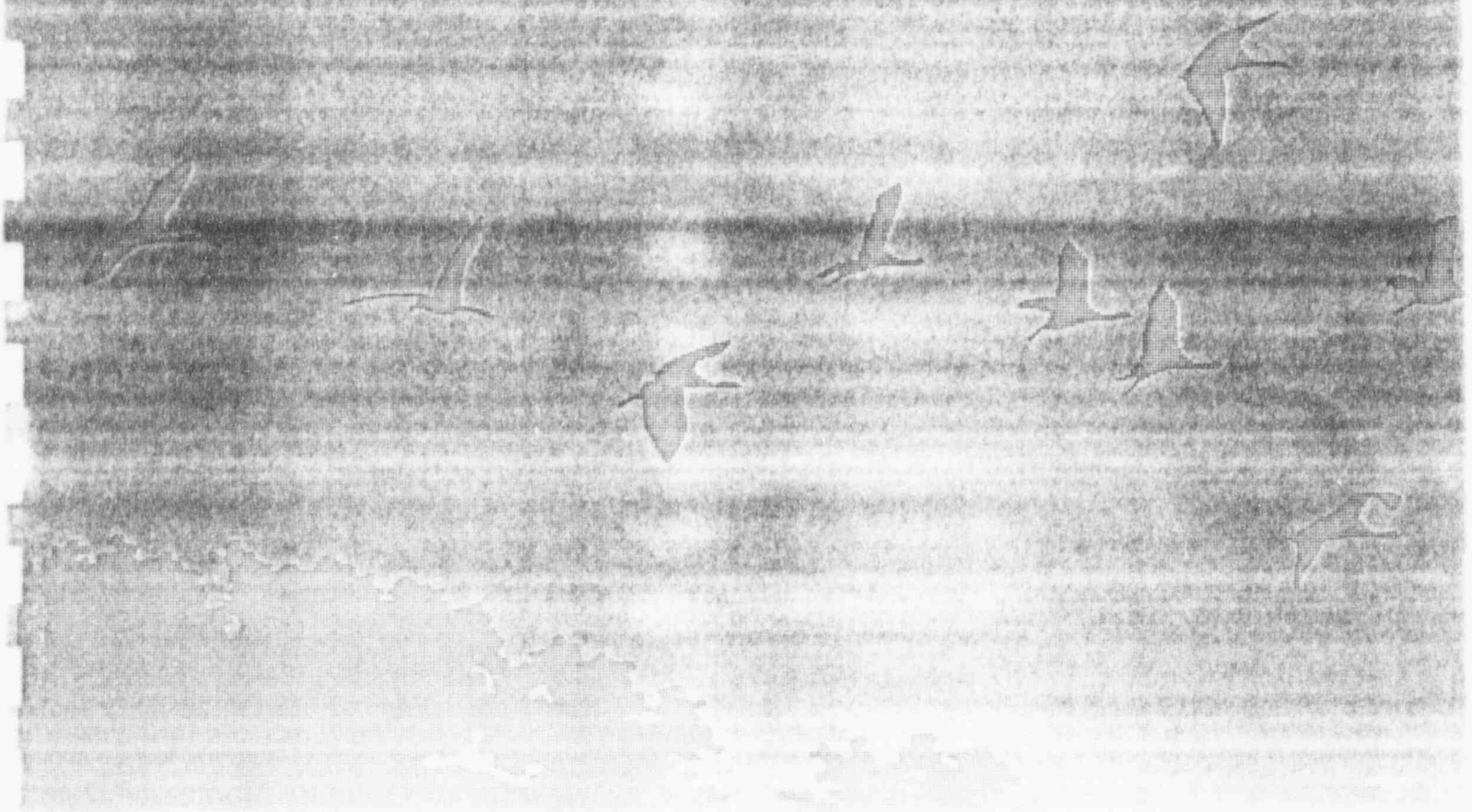
RADIOLOGICAL SURVEY OF THE FORMER DOSIMETER CORPORATION OF AMERICA SITE CINCINNATI, OHIO

[DOCKET NO. 030-05864]

T.J. VITKUS

Prepared for the
U.S. Nuclear Regulatory Commission
Region III Office



ORISE

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

Environmental Survey and Site Assessment Program
Environmental and Health Sciences Division

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Prepared by

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Prepared for the

U.S. Nuclear Regulatory Commission
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FINAL REPORT

SEPTEMBER 1996

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RADIOLOGICAL SURVEY
OF THE
FORMER DOSIMETER CORPORATION OF AMERICA SITE
CINCINNATI, OHIO

