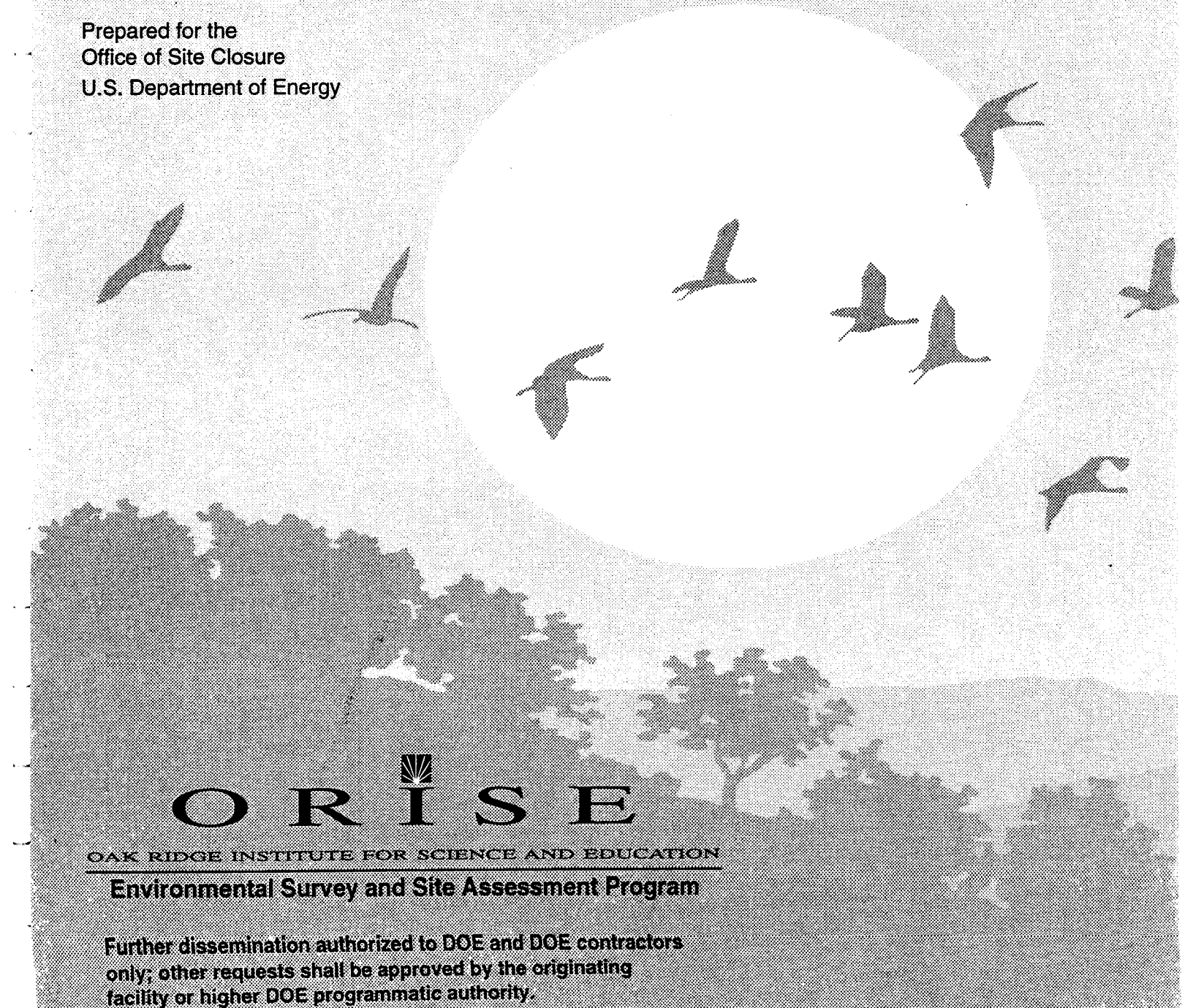
VERIFICATION SURVEY OF BUILDING 4059 (PHASE I) SANTA SUSANA FIELD LABORATORY THE BOEING COMPANY VENTURA COUNTY, CALIFORNIA

J. R. MORTON

Prepared for the
Office of Site Closure
U.S. Department of Energy



ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
Environmental Survey and Site Assessment Program

The Oak Ridge Institute for Science and Education (ORISE) was established by the U.S. Department of Energy to undertake national and international programs in education, training, health, and the environment. ORISE and its programs are operated by Oak Ridge Associated Universities (ORAU) through a contract with the U.S. Department of Energy. Established in 1946, ORAU is a multiuniversity consortium.

VERIFICATION SURVEY OF BUILDING 4059 (PHASE I) SANTA SUSANA FIELD LABORATORY THE BOEING COMPANY VENTURA COUNTY, CALIFORNIA

Prepared by

John R. Morton

Environmental Survey and Site Assessment Program
Radiological Safety, Assessments, and Training
Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0117

Prepared for the

Office of Site Closure
U.S. Department of Energy

FINAL REPORT

DECEMBER 2000

This report is based on work performed under contract DE-AC05-00OR22750 with the U.S. Department of Energy.

VERIFICATION SURVEY
OF BUILDING 4059 (PHASE I)
SANTA SUSANA FIELD LABORATORY
THE BOEING COMPANY
VENTURA COUNTY, CALIFORNIA

Prepared by: _____ Date: 12/11/00
J. R. Morton, Field Survey Team Leader
Environmental Survey and Site Assessment Program

Reviewed by: _____ Date: 12/11/2000
T. J. Vitkus, Survey Projects Manager
Environmental Survey and Site Assessment Program

Reviewed by: R. D. Condra Date: 12/13/2000
R. D. Condra, Laboratory Manager
Environmental Survey and Site Assessment Program

Reviewed by: Ann T Payne Date: 12/14/00
A. T. Payne, Quality Manager
Environmental Survey and Site Assessment Program

Reviewed by: Eric W. Abelquist Date: 12/12/00
E. W. Abelquist, Associate Program Director
Environmental Survey and Site Assessment Program

Reviewed by: _____ Date: 12/14/00
W. L. Beck, Program Director
Environmental Survey and Site Assessment Program

ACKNOWLEDGMENTS

The author would like to acknowledge the significant contributions of the following staff members:

FIELD STAFF

J. S. Cox
T. D. Herrera

LABORATORY STAFF

R. D. Condra
J. S. Cox
W. P. Ivey

CLERICAL STAFF

K. G. Davis
D. K. Herrera
K. L. Pond
A. Ramsey

ILLUSTRATOR

T. D. Herrera

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

PAGE

ABBREVIATIONS AND ACRONYMS

µrem/h	microrem per hour
µR/h	microroentgens per hour
AEC	Atomic Energy Commission
ASME	American Society of Mechanical Engineers
BKG	background
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
D&D	decontamination and decommissioning
$DCGL_w$	derived concentration guideline level
DOE	U.S. Department of Energy
dpm/100 cm^2	disintegrations per minute per one hundred square centimeters
EML	Environmental Measurements Laboratory
ERDA	Energy Research and Development Administration
ϵ_i	instrument efficiency
ϵ_s	source efficiency
ESSAP	Environmental Survey and Site Assessment Program
ETEC	Energy Technology Engineering Center
GM	Geiger-Mueller
ha	hectare
ITP	Intercomparison Test Program
km	kilometer
m	meters
m^2	square meters
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mm	millimeter
M&O	Management and Operation
MDC	minimum detectable concentration
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
RA	remedial action
SSFL	Santa Susana Field Laboratory
SNAP	Systems for Nuclear Auxiliary Power

