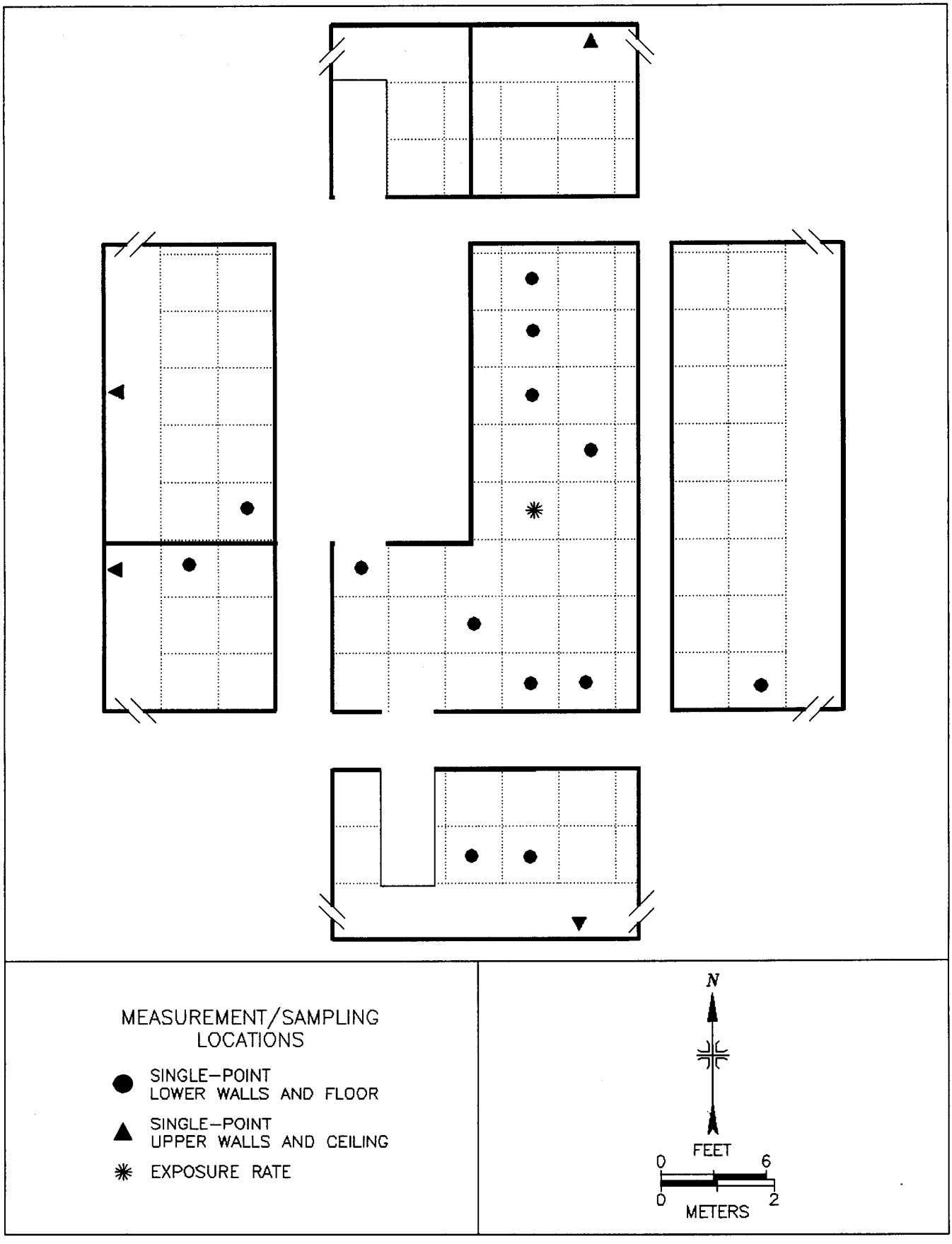
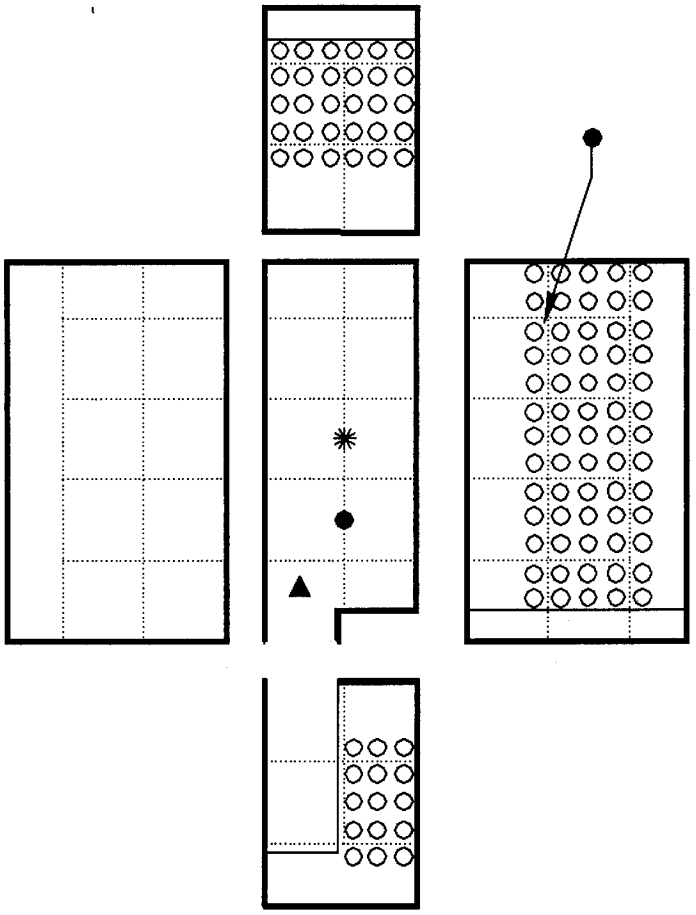