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ABBREVIATIONS AND ACRONYMS

µR/h	microroentgen per hour
AHP	Applied Health Physics
ASME	American Society of Mechanical Engineers
BKG	background
cm^2	square centimeter
cpm	counts per minute
DCA	Dosimeter Corporation of America
DOE	Department of Energy
dpm/100 cm^2	disintegrations per minute/100 square centimeters
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
ESSAP	Environmental Survey and Site Assessment Program
ft^2	square feet
m	meter
m^2	square meter
MDC	minimum detectable concentration
mm	millimeter
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
PIC	pressurized ionization chamber

RADIOLOGICAL SURVEY
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CINCINNATI, OHIO

INTRODUCTION

The Dosimeter Corporation of America (DCA) operated a facility in Cincinnati, Ohio for the production of radiation detection equipment. The facility was licensed in 1969 (License No. 34-13477-01) by the Atomic Energy Commission, predecessor organization to the U. S. Nuclear Regulatory Commission (NRC), for the possession and use of various radioactive sealed sources used for calibrating and checking the manufactured radiation detection equipment. The sources used at the facility included C-14, Na-22, Co-60, Kr-85, Sr-90, Ba-133, Cs-137, Eu-152 and -154, Bi-210, Th-230, U-238, and Am-241. Of these, most had activity levels of a few millicuries, with the exception of several multicurie Co-60 and Cs-137 sources.

On October 6, 1994, DCA ceased operations and began the process of transferring or disposing of radioactive materials in their possession. Applied Health Physics (AHP) was contracted by DCA to perform a final status survey of the facility and to decontaminate a safe where a Cs-137 and an Am-241 source had leaked. The results of the final status survey were submitted to the NRC (DCA 1995). The NRC then formally terminated the license in May 1995. However, NRC's further review of the final status survey report identified significant concerns as to the adequacy of the survey and data provided in support of the license termination (NRC 1996). As a result of these concerns and the fact that DCA no longer exists as a company, the NRC's Region III Office has requested that the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) perform a radiological survey of the former DCA site.

SITE DESCRIPTION

The DCA site is located at 11286 Grooms Road near the junction of I-275 and I-71 in the northeastern section of metropolitan Cincinnati, Ohio (Figure 1). The facility is comprised of four interconnected buildings occupying a total area of approximately 690 m^2 (7400 ft^2). Figure 2 shows the facility floor plan. The building is constructed with concrete slab floors, with either concrete,

cinder block, or sheet rock walls. Ten rooms/buildings were affected by source usage and were included in the final survey (Figure 2). These rooms/buildings occupy approximately 270 m^2 of the total floor space. These areas are rooms 1, 2, 3, 4, 5, 6, and 7 of Building 1; one room in Building 2; and all of Buildings 3 and 4 (Figures 3 through 11).

OBJECTIVES

The objectives of the radiological survey were to provide independent surveys and radiological data for use by the NRC in evaluating the radiological status of the DCA facility relative to the guidelines for release for unrestricted use.

DOCUMENT REVIEW

ESSAP reviewed the licensee's final survey report (DCA 1995). The documentation was reviewed to determine the appropriateness of the final status survey procedures and to determine the adequacy of the survey data.

SURVEY PROCEDURES

ESSAP personnel visited the DCA site on June 26 and 27, 1996 and performed visual inspections and independent measurements and sampling. Survey activities were conducted in accordance with a site-specific survey plan and the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 1996, 1995a and b). Additional information regarding survey and analytical instrumentation and procedures may be found in Appendices A and B.

REFERENCE GRID

ESSAP used the existing 1 m × 1 m grid system established by AHP on the floors and lower walls for referencing survey data. Measurement and sampling locations on ungridded surfaces were referenced to the floor or wall grid, or to prominent building features.

SURFACE SCANS

Surface scans for alpha, alpha plus beta, and gamma activity were performed over 100 percent of the floors and up to 50 percent of the lower walls (up to 2 m) of each affected room/building. Accessible overhead surfaces, where material may have settled or accumulated, were also scanned. Approximately five percent of the total overhead area was scanned. Scans were performed using gas proportional and NaI scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators. Locations of elevated direct radiation were marked for further investigation.

SURFACE ACTIVITY MEASUREMENTS

Initially, construction material specific backgrounds were determined in areas of similar construction but without a history of radioactive material use. ESSAP then selected, either randomly or based on surface scan results, a total of 62 floor and lower wall grid blocks (representing approximately ten percent of the grid blocks) and performed direct measurements for total alpha and beta activity in each selected grid block and at any locations of elevated direct radiation detected by surface scans. Direct measurements were also made at 20 locations on upper surfaces in the affected rooms/buildings. Direct measurements were performed using gas proportional detectors coupled to ratemeter-scalers. A smear sample was collected from each direct measurement location to determine removable gross alpha and gross beta activity. Figures 3 through 11 show measurement and sampling locations.