VERIFICATION SURVEY
OF BUILDING 4059 (PHASE I)
SANTA SUSANA FIELD LABORATORY
THE BOEING COMPANY
VENTURA COUNTY, CALIFORNIA

INTRODUCTION AND SITE HISTORY

Rocketdyne Propulsion and Power of the Boeing Company (Rocketdyne), formerly Rockwell International Rocketdyne Division, operates the Santa Susana Field Laboratory (SSFL). The Energy Technology Engineering Center (ETEC) is that portion of the SSFL, operated for the U.S. Department of Energy (DOE), which performed 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 engineering, developing, testing, and manufacturing operations for nuclear reactor systems and components. Other SSFL activities have also been conducted for the National Aeronautics and Space Administration, the U.S. Department of Defense, and other government related or affiliated organizations and agencies. Some activities have been licensed by the U.S. Nuclear Regulatory Commission (NRC) and by the Radiologic Health Branch of the State of California 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 (predominantly in enriched isotopic abundances), plutonium, Am-241, fission products (primarily Cs-137 and Sr-90), and activation products (tritium [H-3], Co-60, Eu-152, Eu-154, and Ni-63). 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, but were accelerated in the 1990's, as the remaining DOE program operations at ETEC were terminated, effective September 30, 1995. As part of this D&D program, Rocketdyne performed

decommissioning and final status surveys of a number of facilities that supported the various nuclear-related ETEC operations during the latter part of the 1950's and continuing through to the present. Environmental management of DOE contaminated properties continues under the termination clause of the existing Management and Operation (M&O) contract. A facility that was recently addressed was Building 4059.

Building 4059 was constructed during 1962 and 1963. The facility housed a research and development program known as the Systems for Nuclear Auxiliary Power (SNAP). The program was established to develop and test power systems for use as subsidiary nuclear power units in specialized applications. Atomic International developed the SNAP 8 reactor, under contract to the AEC, for use in this program. Reactor operation began in 1963 and was followed by a shutdown in 1964 to permit building modifications. The last test was conducted in 1969 at which time the reactor was shut down. The SNAP project resulted in the radiological contamination and activation of those portions of Building 4059 associated with reactor operations. Contamination was principally the result of neutron activation; the primary contaminants were Co-60, Eu-152, Eu-154, Fe-55, and H-3. Decommissioning of the facility was initiated in the 1970's followed by annual inspections and radiological survey work. Inspections performed in 1983 revealed that groundwater was leaking into the facility. Rocketdyne stabilized the problem and a water management plan was implemented. Structural deterioration was revealed in 1987 after water was discovered in previously dry areas. Due to the potential risk of contamination through pathways between the outside and the vault interior, the Building 4059 Vault Remediation Program was initiated. The initial remedial activities removed the most highly activated sources of contamination, including the vacuum duct, vacuum vessel, and north test cell shielding concrete. Further remediation of structural concrete would have compromised the structural integrity of the building. Therefore, Rocketdyne planned to complete decommissioning of Building 4059 in two phases. Phase I involved remediating and performing final release surveys of all non-activated above- and below-grade areas, followed by demolition of these portions of the facility. Phase II will involve the demolition of the activated sub-grade portion of the structure, followed by release surveys of the resultant excavation.

DOE's Office of Site Closure—previously the 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. The purpose of these independent verification activities is to confirm that remedial actions have been effective in meeting established and site-specific 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 4059.

SITE DESCRIPTION

The SSFL is located in the Simi Hills of southeastern Ventura County, California, approximately 47 kilometers (km [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 Boeing/Rocketdyne-owned facilities located within the 117 ha Area IV. The ETEC portion of Area IV consists of government-owned buildings that occupy 36 ha.

Building 4059 is located at the intersection of 20th and "B" Streets in the north-central part of Area IV (Figure 2). The facility consists of the sub-grade reactor vault and an above-grade support facility. The reactor vault measures 8.5 meters (m) wide, 12 m long, and 9.8 m deep and is constructed of poured concrete and concrete block. The above-grade portion of the building is a single story structure partitioned with drywall into multiple rooms and a high bay constructed of concrete and corrugated steel (Figure 3). The floor area measures approximately 1,000 square meters (m^2). Within the Building 4059 enclosure is the detached steel-framed Building 4459 with an approximate floor area of 84 m^2.

OBJECTIVES

The objectives of the verification process were to provide independent document reviews and measurement and sampling data for use by the DOE in determining the radiological status of the

Building 4059 facility and whether or not the facility meets the guideline requirements for release without radiological restrictions.

DOCUMENT REVIEW

Survey plans and final status reports were reviewed for appropriateness of procedures and adequacy of the data for demonstrating compliance with established guidelines (Boeing 1999a and b). Information was evaluated to ensure that areas identified as exceeding site guidelines had been decontaminated and that residual surface activity levels or soil concentrations satisfied the established guidelines.

PROCEDURES

During the period of October 26 through 28, 1999, ESSAP performed verification surveys of Building 4059 at the SSFL. The surveys were performed in accordance with a survey plan, submitted to and approved by the DOE, and the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 1999a, 1998a and b).

SURVEY PROCEDURES

The following procedures were applicable for the surveys of Building 4059. Rocketdyne had catagorized the surveyed areas as Class 1, 2, or 3 based on a given area's history of radioactive materials use. Class 1 areas were those that had been contaminated above the derived concentration guideline level ($DCGL_W$) prior to remediation operations. Class 2 survey units included those areas where slight contamination may have existed, but at levels less than the $DCGL_W$. Class 3 survey units included areas where no contamination existed during the building's history. ESSAP surveyed the basement/vault (Class 1); the high bay, stairwells, and Building 4459 (Class 2); and the locker room and equipment room (Class 3) in Building 4059.

Reference System

Measurement and sampling locations were referenced to the existing grid established by Rocketdyne. Any measurements or sampling performed on ungridded surfaces were referenced to the floor and lower wall grids or prominent building features.

Surface Scans

Surface scans for gamma and beta activity were performed on 25 to 50 percent of those surfaces designated as Class 1 and 2 and a maximum of 10 percent of Class 3 surfaces. Scans were performed using NaI scintillation and gas proportional detectors coupled to ratemeters or ratemeter-scalers with audible indicators. GM detectors were also used to survey locations that were difficult to access using the larger hand-held gas proportional detectors. Particular attention was given to cracks and joints in the floor and walls, ledges, drains, ducts, and other locations where material may have accumulated. Any locations of elevated direct radiation detected by scans were marked for further investigation.

Surface Activity Measurements

Construction material-specific background surface activity measurements were used for correcting gross surface activity measurements (NRC 1998).

