ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

July 19, 1999

Mr. Anand Gupta
U.S. Department of Energy
EM-44
Cloverleaf Building
Washington, DC 20585-0002

SUBJECT: FINAL REPORT—VERIFICATION SURVEY OF THE DESOTO MASS SPECTROSCOPY LABORATORY (BUILDING 104), ROCKETDYNE PROPULSION AND POWER, BOEING NORTH AMERICAN, INC., CANOGA PARK, CALIFORNIA

Dear Mr. Gupta:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) performed a verification survey of the subject facility during September 1998. Enclosed is the final report detailing the survey results. Comments received on the draft report have been incorporated.

Please contact me at (423) 576-5073 or Eric Abelquist at (423) 576-3740 should you have any questions.

Sincerely,

Timothy J. Vitkus
Survey Projects Manager
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TJV:cds

Enclosure

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File/402

VERIFICATION SURVEY OF THE DESOTO MASS SPECTROSCOPY LABORATORY (BUILDING 104) SANTA SUSANA FIELD LABORATORY BOEING NORTH AMERICAN, INC., CANOGA PARK, CALIFORNIA

T. J. VITKUS

Prepared for the
Office of Environmental Restoration
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 consortium of 87 colleges and universities.

VERIFICATION SURVEY OF THE DESOTO MASS SPECTROSCOPY LABORATORY (BUILDING 104) ROCKETDYNE PROPULSION AND POWER BOEING NORTH AMERICAN, INC. CANOGA PARK, CALIFORNIA

Prepared by

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Prepared for the

Office of Environmental Restoration
U.S. Department of Energy

FINAL REPORT

JUNE 1999

This report is based on work performed under a contract with the U.S. Department of Energy.

VERIFICATION SURVEY
OF THE
DESOTO MASS SPECTROSCOPY LABORATORY (BUILDING 104)
SANTA SUSANA FIELD LABORATORY
BOEING NORTH AMERICAN, INC.
CANOGA PARK, CALIFORNIA

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ACKNOWLEDGMENTS

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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
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DOE	U.S. Department of Energy
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	foot
ha	hectare
km	kilometer
m^2	square meter
M&O	Management and Operating
MDC	minimum detectable concentration
mm	millimeter
mrem/yr	millirem per year
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
SSFL	Santa Susana Field Laboratory

VERIFICATION SURVEY OF THE DESOTO MASS SPECTROSCOPY LABORATORY (BUILDING 104) ROCKETDYNE PROPULSION AND POWER BOEING NORTH AMERICAN, INC. CANOGA PARK, CALIFORNIA

INTRODUCTION AND SITE HISTORY

The DeSoto Building 104, located in Canoga Park, California, was one of several buildings comprising the headquarters of the former Atomics International from 1960 to 1984. In 1984, Atomics International merged with Rocketdyne and since then with Boeing North American, Inc. Rocketdyne operated a Mass Spectroscopy Laboratory within Building 104 which was used to analyze low-level, activated test samples for universities and national laboratories beginning in the 1970's until 1995. Typical radionuclides controlled by the laboratory were activation products such as Mn-54, Mn-56, Co-58, Co-60, Fe-59, Nb-95, and Cs-137. Uranium isotopes were also used. In 1996, the laboratory was relocated to Battelle—Pacific Northwest Laboratories.

Decontamination and decommissioning (D&D) of contaminated Rocketdyne facilities began in the late 1960's and continues as the remaining U.S. Department of Energy (DOE) program operations are terminated. As part of this D&D program, Rocketdyne/Boeing has performed, or is in the process of performing decommissioning and final status surveys of a number of facilities that supported the various nuclear-related operations, most of which were at the Santa Susana Field Laboratory which Rocketdyne operated for the DOE. Environmental management of DOE contaminated properties continues under the termination clause of Rocketdyne's Management and Operating (M&O) contract. D&D activities for the Mass Spectroscopy Laboratory were initiated in 1997, and included removal of all cabinets, furniture, floor tile, ventilation ducting, piping, conduit, dry wall, and ceiling panels. A final survey was completed in 1998 (Boeing 1998a).

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 Rocketdyne. 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 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 Rocketdyne, and has been requested to verify the current radiological status of each of these facilities.

SITE DESCRIPTION

The Mass Spectroscopy Laboratory, is within Building 104 at Boeing North American, Inc.'s DeSoto Facility, which is located at 8900 DeSoto Avenue in Canoga Park, approximately five miles east of the SSFL site (Figures 1 and 2). The laboratory is located in the northeast quadrant of the first floor of Building 104 and includes the offices along the north quadrant that were used during the D&D activities. Figure 3 shows the original laboratory floor plan. Overall, the laboratory contained approximately 460m^2 (4900ft^2) of floor area. The laboratory was constructed with a concrete floor and orginally, concrete walls which separated the laboratory from surrounding offices.

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 area and whether or not the area meets the guideline requirements for release without radiological restrictions.

DOCUMENT REVIEW

Survey plans and procedures were reviewed for appropriateness and the final data and final status survey report were reviewed for adequacy relative to demonstrating compliance with the DOE requirements for release for unrestricted use (Boeing 1998a and b).