FIGURE 5: Building T012, Room 109 - Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SINGLE-POINT LOWER WALLS AND FLOOR
- SINGLE-POINT UPPER WALLS AND CEILING
- EXPOSURE RATE

STORAGE TUBES

N

FEET 0 6

METERS 0 2

FIGURE 6: Building T012, Room 109, Fuel Storage Cell – Measurement and Sampling Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY LEVELS
BUILDING T012
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Number of Measurement Locations	Range of Total Activity (dpm/100 cm^2)		Range of Removable Activity (dpm/100 cm^2)	
		Single Measurement			
		Alpha	Beta	Alpha	Beta
Critical Cell					
Floor	8	<34	<230	<9	<15
Lower Walls	8	<34 to 170	<230	<9	<15
Upper Surfaces	5	<34	<230	<9	<15
Room 109					
Floor	8	<34	280 to 480	<9	<15
Lower Walls	5	<34	<230 to 330	<9	<15
Upper Surfaces	4	<34	<230	<9	<15
Fuel Storage Cell					
Floor	1	<34	380	<9	<15
Lower Wall	1	<34	<230	<9	<15
Ceiling (Attic)	1	<34	<230	<9	<15

[a]Refer to Figures 4 through 6.

TABLE 2

EXPOSURE RATES
BUILDING T012
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Exposure Rate at 1 m (μR/h)
Critical Cell	12
Room 109	15
Fuel Storage Cell	15

[a]Refer to Figures 4 through 6.

REFERENCES

Oak Ridge Institute for Science and Education (ORISE). Survey Procedures Manual for the Energy/Environment Systems Division, Environmental Survey and Site Assessment Program, Revision 9. Oak Ridge, TN; April 30, 1995a.

Oak Ridge Institute for Science and Education. Quality Assurance Manual for the Energy/Environment Systems Division, Environmental Survey and Site Assessment Program, Revision 7. Oak Ridge, TN; January 31, 1995b.

Oak Ridge Institute for Science and Education. Laboratory Procedures Manual for the Energy/Environment Systems Division, Environmental Survey and Site Assessment Program, Revision 9. Oak Ridge, TN; January 31, 1995c.

Oak Ridge Institute for Science and Education. Revised Verification Survey Plan for Buildings T012 and T363, Santa Susana Field Laboratory, Rockwell International, Ventura County, California. Oak Ridge, TN; July 18, 1996a.

Oak Ridge Institute for Science and Education. Comments on the Final Radiological Survey Reports for Buildings T012 and T363, Santa Susana Field Laboratory, Ventura County, California. Oak Ridge, TN; September 9, 1996b.

Rocketdyne Division, Rockwell International Corporation (Rockwell). Final Radiological Survey Report for Building T012. Canoga Park, CA; June 14, 1996.

U. S. Department of Energy (DOE). Radiation Protection of the Public and the Environment. Washington, DC: DOE Order 5400.5; February 1990 and Change 2, January 1993.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the authors or their employers.