Direct measurements for beta surface activity were performed at a total of 90 locations within the Phase I portions of Building 4059 (Figures 4 through 8). Additional measurements for the determination of average activity over a 1 m^2 area were performed within one grid block on a basement wall. One smear sample for the determination of removable activity was collected at each direct measurement location. Direct measurements were made using gas proportional detectors coupled to ratemeter-scalers.

Exposure Rate Measurements

Exposure rates were measured at one meter above the surface at a total of six locations within Buildings 4059 using a microrem meter (Figures 4 through 8). The Rocketdyne-determined background exposure rate measurements were used for comparison.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ORISE's ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Sample analyses were performed in accordance with the ORISE/ESSAP Laboratory Procedures Manual (ORISE 1999b). Smears were analyzed for gross alpha and gross beta activity using a low-background proportional counter. Smear data and direct measurement data were converted to units of disintegrations per minute per one hundred square centimeters (dpm/100 cm^2). Exposure rates were reported in units of microroentgens per hour (μR/h). The data generated were compared with Rocketdyne documentation and the DOE generic and site-specific guidelines established for release for unrestricted use.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP's review of Rocketdyne's project documentation indicated that most procedures and methods used by Rocketdyne were adequate and that data were appropriate for demonstrating compliance with the release criteria (Boeing 1999a and b). Comments identified were provided to the DOE (ORISE 1999c and d). Rocketdyne adequately addressed these comments in subsequent correspondence (Boeing 2000).

Surface Scans

Surface scans of the floors and lower walls in the Building 4059 vault and in Building 4459 identified two locations of elevated direct beta radioactivity. Surface scans of remaining areas did

not identify any locations of direct radiation in excess of ambient background levels.

Surface Activity Levels

Results of the total and removable surface activity levels are summarized in Table 1. Final total beta surface activity levels ranged from -460 to 8,300 dpm/100 cm^2. Additional measurements were performed in one area of elevated activity in Building 4059 for the purpose of determining the average beta activity levels over the contiguous 1 m^2. The average activity for the 1 m^2 was 3,500 dpm/100 cm^2. One location in Building 4459 had an initial total activity of 19,000 dpm/100 cm^2. Rocketdyne personnel remediated the location and reduced the activity to 2,500 dpm/100 cm^2.

Removable surface activity levels ranged from 0 to 9 dpm/100 cm^2 for alpha and from -5 to 17 dpm/100 cm^2 for beta.

Exposure Rates

Exposure rates are summarized in Table 2. Rocketdyne-determined background exposure rates for Area IV SSFL structures averaged 8 μR/h, while ESSAP site exposure rates, including background, ranged from 7 to 20 μR/h.

COMPARISON OF RESULTS WITH GUIDELINES

Surface activity levels in each area were compared to the appropriate residual radioactive material guidelines specified in DOE Order 5400.5 for mixed fission products (DOE 1990). The applicable guidelines are as follows:

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

One measurement location on the Building 4059 vault lower wall exceeded the 5,000 dpm/100 cm^2 guideline for a 1 m^2 area, but was less than the 15,000 dpm/100 cm^2 maximum guideline in a 100 cm^2 area. After additional measurements were performed, the 1 m^2 average was determined to be 3,500 dpm/100 cm^2, which satisfies the guideline. One location on the lower wall of Building 4459 had an initial surface activity of 19,000 dpm/100 cm^2. The post-remedial action (RA) surface activity was 2,500 dpm/100 cm^2. Therefore, all final residual surface activity levels satisfied these guidelines.

The DOE's exposure rate guideline is 20 μR/h above background (DOE 1990), although Rocketdyne has elected to use a more restrictive guideline of 5 μR/h above background. All exposure rates were below this guideline, with the exception of one exposure rate measurement which was performed in the west vault area of Building 4059. This area had an exposure rate of 12 μR/h above background, which exceeded the Rocketdyne/Boeing-selected guideline, but was within the DOE generic exposure rate guideline. This location was proximate to remaining known activated concrete, which will be disposed of as radiological waste during the Phase II portion of the building demolition.

SUMMARY

During the period of October 26 through 28, 1999, the Environmental Survey and Site Assessment Program performed verification surveys of the Phase I portions of Building 4059 at the Santa Susana Field Laboratory. Verification activities included document reviews, surface scans, surface activity measurements, and exposure rate measurements.

ESSAP's verification surveys identified one location in the basement of Building 4059 which exceeded the average guideline and one location in Building 4459 that exceeded the maximum guideline. The location in Building 4059 was determined to be below the applicable guideline once additional measurements were performed over the contiguous 1 m^2 area. The location in Building 4459 was remediated by Rocketdyne personnel and its surface activity was reduced to levels below

the applicable guidelines. All other total and removable activity levels satisfied the DOE average and maximum guidelines for release for unrestricted use. All exposure rate measurements were less than the guideline levels, with the exception of one measurement in the west vault area of Building 4059. This elevated reading was likely due to the high activity of the reactor test cells, which were located directly below the floor surface. These test cells will be remediated during Phase II of the building demolition. Therefore, it is ESSAP's opinion that the elevated exposure rate is not indicative of the vault floor surface being contaminated.

The one location in Building 4459 that required remedial activities was within a Class 2 area. Since this activity was in excess of 5,000 dpm/cm^2, based on guidance provided in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), this area should be re-classified as a Class 1 area and surveyed to those specifications by Rocketdyne. Rocketdyne subsequently performed a 100% scan survey of Building 4459 and found the surfaces to be free of any additional elevated surface activity (DOE 2000).