PROCEDURES

A survey team from ESSAP visited the DeSoto facility on September 30, 1998 and performed visual inspections and independent measurements and sampling of the Mass Spectroscopy Laboratory.

The verification survey activities were conducted in accordance with a DOE approved site-specific survey plan and the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 1998a, b, and c). Survey procedures included surface scans, total and removable surface activity measurements, and exposure rate measurements. Additional information regarding survey and analytical equipment and procedures may be found in Appendices A and B.

REFERENCE SYSTEM

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

SURFACE SCANS

Surface scans for alpha, beta, and gamma activity were performed on 100 percent of the floors and 25 to 50 percent of the lower walls (up to 2 meters) using NaI scintillation and gas proportional detectors coupled to ratemeters or ratemeter-scalers with audible indicators. Particular attention was given to cracks and joints in the floor and walls, ledges, drains, ducts, and other locations where material may have accumulated. Locations of elevated direct radiation levels detected by scans were marked for further investigation.

SURFACE ACTIVITY MEASUREMENTS

Initially, direct measurements were performed on various construction materials in areas of similar construction, but with no history of radioactive materials use in order to obtain construction material specific backgrounds.

Direct measurements, using gas proportional detectors coupled to ratemeter-scalers, for total alpha and total beta surface activity were performed at 30 locations within the laboratory and adjoining areas. Measurement locations were chosen either randomly or based on surface scan results. A smear sample for the determination of removable activity was collected at each direct measurement location. Figures 4 through 7 show measurement locations.

EXPOSURE RATE MEASUREMENTS

Background exposure rate measurements were collected in an area of Building 104 of similar construction but with no history of radioactive materials use. Exposure rates were measured at five locations in the Mass Spectroscopy Laboratory and adjoining areas (Figures 4, 5, and 7). Exposure rates were measured at one meter above the surface using a microrem meter.

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 1998d). Smears were analyzed using a low-background gas proportional counter. Smear and direct measurement results were then 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). The data generated were then compared with Rocketdyne/Boeing's documentation and the DOE guidelines established for release to unrestricted use.

FINDINGS AND RESULTS

DOCUMENT REVIEW

The procedures used for the final status survey were appropriate for the detection of the contaminants of concern at the guideline levels. The final status survey data provide an adequate description of the radiological status of the Mass Spectroscopy Laboratory and indicate that the guidelines for release for unrestricted use have been satisfied.

SURFACE SCANS

Surface scans identified one location of elevated direct alpha plus beta radiation in excess of the ambient background levels on the floor of the Mass Spectroscopy Laboratory. Follow-up investigations determined that the levels were below acceptable criteria. All remaining area scans did not identify any additional locations of elevated direct radiation.

SURFACE ACTIVITY LEVELS

Surface activity levels are summarized in Table 1. Total alpha activity levels ranged from -14 to 87 dpm/100 cm^2 and total beta activity levels ranged from -340 to 900 dpm/100 cm^2. Removable activity levels ranged from 0 to 2 dpm/100 cm^2 and -6 to 9 dpm/100 cm^2 for gross alpha and gross beta, respectively.

EXPOSURE RATES

Exposure rates at one meter above the surface are summarized in Table 1 and ranged from 9 to 11 μR/h. The background exposure rates within Building 104 averaged 9 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 the Mass Spectroscopy Laboratory 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 one meter above the surface were within these guidelines.

SUMMARY

During September 1998, the Environmental Survey and Site Assessment Program performed verification activities for the Rocketdyne/Boeing Mass Spectroscopy Laboratory at the DeSoto facility located in Canoga Park, California. Verification activities included document reviews, surface scans, surface activity measurements, and exposure rate measurements.

The results of the independent verification survey support Rocketdyne/Boeing's final status survey conclusion that the radiological conditions of the Mass Spectroscopy Laboratory satisfy the DOE guidelines. All verification surface activity levels were 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 Rocketdyne/Boeing has elected to use.