EXPOSURE RATE MEASUREMENTS

Background exposure rates were determined at six locations of similar construction but without a history of radioactive materials use (Figure 12). Exposure rate measurements were then performed at a total of 14 locations with a minimum of one measurement in each room/building surveyed (Figures 3 through 11). Exposure rate measurements were performed at 1 m above the surface using a pressurized ionization chamber (PIC).

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 1995c). Smear samples were analyzed for gross alpha and gross beta activity using a low-background proportional counter. Smear results 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 microroentgens per hour (μR/h).

The data generated was then compared with the NRC's residual surface activity and exposure rate guidelines for release for unrestricted use.

FINDINGS AND RESULTS

DOCUMENT REVIEW

Radiological data provided in the licensee's final status survey report was not in a format that could be directly compared with the guidelines for release for unrestricted use. Sufficient information also was not included in the document that permitted the reviewer to determine the adequacy and appropriateness of the final status survey procedures.

SURFACE SCANS

Surface scans identified one location of elevated direct alpha radiation on the west wall of Building 1, Room 5 (Figure 7). The total area affected by the elevated direct radiation was less than 200 cm^2. There were no other locations of elevated alpha, beta, or gamma activity detected.

SURFACE ACTIVITY LEVELS

Surface activity levels for the DCA facility are summarized in Table 1. Total surface activity levels ranged from less than 94 to 640 dpm/100 cm^2 for alpha and ranged from less than 310 to 600 dpm/100 cm^2 for beta. Removable activity levels were less than or equal to the minimum detectable concentrations (MDC) of the procedure which were 9 dpm/100 cm^2 for gross alpha and 15 dpm/100 cm^2 for gross beta.

EXPOSURE RATES

Facility exposure rates at 1 m above surfaces are presented in Table 2. Background exposure rates ranged from 9 to 12 μR/h. Exposure rates within the affected portions of the facility ranged from 8 to 10 μR/h.

COMPARISON OF RESULTS WITH GUIDELINES

Because DCA was licensed to possess a variety of radionuclides, the most restrictive guidelines for alpha and beta emitters were selected for data comparison—these are the NRC's guidelines for Am-241 and Sr-90 which are summarized in Appendix C (NRC 1987). The applicable residual alpha surface activity guidelines are:

Total Activity

100 dpm/100 cm^2, averaged over a 1 m^2 area

300 dpm/100 cm^2, maximum in a 100 cm^2 area

Removable Activity

20 dpm/100 cm^2, removable

The applicable residual beta surface activity guidelines are:

Total Activity

1,000 dpm/100 cm^2, averaged over a 1 m^2 area

3,000 dpm/100 cm^2, maximum in a 100 cm^2 area

Removable Activity

200 dpm/100 cm^2, removable

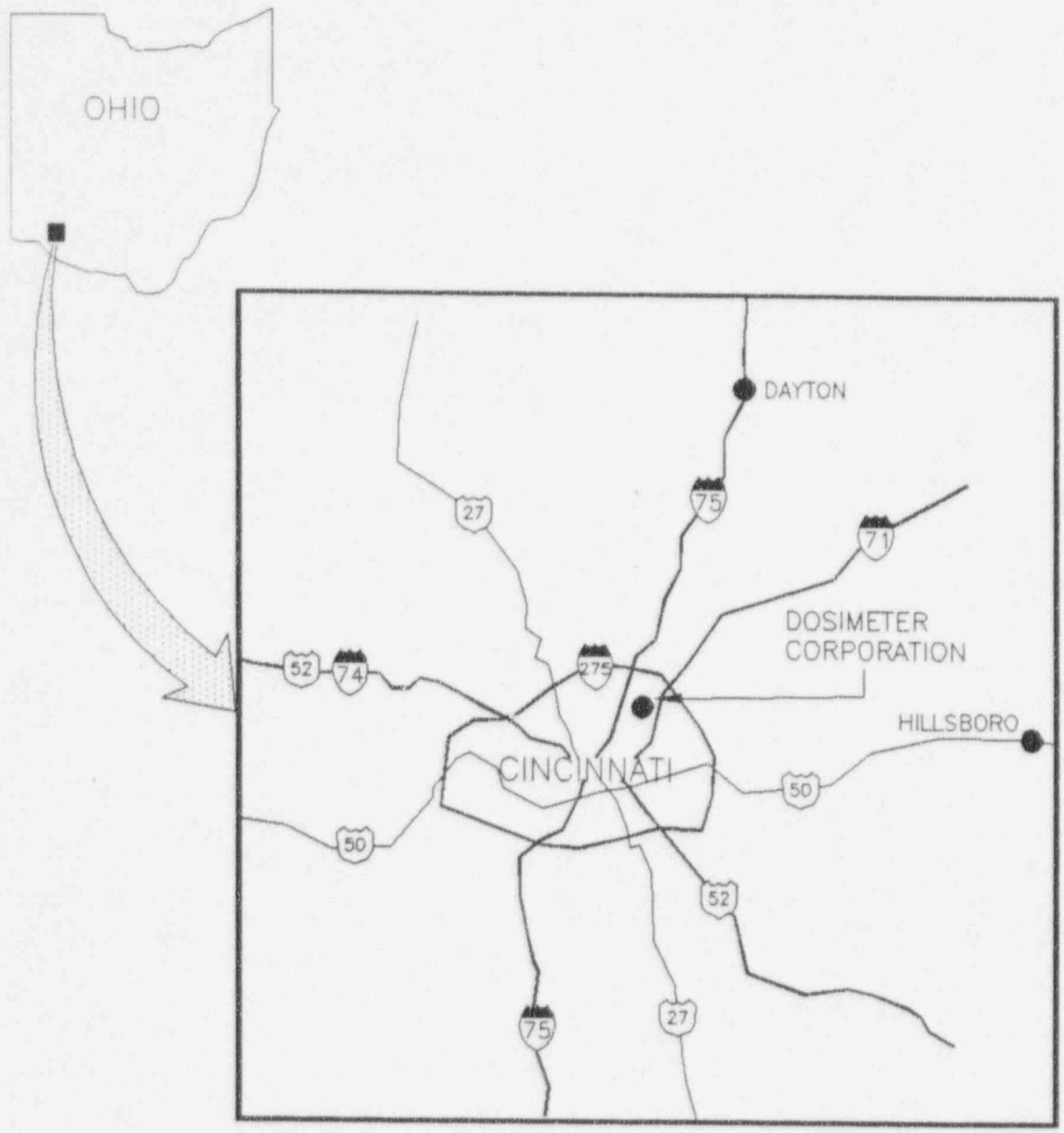
One measurement location on the west wall of Building 1, Room 5—with residual alpha activity of 640 dpm/100 cm^2—was in excess of the maximum allowable total surface activity guideline. All remaining alpha and beta surface activity levels were less than the respective average allowable guideline. In addition, removable activity levels were less than the guidelines.

The exposure rate guideline currently being used by the NRC is 5 μR/h above background (NRC 1991). Exposure rates for the facility were within this guideline.

SUMMARY

The Environmental Survey and Site Assessment Program of the Oak Ridge Institute for Science and Education performed a radiological survey of the former Dosimeter Corporation of America facility located in Cincinnati, Ohio. The procedures included independent document reviews, and during the period June 26 and 27, 1996, ESSAP personnel performed independent surface scans, total and removable surface activity measurements and sampling, and exposure rate measurements. The survey was performed in order to provide sufficient radiological data for use by the NRC in reevaluating the site's radiological status relative to the NRC's guidelines for release for unrestricted use.

The results of the survey identified one location of residual alpha contamination in excess of the NRC's maximum allowable surface activity guideline. However, based on extensive surface scans of the facility together with additional surface activity measurements, this area appears to be isolated and is not indicative of extensive contamination. Exposure rates within the facility were determined to be below the guideline.