FIGURES

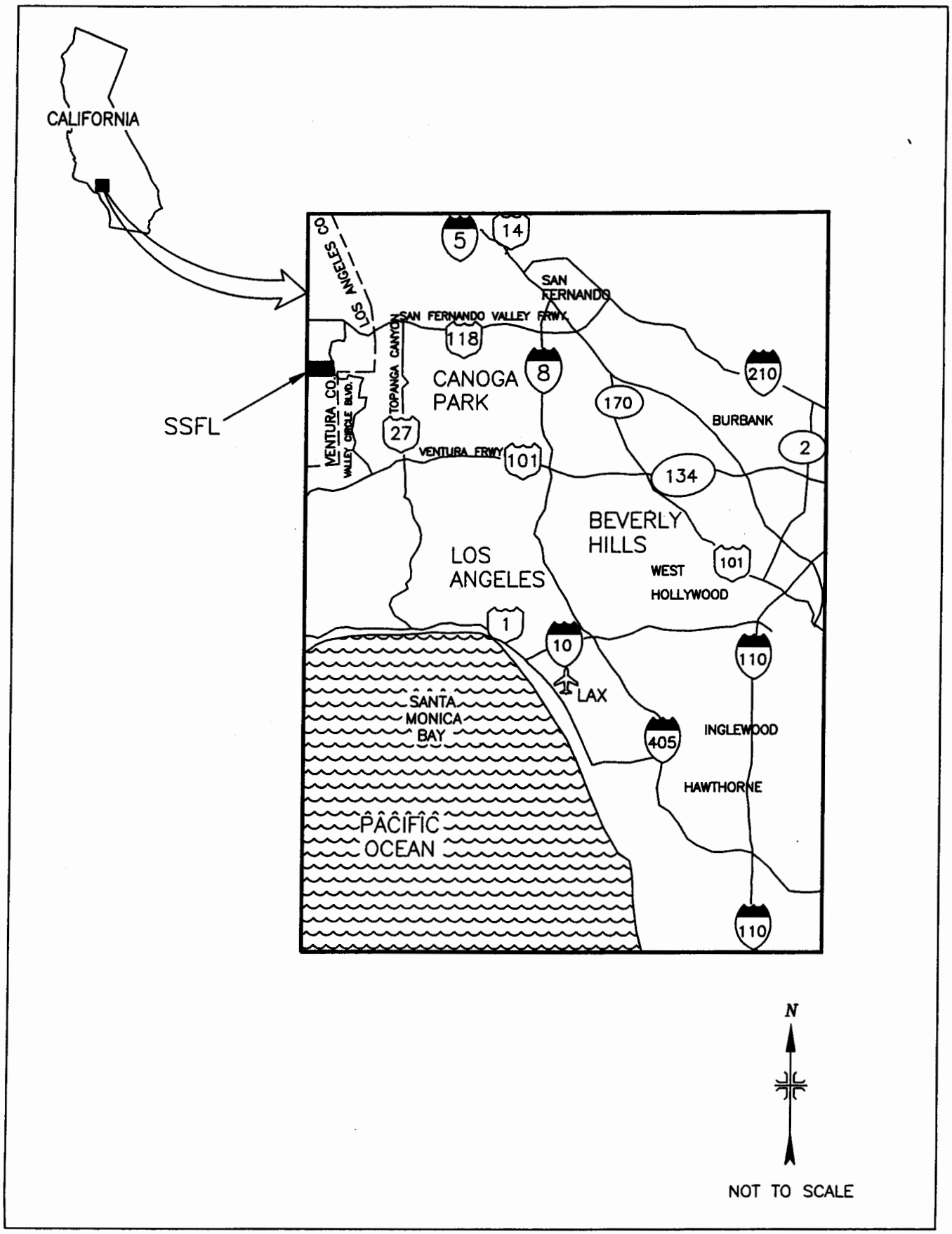


FIGURE 1: Los Angeles California Area – Location of Santa Susana Field Laboratory Site

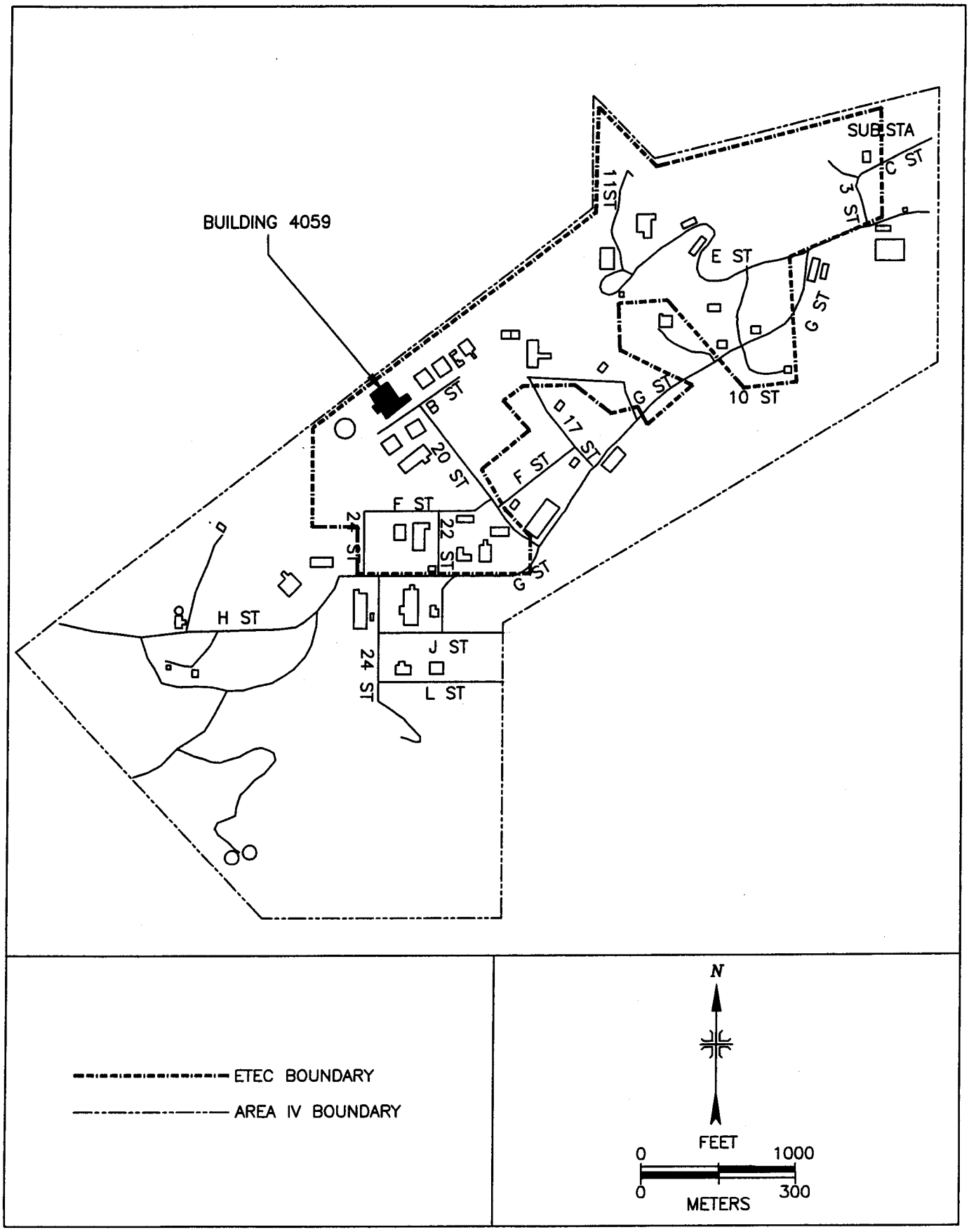


FIGURE 2: Santa Susana Field Laboratory Area IV, Plot Plan – Location of Building 4059