FIGURES

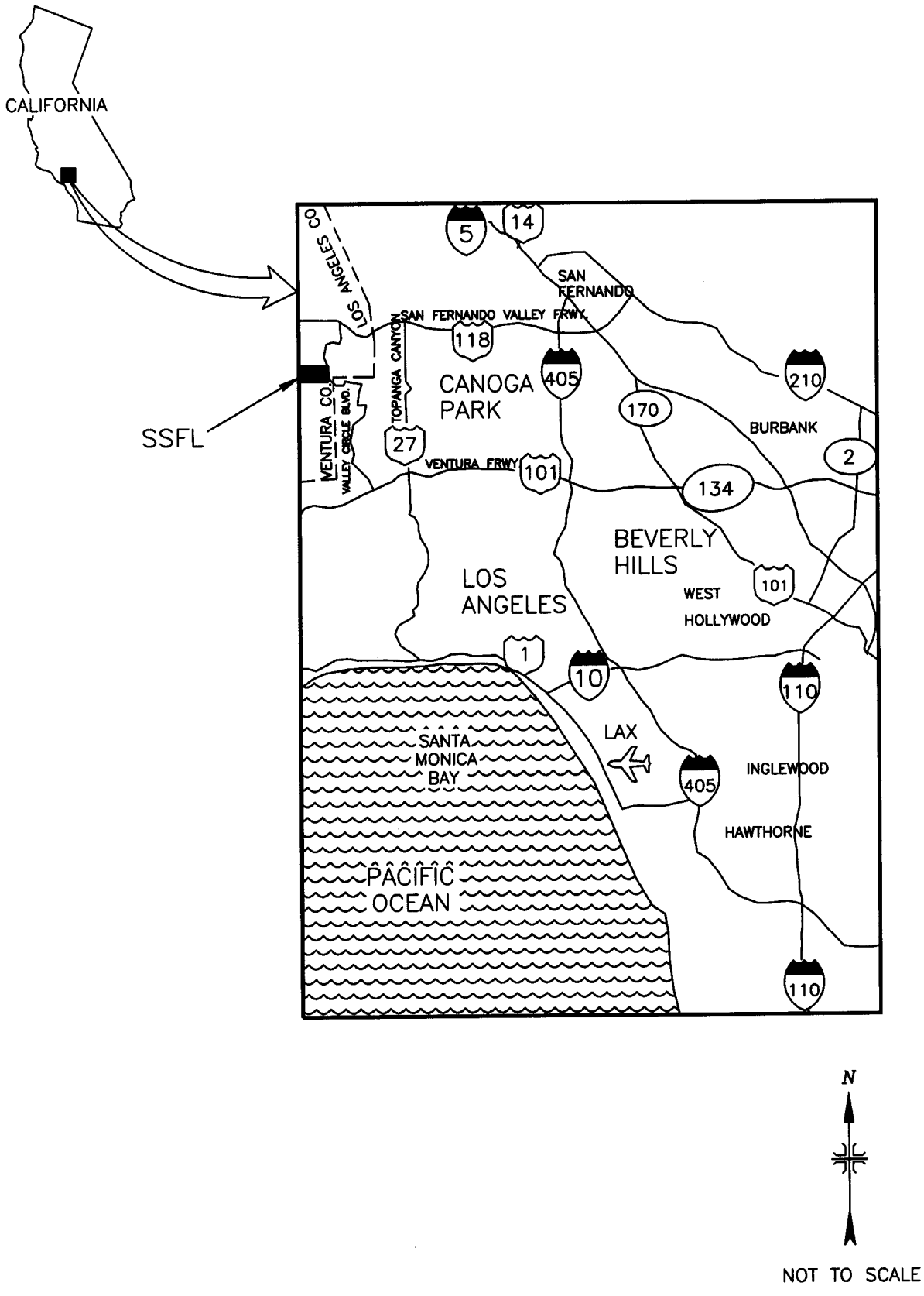

FIGURE 1: Los Angeles, California Area – Location of the Santa Susana Field Laboratory Site