NOT TO SCALE

FIGURE 1: Location of the Dosimeter Corporation of America Site

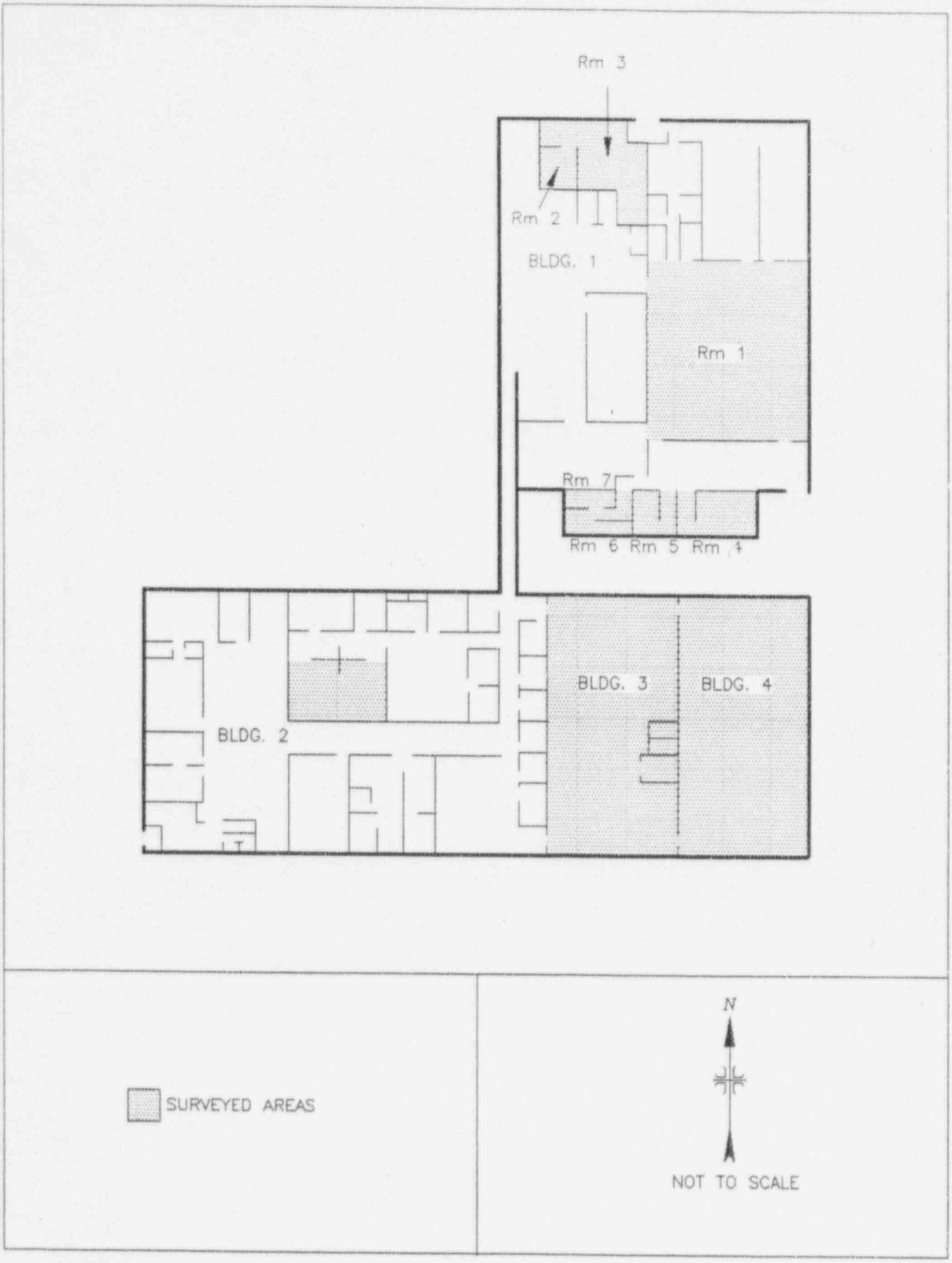
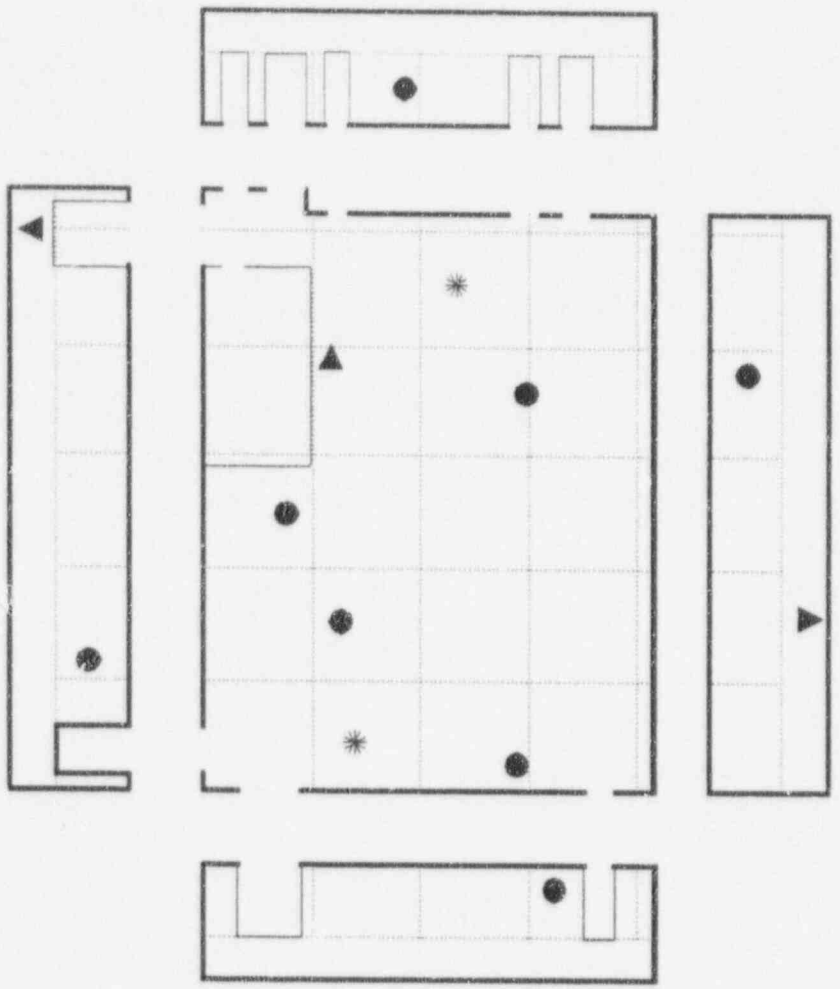