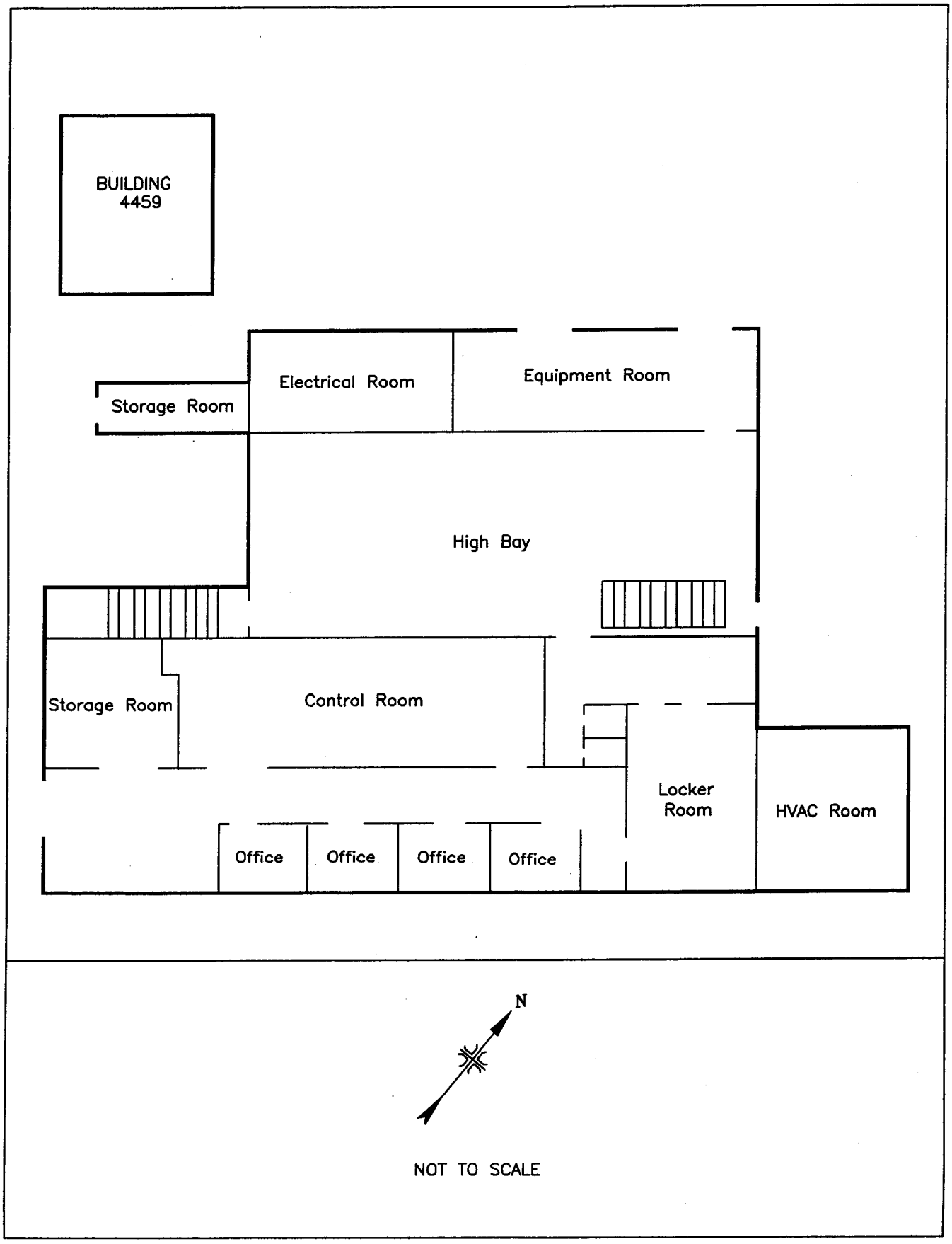
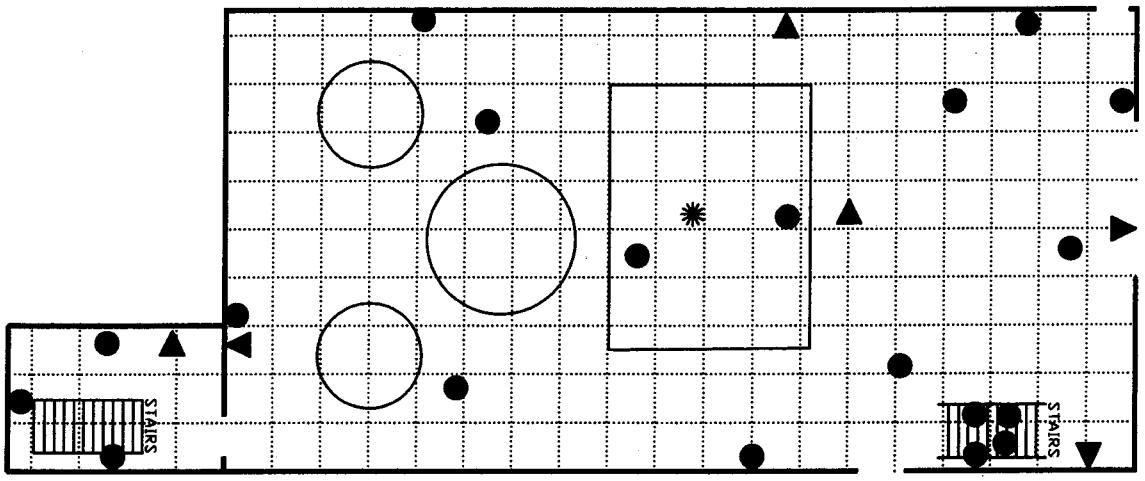


FIGURE 3: Plot Plan of the Above-Grade Portion of Building 4059 and Building 4459



MEASUREMENT/SAMPLING LOCATIONS

- ● SINGLE-POINT LOWER WALLS AND FLOOR
- ▲ SINGLE-POINT UPPER WALLS AND CEILING
- ✳ EXPOSURE RATE

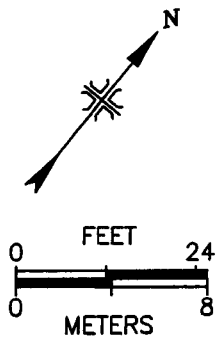
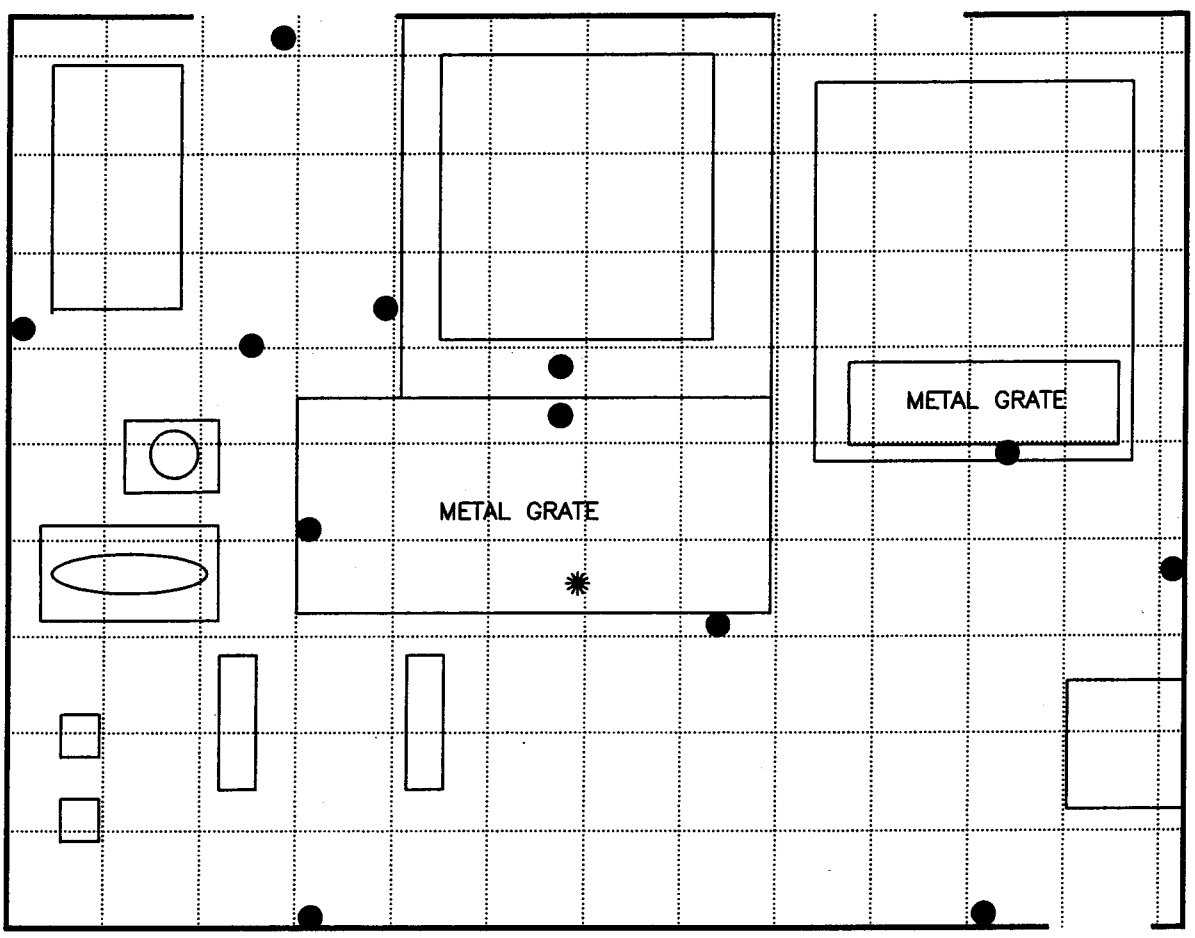