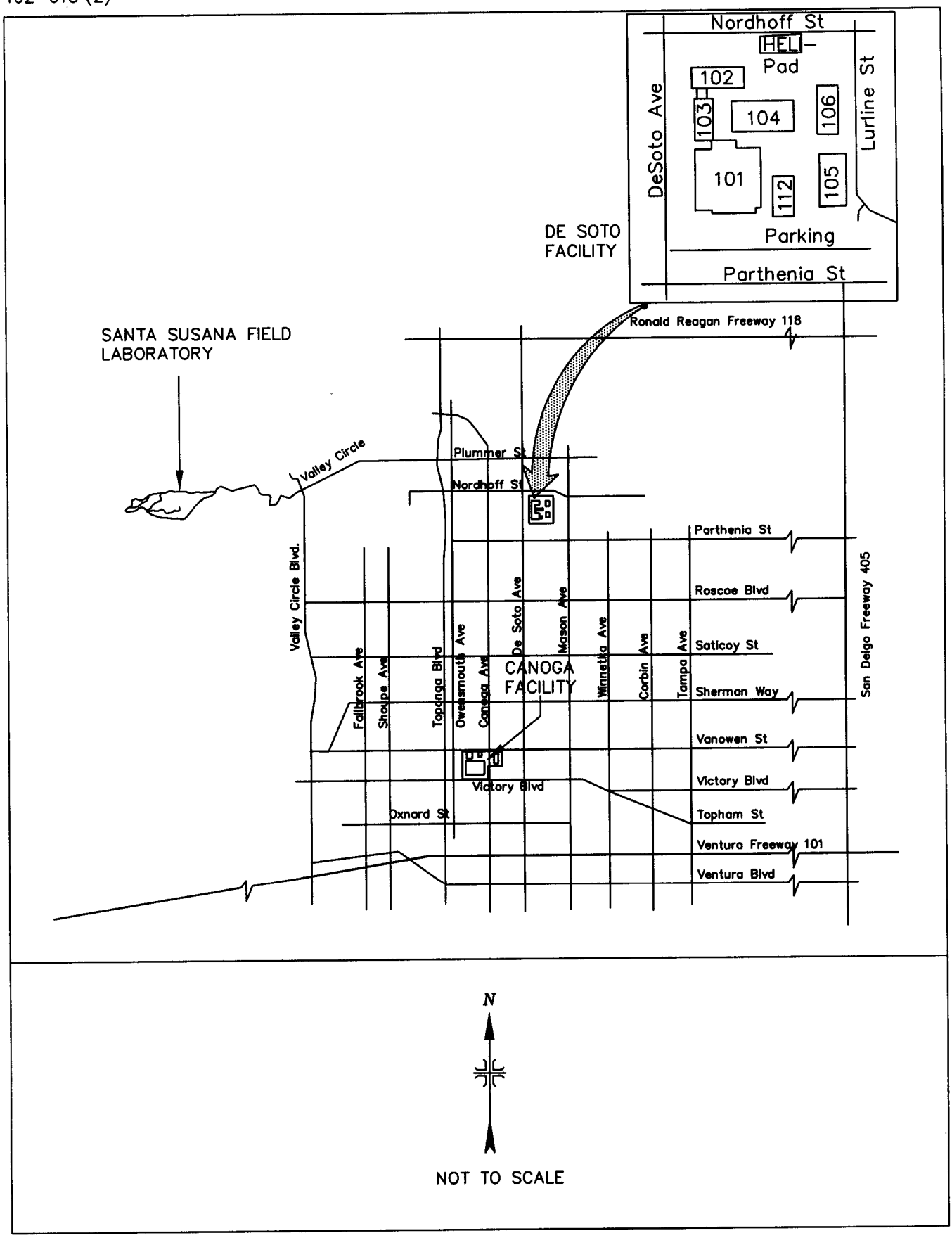

FIGURE 2: Location of the DeSoto Facility and Building 104

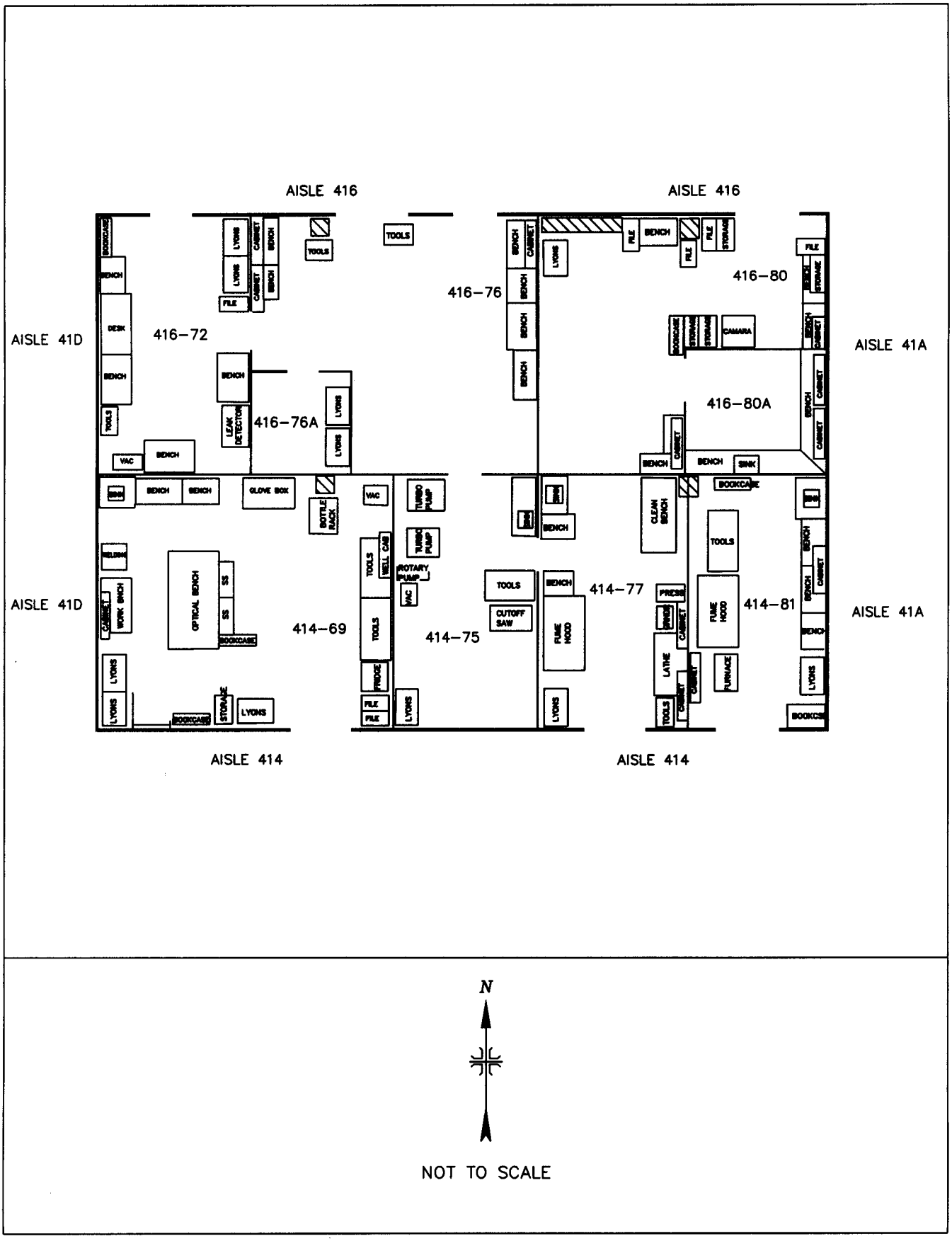

FIGURE 3: Mass Spectroscopy Laboratory – Original Floor Plan

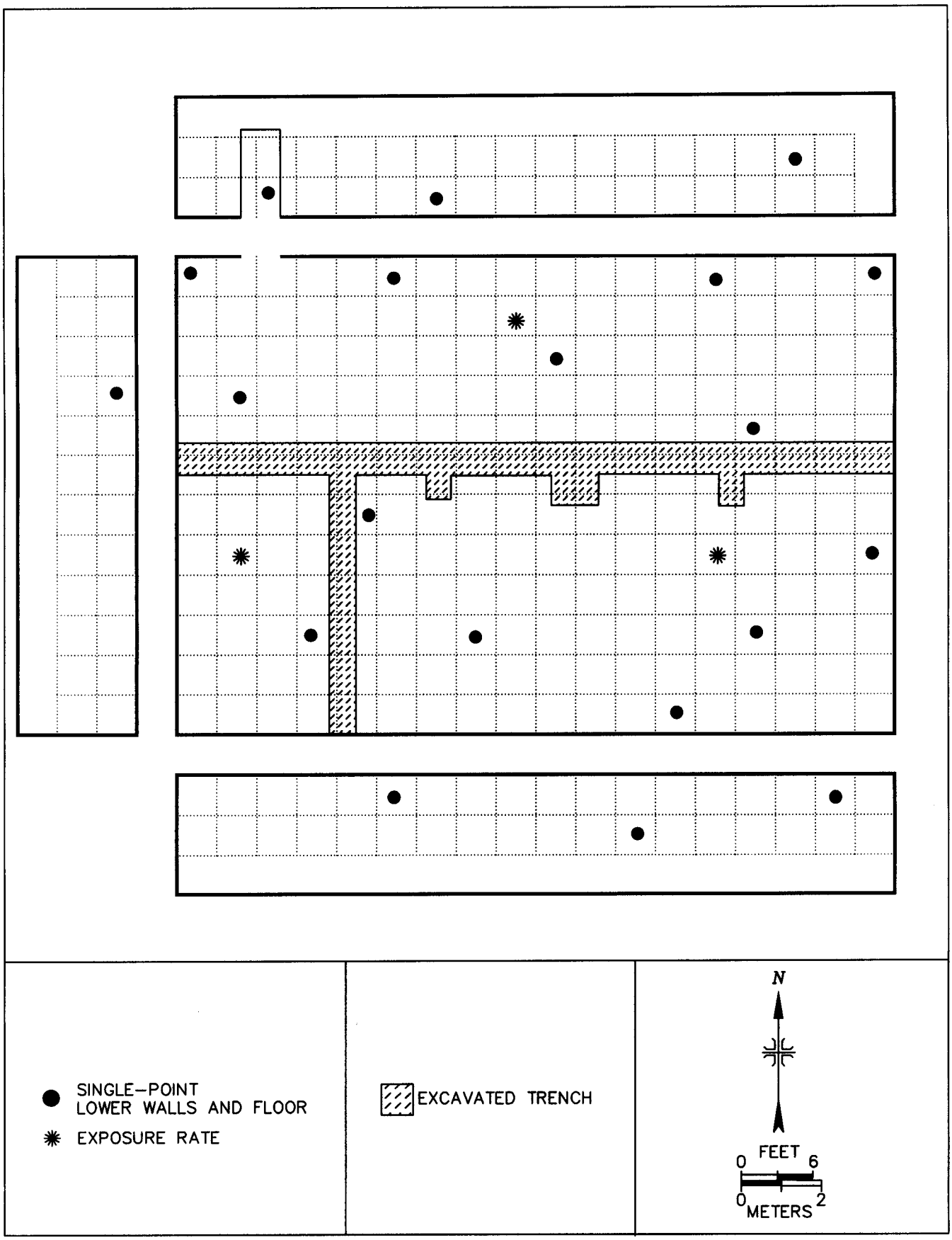

FIGURE 4: Mass Spectroscopy Laboratory – Measurement and Sampling Locations

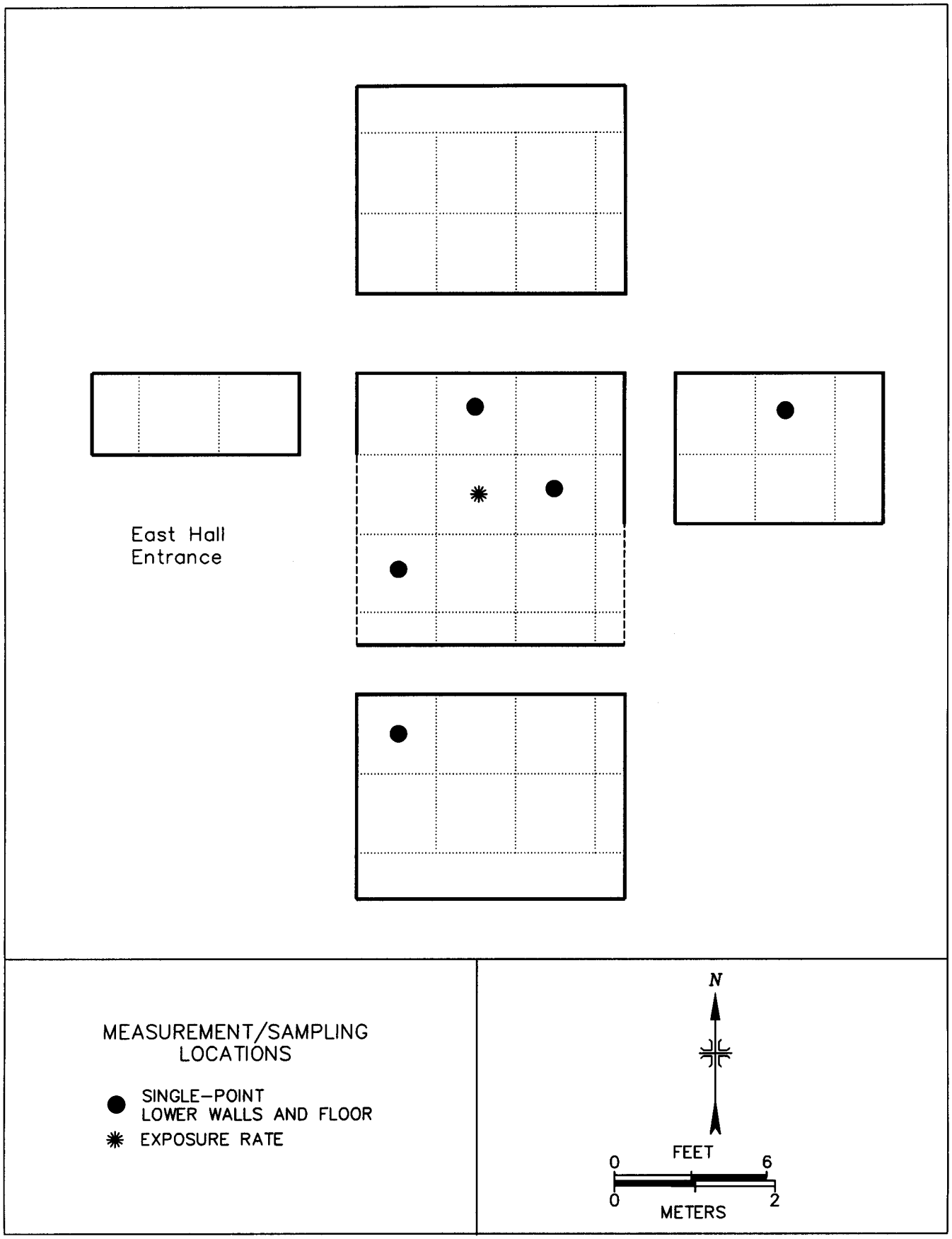

FIGURE 5: Building 104, AB-33 - Measurement and Sampling Locations

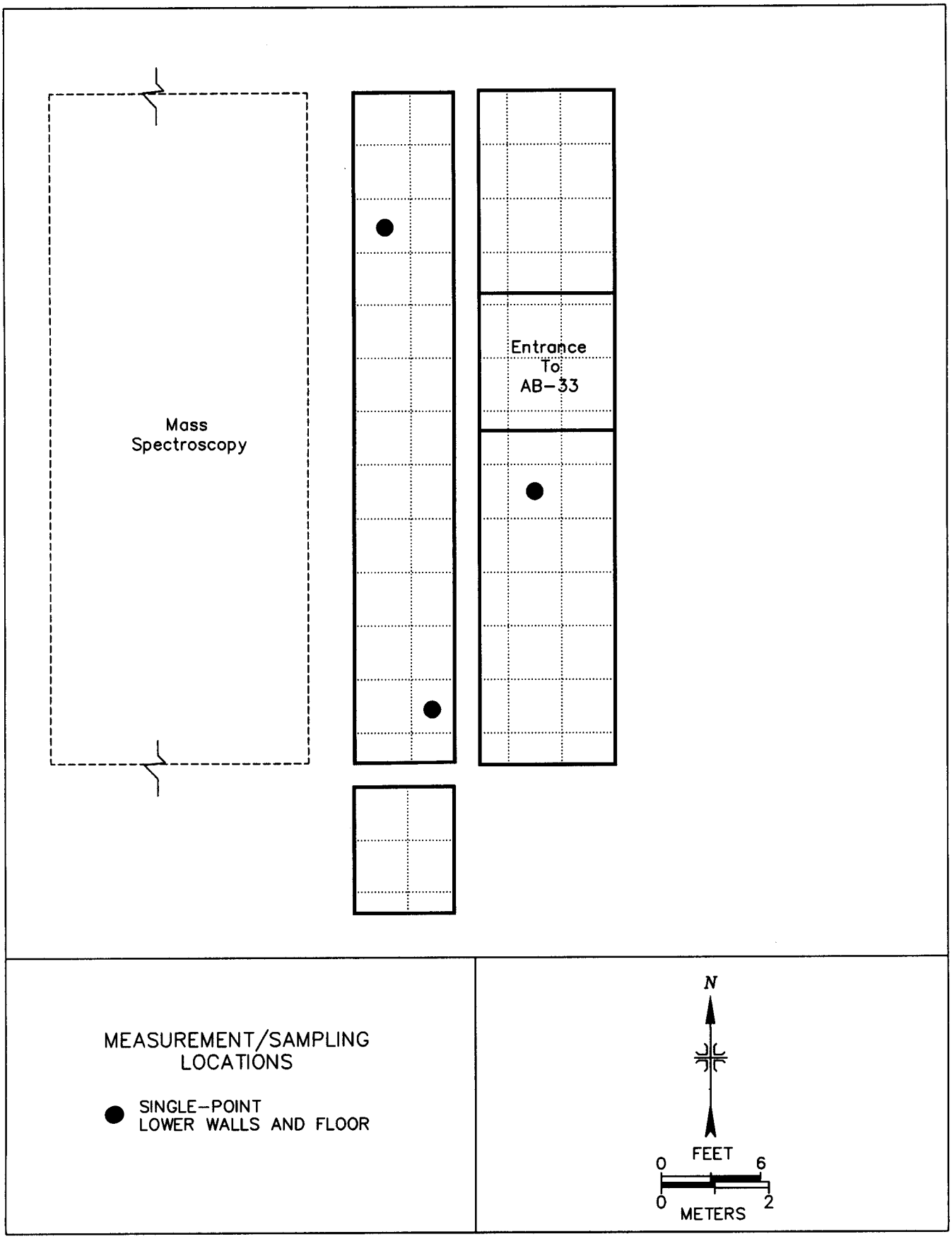

FIGURE 6: Building 104, East Hallway – Measurement and Sampling Locations

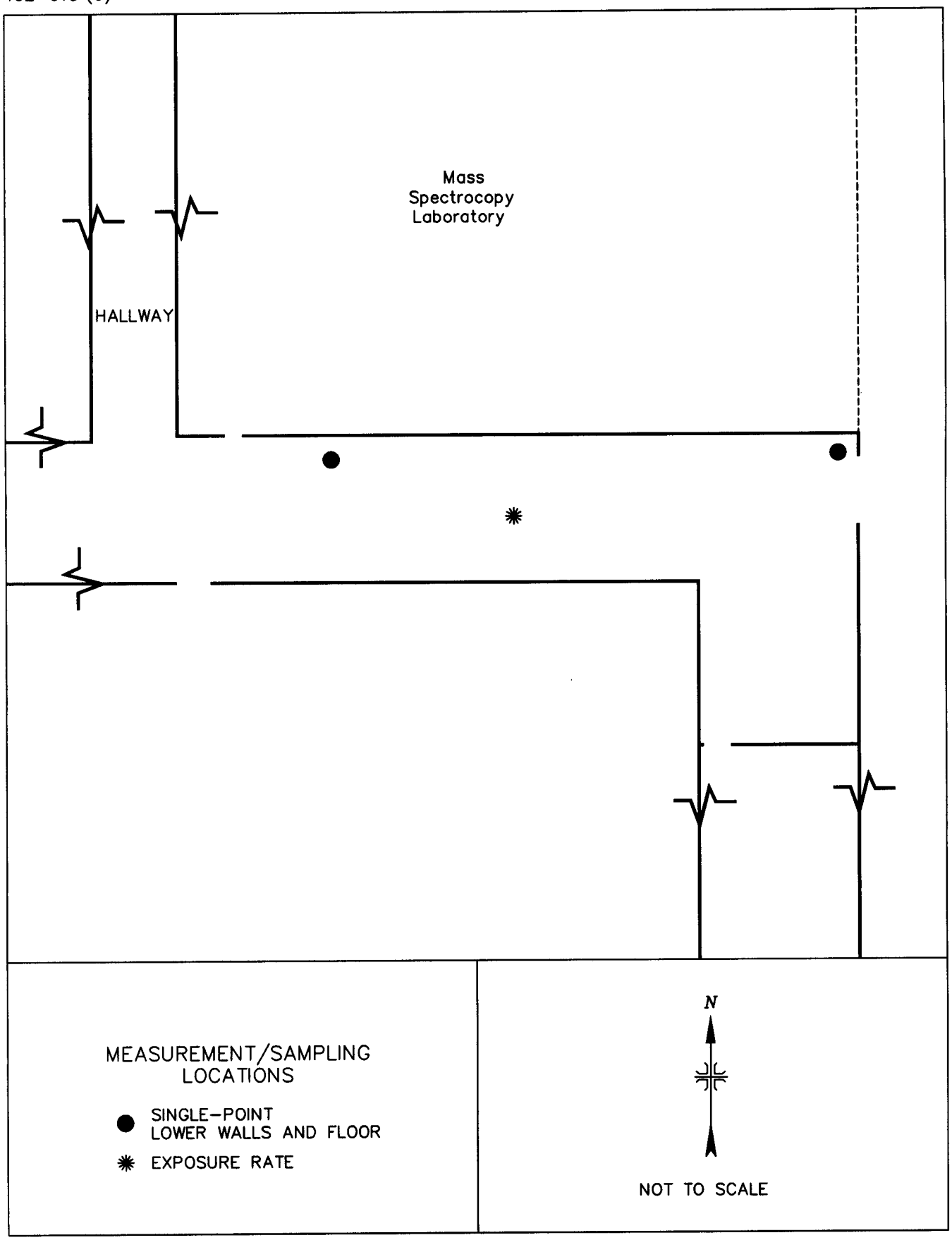

FIGURE 7: Building 104, South Hallway – Measurement and Sampling Locations

TABLE

TABLE 1

SUMMARY OF EXPOSURE RATES AND SURFACE ACTIVITY LEVELS
DESOTO MASS SPECTROSCOPY LABORATORY (BUILDING 104)
SANTA SUSANA FIELD LABORATORY
BOEING NORTH AMERICAN, INC.
CANOGA PARK, CALIFORNIA

Location[a]	Number of Exposure Rate Measurements Locations	Exposure Rate Range (μR/h)	Number of Surface Activity Measurement Locations	Total Activity Range (dpm/100 cm^2)		Removable Activity Range (dpm/100 cm^2)	