FIGURE 2: Dosimeter Corporation of America – Floor Plan and Surveyed Areas



MEASUREMENT/SAMPLING LOCATIONS

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

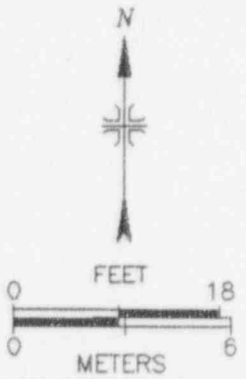


FIGURE 3: Building 1, Room 1 – Measurement and Sampling Locations

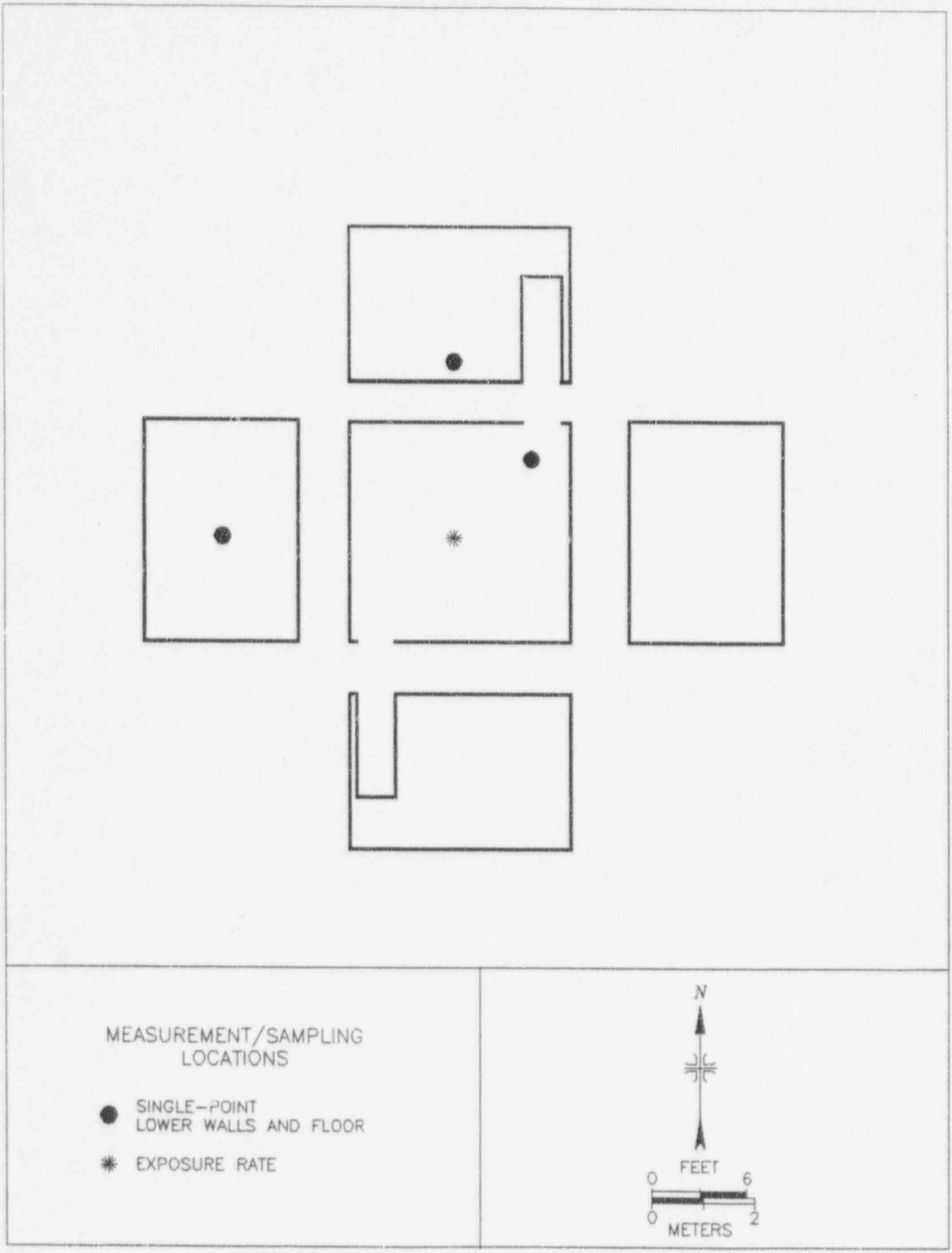


FIGURE 4: Building 1, Room 2 – Measurement