FIGURE 4: Building 4059, High Bay – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SINGLE-POINT LOWER WALLS AND FLOOR
- EXPOSURE RATE

N

FEET
0 6
0 2
METERS

FIGURE 5: Building 4059, Equipment Room – Measurement and Sampling Locations

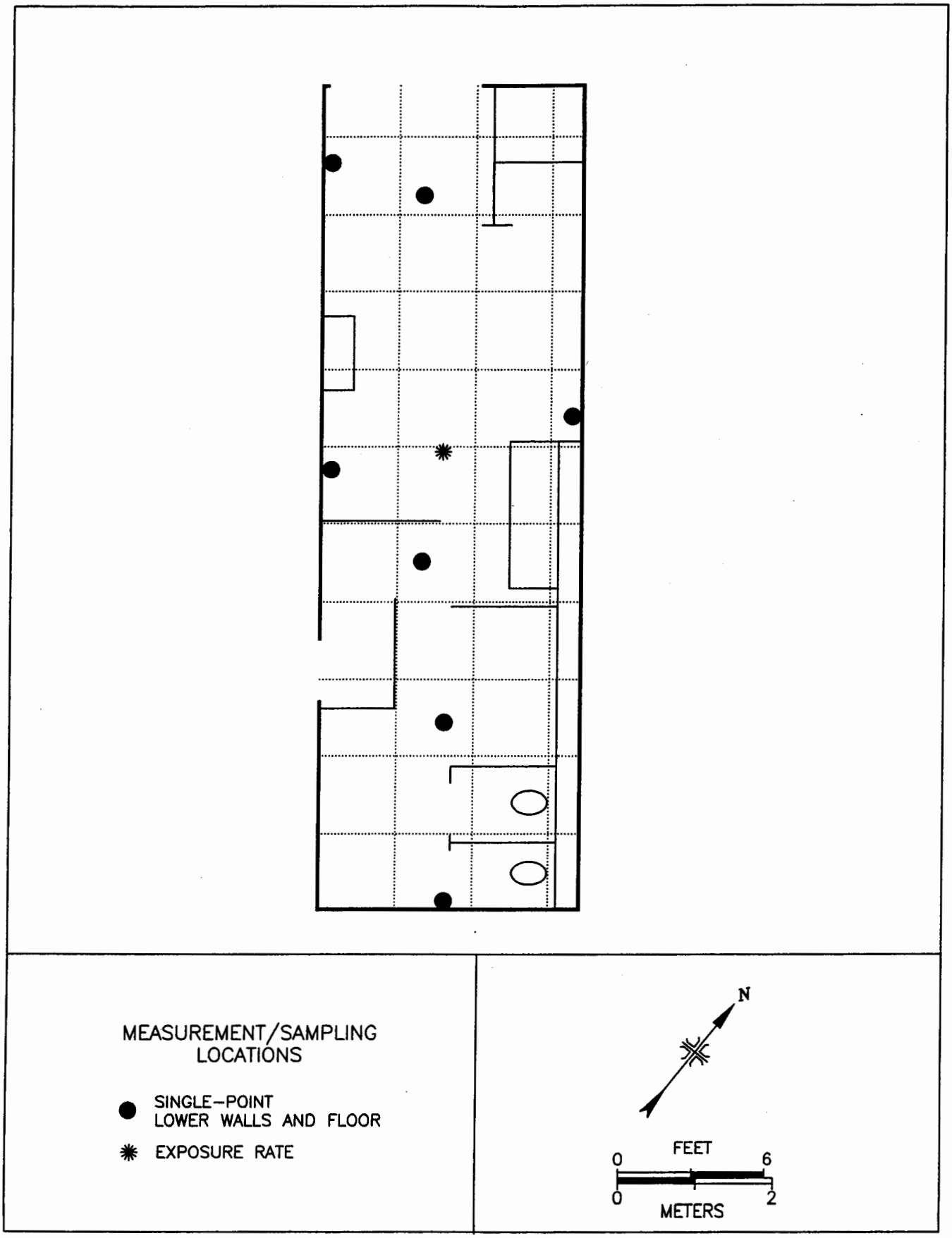
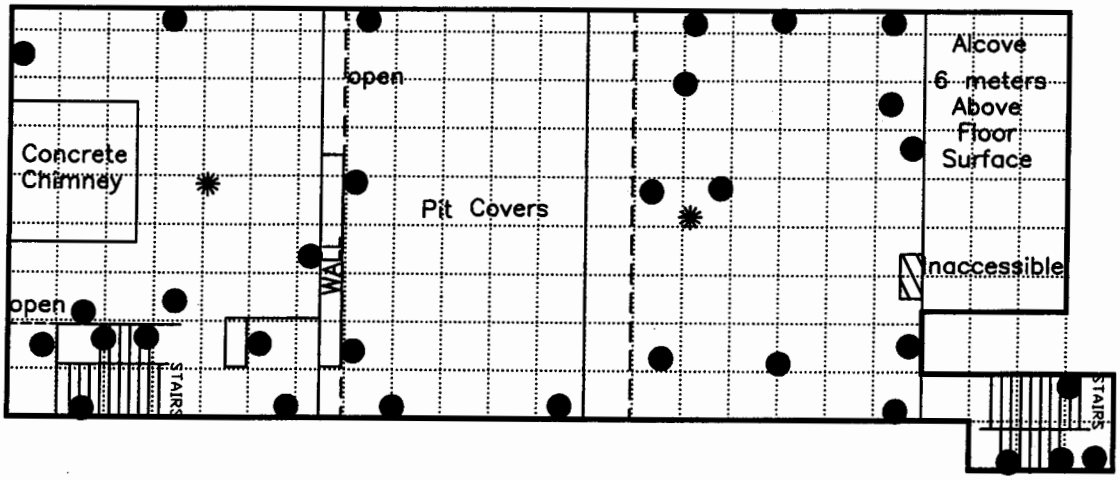