			Single-Point	Alpha	Beta	Alpha	Beta
MASS SPEC. LAB							
Floor	3	9 to 10	12	-7 to 87	-8 to 903	0 to 2	-4 to 9
Lower Wall	NA	NA	8	-14 to 7	-339 to 137	0 to 2	-6 to 2
EAST HALLWAY							
Floor	NA	NA	2	0 to 14	82	0	-3 to 1
Lower Wall	NA	NA	1	-7	57	0	1
FOYER							
Floor	1	11	3	0 to 22	30 to 82	0	-3 to 1
Lower Wall	NA	NA	2	0	-19 to 328	0	-2 to 1
SOUTH HALLWAY							
Floor	1	10	2	22 to 29	118 to 156	0 to 2	-1 to 6

[a]Refer to Figures 4 through 7.

REFERENCES

Boeing North American, Inc., Rocketdyne Division. Final Survey Report of the DeSoto Building 104, Mass Spectroscopy Laboratory. Canoga Park, CA; December 16, 1998a.

Boeing North American, Inc., Rocketdyne Division (Boeing). DeSoto Mass Spectrometry Laboratory Final Survey Plan. Canoga Park, CA: July 18, 1998b.

Oak Ridge Institute for Science and Education. Proposed Verification Survey Plan for the DeSoto Mass Spectrometry Laboratory (104), the Building 4019 Test Vault, and the T064 Side Yard, Santa Susana Field Laboratory, Boeing North America, Inc., Ventura County, California. Oak Ridge, TN; September 23, 1998a.