DIRECT RADIATION MEASUREMENT

Instruments

Eberline Pulse Ratemeter
Model PRM-6
(Eberline, Santa Fe, NM)

Ludlum Ratemeter-Scaler
Model 2221
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Ludlum Floor Monitor
Model 239-1
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Detectors

Eberline ZnS Scintillation Detector
Model AC-3-7
Effective Area, 74 cm^2
(Eberline, Santa Fe, NM)

Ludlum Gas Proportional Detector
Model 43-68
Effective Area, 126 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Ludlum Gas Proportional Detector
Model 43-37
Effective Area, 550 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Reuter-Stokes Pressurized Ionization Chamber
Model RSS-111
(Reuter-Stokes, Cleveland, OH)

Victoreen NaI Scintillation Detector
Model 489-55
3.2 cm x 3.8 cm crystal
(Victoreen, Cleveland, OH)

LABORATORY ANALYTICAL INSTRUMENTATION

Low Background Gas Proportional Counter
Model LB-5100-W
(Oxford, Oak Ridge, TN)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the probes slowly over the surface; the distance between the probe and the surface was maintained at a minimum - nominally about 1 cm. Surfaces were scanned using either a large area gas proportional floor monitor or small area (74 cm^2 or 126 cm^2) hand-held detectors. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument. Combinations of detectors and instruments used for the scans were:

Alpha	-	gas proportional detector with ratemeter-scaler
	-	ZnS scintillation detector with ratemeter-scaler
Alpha-Beta	-	gas proportional detector with ratemeter-scaler
Gamma	-	NaI scintillation detector with ratemeter

Surface Activity Measurements

Measurements of total alpha and total beta activity levels were performed using gas proportional detectors with portable ratemeter-scalers. Alpha and beta activity measurements were performed on randomly selected areas and at locations of elevated direct radiation, using gas proportional detectors with ratemeter-scalers.

Count rates (cpm), which were integrated over 1 minute in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net rate by the 4 π efficiency and correcting for the active area of the detector. The alpha activity background count rates for the gas proportional detectors averaged one cpm for all surfaces. The beta activity background count rates for the gas proportional detectors averaged 383 cpm. The alpha efficiency factor was 0.17 calibrated to Th-230.

The beta efficiency factor was 0.33 calibrated to Tl-204. The alpha minimum detectable concentration (MDC) was 34 dpm/100 cm^2, while the beta activity MDC was 230 dpm/100 cm^2. The effective window area for the gas proportional was 126 cm^2.

Removable Activity Measurements

Removable activity levels were determined using numbered filter paper disks, 47 mm in diameter. Moderate pressure was applied to the smear and approximately 100 cm^2 of the surface was wiped. Smears were placed in labeled envelopes with the location and other pertinent information recorded.

Exposure Rate Measurements

Measurements of gamma exposure rates were performed using a pressurized ionization chamber. The instrument was adjusted to one meter (3.3 ft) above the surface and allowed to stabilize. The measurement was read directly in μR/h.

Radiological Analyses

Removable Activity

Smears were counted on a low background gas proportional system for gross alpha and gross beta activity.

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

Detection limits, referred to as minimum detectable concentration (MDC), were based on 2.71 plus 4.65 times the standard deviation of the background count [$2.71 + (4.65\sqrt{BKG})$]. When the activity was determined to be less than the MDC of the measurement procedure, the result was reported as less than MDC. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

CALIBRATION AND QUALITY ASSURANCE

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry recognized organization were used. Calibration of pressurized ionization chambers was performed by the manufacturer.

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual, Revision 9 (April 1995)
- Laboratory Procedures Manual, Revision 9 (January 1995)
- Quality Assurance Manual, Revision 7 (January 1995)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C and ASME NQA-1 for Quality Assurance and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in EPA and EML laboratory Performance Evaluation Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

BASIC DOSE LIMITS

The basic limit for the annual radiation dose (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as low as reasonable achievable principles to set site-specific guidelines.

STRUCTURE GUIDELINES

Indoor/Outdoor Structure Surface Contamination

Radionuclides[a]	Allowable Total Residual Surface Contamination (dpm/100 cm^2)[b] Average[c,d]	Maximum[d,e]	Removable[f]
Transuranics, Ra-226, Ra-228, Th-230 Th-228, Pa-231, Ac-227, I-125, I-129 [g]	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000α	15,000α	1,000α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above [h]	5,000β-γ	15,000β-γ	1,000β-γ

External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restriction on its use shall not exceed the background level by more than 20 μR/h and will comply with the basic dose limits when an appropriate-use scenario is considered.

[a] Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[d] The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at a depth of 1 cm.

[e] The maximum contamination level applies to an area of not more than 100 cm^2.

[f] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels, if direct scan surveys indicate that total residual surface contamination levels are within the limits for removable contamination.

[g] Guidelines for these radionuclides are not given in DOE Order 5400.5; however, these guidelines are considered applicable until guidance is provided.

[h] This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90, which has been separated from the other fission products, or mixtures where the Sr-90 has been enriched.

REFERENCES

"U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites," Revision 2, March 1987.

"DOE Order 5400.5, Radiation Protection of the Public and the Environment," January 1993.