FIGURE 6: Building 4059, Locker Room – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SINGLE-POINT LOWER WALLS AND FLOOR
- GRID BLOCK
- EXPOSURE RATE

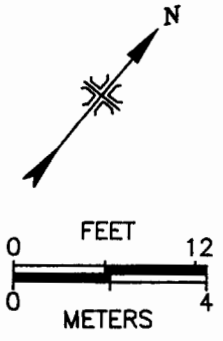


FIGURE 7: Building 4059, Vault – Measurement and Sampling Locations

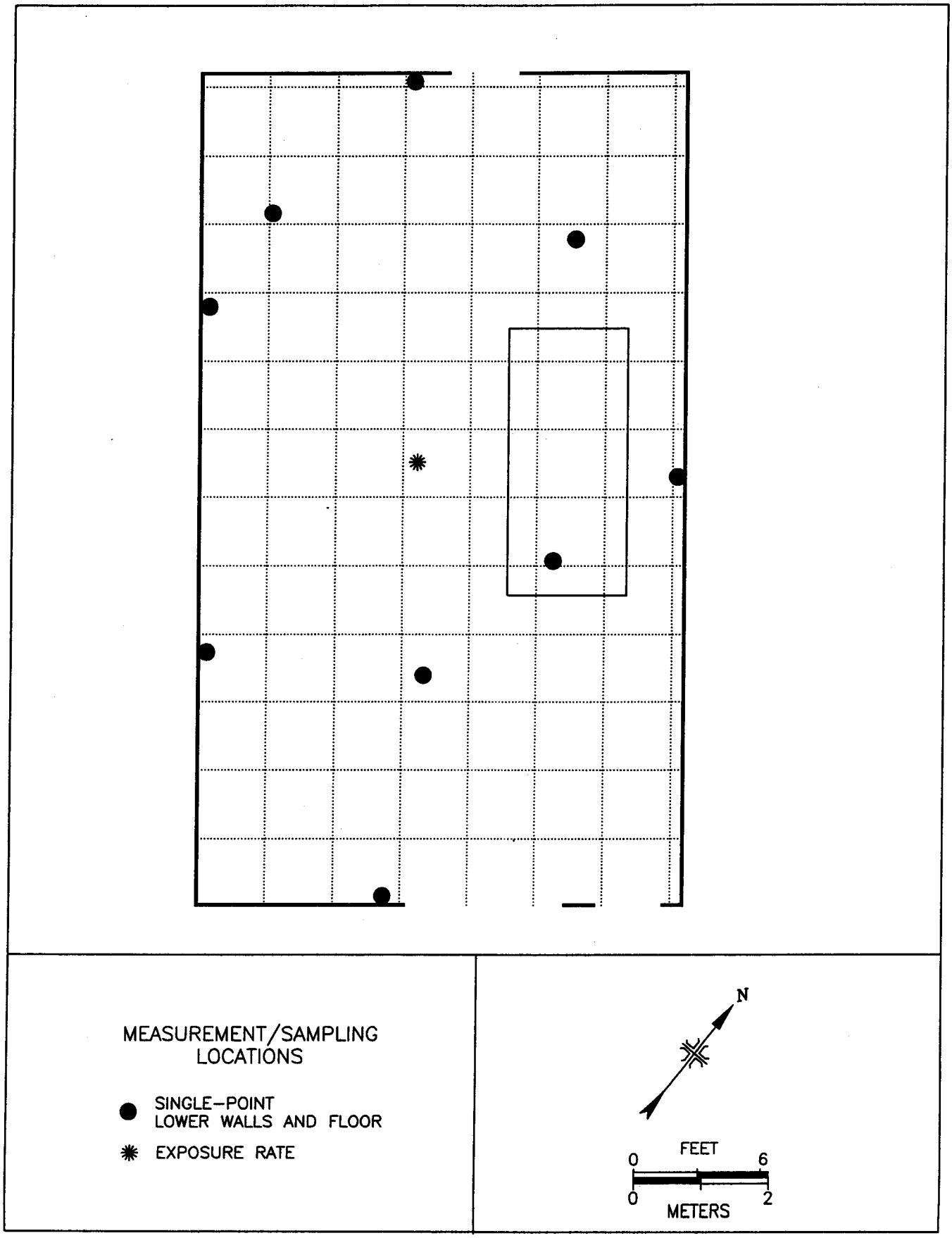


FIGURE 8: Building 4459 – Measurement and Sampling Locations

TABLES

TABLE 1

SUMMARY OF SURFACE ACTIVITY LEVELS
BUILDING 4059
SANTA SUSANA FIELD LABORATORY
THE BOEING COMPANY
VENTURA COUNTY, CALIFORNIA

Location[a]	Number of Measurement Locations		Total Activity Range (dpm/100 cm^2)	Removable Activity Range (dpm/100 cm^2)[b]	
			Single Measurements		
	Single-point	Grid Blocks	Beta	Alpha	Beta
Building 4059					
Basement/Vault	29	1	-100 to 8,300[c]	0 to 3	-4 to 6
East and West Stairwells	16	NA	8 to 1,700	0 to 3	-5 to 14
High Bay	17	NA	-460 to 2,300	0 to 1	-5 to 3
Equipment Room	12	NA	71 to 2,000	0 to 3	-4 to 7
Locker Room	7	NA	-420 to 2,100	0 to 3	-2 to 7
Building 4459	9	NA	-40 to 2,500	0 to 9	-3 to 17

[a]Refer to Figures 4 through 8.
[b]MDC for the procedure is 12 dpm/100 cm^2 for alpha and 16 dpm/100 cm^2 for beta.
[c]The 1 m^2 average activity for this location was 3500 dpm/100 cm^2.

TABLE 2

EXPOSURE RATES
BUILDING 4059
SANTA SUSANA FIELD LABORATORY
THE BOEING COMPANY
VENTURA COUNTY, CALIFORNIA

Location[a]	Exposure Rate at 1m (μR/h)
Building 4059	
Vault—East	11
Vault—West	20
High Bay	7
Equipment Room	11
Locker Room	7
Building 4459	10

[a]Refer to Figures 4 through 8.

REFERENCES

Boeing. RS-00001, Building 4059, Phase I Final Status Survey Procedure. Canoga Park, CA; April 29, 1999a.

Boeing. Building 4059 Final Status Survey Report (Phase I). Rocketdyne, CA: September 1999b.

Response to ORISE Comments on Final Status Survey Procedures for B/4059 Phase I, B/4020 and the 17th Street Drainage Area, and Final Status Survey Reports for B/4059 Phase I and 17th Street Drainage Area. Canoga Park, California. April 4, 2000.

Oak Ridge Institute for Science and Education (ORISE). Survey Procedures Manual for the Environmental Survey and Site Assessment Program. Oak Ridge, Tennessee; January 1998a.

Oak Ridge Institute for Science and Education. Quality Assurance Manual for the Environmental Survey and Site Assessment Program. Oak Ridge, Tennessee; May 1998b.