Oak Ridge Institute for Science and Education. Survey Procedures Manual for the Energy/Environment Systems Division, Environmental Survey and Site Assessment Program, Revision 10. Oak Ridge, Tennessee; January 7, 1998b.

Oak Ridge Institute for Science and Education. Quality Assurance Manual for the Energy/Environment Systems Division, Environmental Survey and Site Assessment Program, Revision 8. Oak Ridge, Tennessee; May 1, 1998c.

Oak Ridge Institute for Science and Education. Laboratory Procedures Manual for the Energy/Environment Systems Division, Environmental Survey and Site Assessment Program, Revision 11. Oak Ridge, Tennessee; February 17, 1998d.

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 author or his 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

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

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)

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 detectors slowly over the surface; the distance between the detector 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 (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-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 total efficiency ($\epsilon_i \times \epsilon_s$) and correcting for the active area of the detector. 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 within Building 104 having similar construction to the Mass Spectroscopy Laboratory but without a history of radiological use. The respective alpha and beta background count rates for the 126 cm^2 gas proportional detectors were 3 and 510 cpm for unpainted concrete, 2 and 296 cpm for sheet rock and metal, and 1 and 413 cpm

for painted concrete. The 2 π alpha instrument efficiency factor was 0.43 for the gas proportional detector calibrated to Th-230. The 2 π beta instrument efficiency factor was 0.59 for the gas proportional detector calibrated to Tl-204. The source efficiency factors were 0.25 and 0.50 for alpha and beta, respectively. The corresponding total efficiencies were 0.11 for alpha and 0.29 for beta. The alpha minimum detectable concentrations (MDC) ranged from 55 to 80 dpm/100 cm^2, while the beta activity MDCs ranged from 230 to 300 dpm/100 cm^2. The physical probe 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 at one meter above surfaces using a microrem meter. Although the instrument displays data in μrem/h, the μrem/h to μR/h conversion is essentially unity.

RADIOLOGICAL ANALYSES

Removable Activity

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

DETECTION LIMITS

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 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.

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 10 (January 7, 1998)
- Laboratory Procedures Manual, Revision 12 (June 22, 1998)
- Quality Assurance Manual, Revision 8 (May 1, 1998)

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.