Oak Ridge Institute for Science and Education. Proposed Verification Survey Plan for the17th Street Drainage Area and Building 4059, Phase I, Santa Susana Field Laboratory, The Boeing Company, Ventura County, California. Oak Ridge, TN; October 13, 1999a.

Oak Ridge Institute for Science and Education. Laboratory Procedures Manual for the Environmental Survey and Site Assessment Program. Oak Ridge, Tennessee; October 1999b.

Oak Ridge Institute for Science and Education. Document Review—Comments on the Final Status Survey Procedures for the 17th Street Drainage Area and Building 4059 Phase I, Santa Susana Field Laboratory, Ventura County, California. Oak Ridge, TN; August 30, 1999c.

Oak Ridge Institute for Science and Education. Document Review—Comments on the Final Status Survey Report for Building 4059 Phase I, Santa Susana Field Laboratory, Ventura County, California. Oak Ridge, TN; October 4, 1999d.

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

U.S. Department of Energy. Response to ORISE Comments on Final Status Survey Procedures for B/4049 Phase I, B/4020 and the 17th Street Drainage Area, and the Final Status Survey Reports for B/4059 Phase I and 17th Street Drainage Area, Oakland, California; April 4, 2000

U.S. Nuclear Regulatory Commission (NRC). Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions. NUREG-1507. Washington, DC; June 1998.

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 author or his employer.

DIRECT RADIATION MEASUREMENT

Instruments

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

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

Detectors

Bicron Micro-Rem Meter
(Bicron Corporation, Newburg, OH)

Eberline GM Detector
Model HP-260
Physical Probe Area, 20 cm^2
(Eberline, Santa Fe, NM)

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

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

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

PROJECT HEALTH AND SAFETY

All survey and laboratory activities were conducted in accordance with ORISE health and safety and radiation protection procedures.

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.

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, (January 1998)
- Laboratory Procedures Manual, (October 1999)
- Quality Assurance Manual, (May 1998)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 414.1A 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 MAPEP, NRIP, and ITP and EML Laboratory Quality Assurance Programs.

- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the detectors slowly over the surface; the distance between the detector and the surface was maintained at a minimum - nominally about 1 cm. A large surface area, gas proportional floor monitor was used to scan the floors of the surveyed areas. Other surfaces were scanned using small area (20 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:

Beta - gas proportional detector with ratemeter-scaler

Beta-Gamma - GM detector with ratemeter-scaler

Gamma - NaI scintillation detector with ratemeter

Scan minimum detectable concentrations (MDCs) were estimated using the calculational approach described in NUREG-1507.[1] The scan MDC is a function of many variables, including the background level. Typical beta background levels for the floor monitor range from 800 to 1400 cpm, range from 250 to 450 cpm for the hand-held gas proportional detector, and from 35 to 60 cpm for the GM detectors. Additional parameters selected for the calculation of scan MDCs include a one-second observation interval for the gas proportional detectors and a two-second interval for the GM detector, a specified level of performance at the first scanning stage of 95% true positive rate and 25% false positive rate, which yields a d′ value of 2.32 (NUREG-1507, Table 6.1), and a surveyor efficiency of 0.5. The instrument efficiencies for the hand-held gas proportionals and GM detector

[1]NUREG-1507. Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions. US Nuclear Regulatory Commission. Washington, DC; June 1998.

calibrated to Tc-99 were 0.10 and 0.07, respectively. To illustrate an example for the hand-held gas proportional, the minimum detectable count rate (MDCR) and scan MDC can be calculated as follows:

b_i = (250 cpm)(1 s)(1 min/60 s) = 4.1 counts,

MDCR = (2.32)(4.1)^{½} [(60 s/min)/(1 s)] = 284 cpm,

$MDCR_{surveyor}$ = 284/(0.5)^{½} = 401 cpm

The scan MDC is calculated assuming a source efficiency of 0.25 (for Tc-99):

$$Scan\ MDC = \frac{MDCR_{surveyor}}{(\epsilon_s)\ (\epsilon_i)\ (\frac{probe\ area}{100\ cm^2})} = xxx\ dpm/100\ cm^2$$

For the given background range, the estimated scan MDC for the hand-held gas-proportional detector was 3,264 dpm/100 cm^2 and 7800 dpm/100 cm^2 for the GM detector.

Surface Activity Measurements

Measurements of total surface activity levels were performed using gas proportional with portable ratemeter-scalers. Surface activity measurements were performed on upper room surfaces, some equipment, and at locations of elevated direct radiation.

Count rates (cpm), which were integrated over one minute with the detector held in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net rate by the total efficiency ($\epsilon_i \times \epsilon_s$) and correcting for the active area of the detector. The 2π instrument efficiency factors (ϵ_i) was 0.39 for the gas proportional detectors calibrated to Tc-99. The source efficiency factor (ϵ_s) was 0.25. The total beta efficiency factor for the gas proportional detectors was 0.10.

Because different building materials (poured concrete, brick, wood, steel, etc.) may have different background levels, average background count rates were determined for each material encountered in the surveyed area at a location of similar construction and having no known radiological history. The beta activity background count rates for the gas proportional detectors averaged 332 cpm for concrete block and floors, 302 for drywall, and 303 for metal. The beta minimum detectable concentrations (MDC) ranged from 660 to 690 dpm/100. The physical surface area assessed by the gas proportional detectors was 126 cm^2.

Removable Activity Measurements

Removable gross alpha and gross beta 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 dose equivalent rates (μrem/h) were performed at 1 m above the surface using a Bicron microrem meter. Although the instrument displays data in μrem/h, the μrem/h to μR/h conversion is essentially unity.

ANALYTICAL PROCEDURES

Gross Alpha/Beta

Smears were counted on a low background gas proportional system for gross alpha and gross beta activity. The MDCs of the procedure were 12 dpm/100 cm^2 for gross alpha and 16 dpm/100 cm^2 for gross beta.

UNCERTAINTIES AND DETECTION LIMIT

Detection limits, referred to as minimum detectable concentration (MDC), were based on 3 plus 4.65 times the standard deviation of the background count [$3 + (4.65\sqrt{BKG})$]. 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 radionuclide in samples, the detection limits differ from sample to sample and instrument to instrument.

APPENDIX C

SUMMARY OF DEPARTMENT OF ENERGY RESIDUAL RADIOACTIVE MATERIAL GUIDELINES

APPENDIX C

SUMMARY OF DEPARTMENT OF ENERGY RESIDUAL RADIOACTIVE MATERIAL GUIDELINES

BASIC DOSE LIMITS

The basic dose 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 reasonably achievable principles to set site-specific guidelines.

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.

SURFACE CONTAMINATION GUIDELINES

	Allowable Total Residual Surface Contamination (dpm/100 cm^2)[a]		
Radionuclides[b]	Average[c,d]	Maximum[d,e]	Removable[d,f]
Transuranics, Ra-226, Ra-228, Th-230 Th-228, Pa-231, Ac-227, I-125, I-129	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	5,000β-γ	15,000β-γ	1,000β-γ

[a] 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.

[b] 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.

[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. The numbers in this column are maximum amounts.