and Sampling Locations

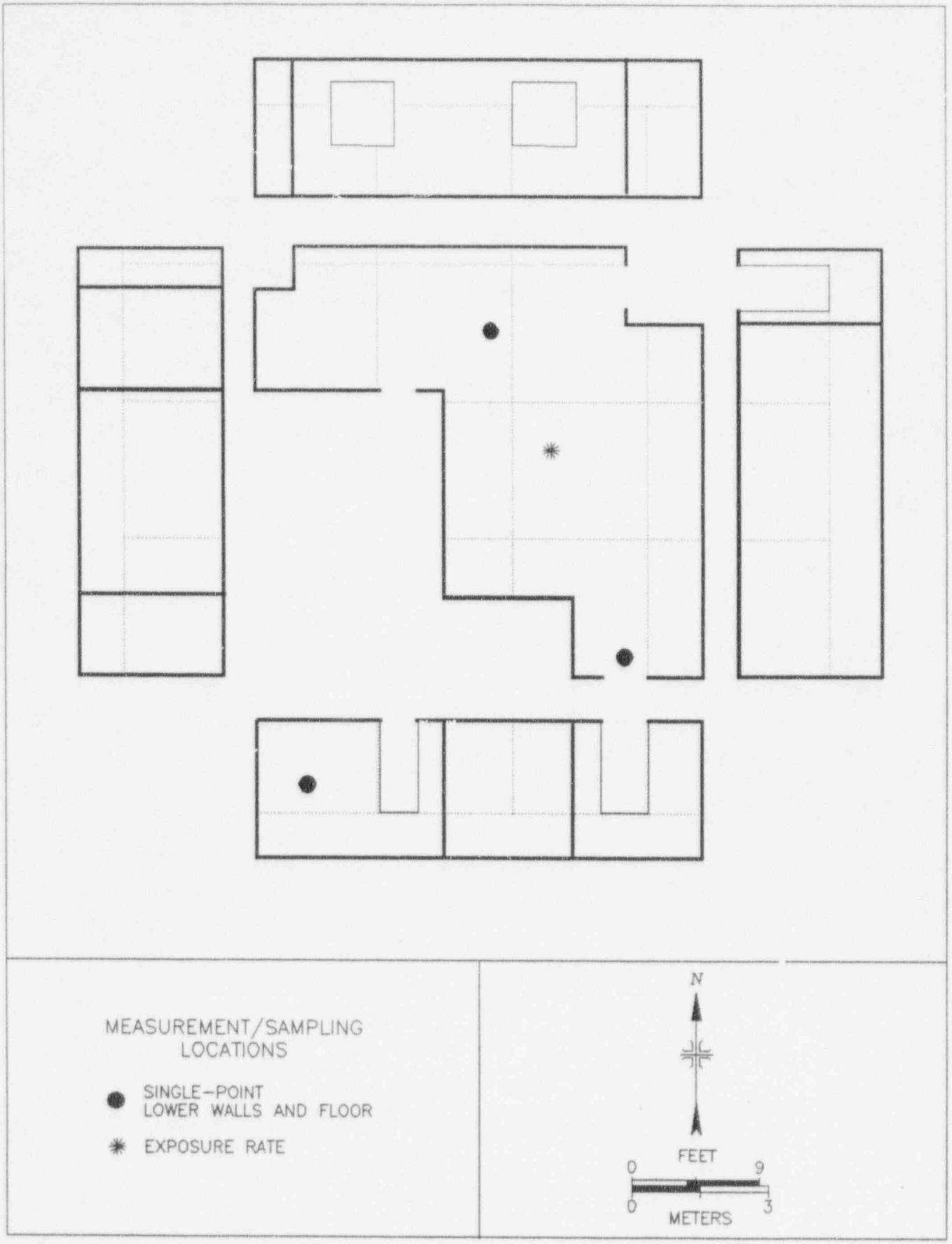


FIGURE 5: Building 1, Room 3 – Measurement and Sampling Locations

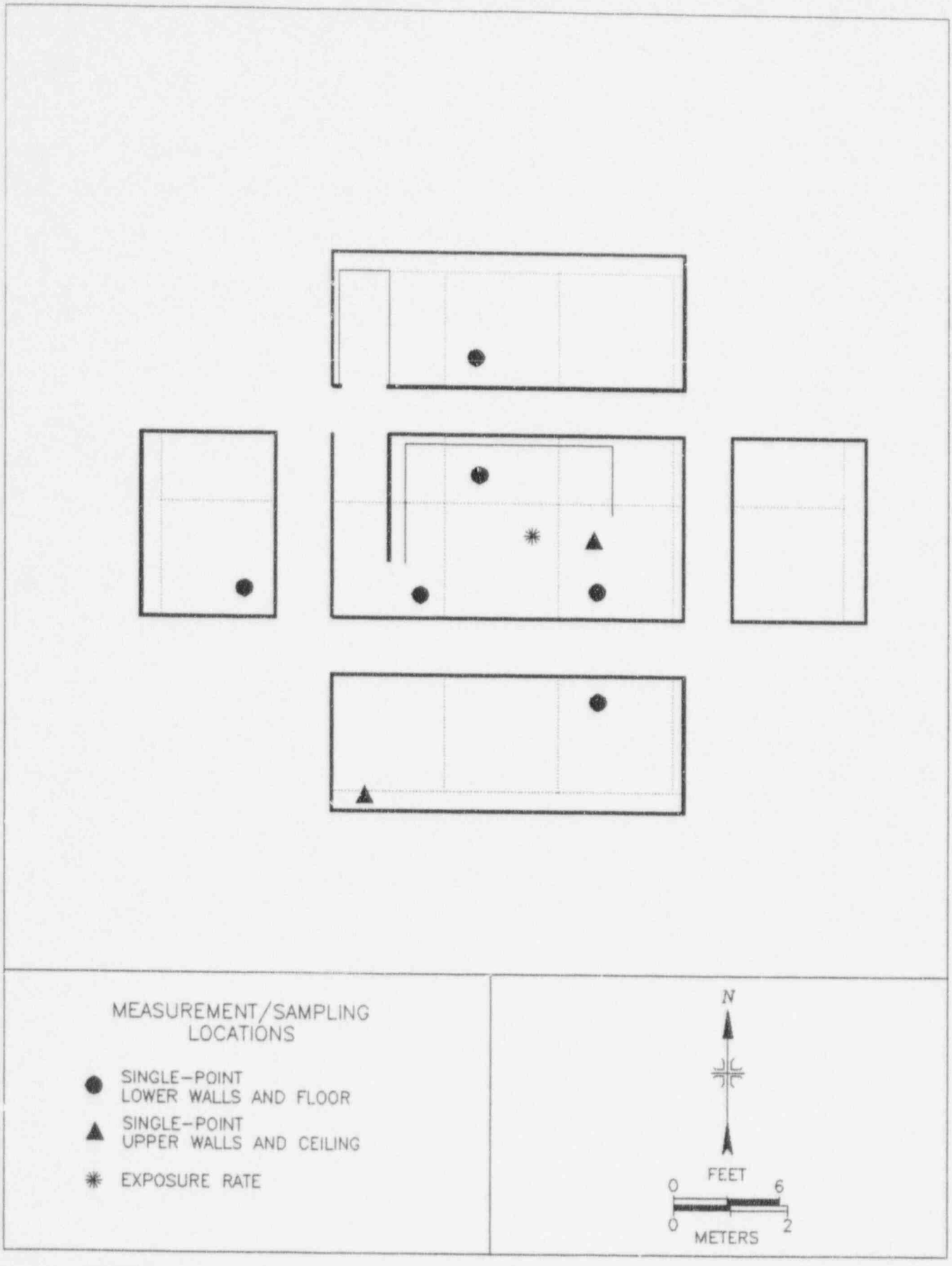
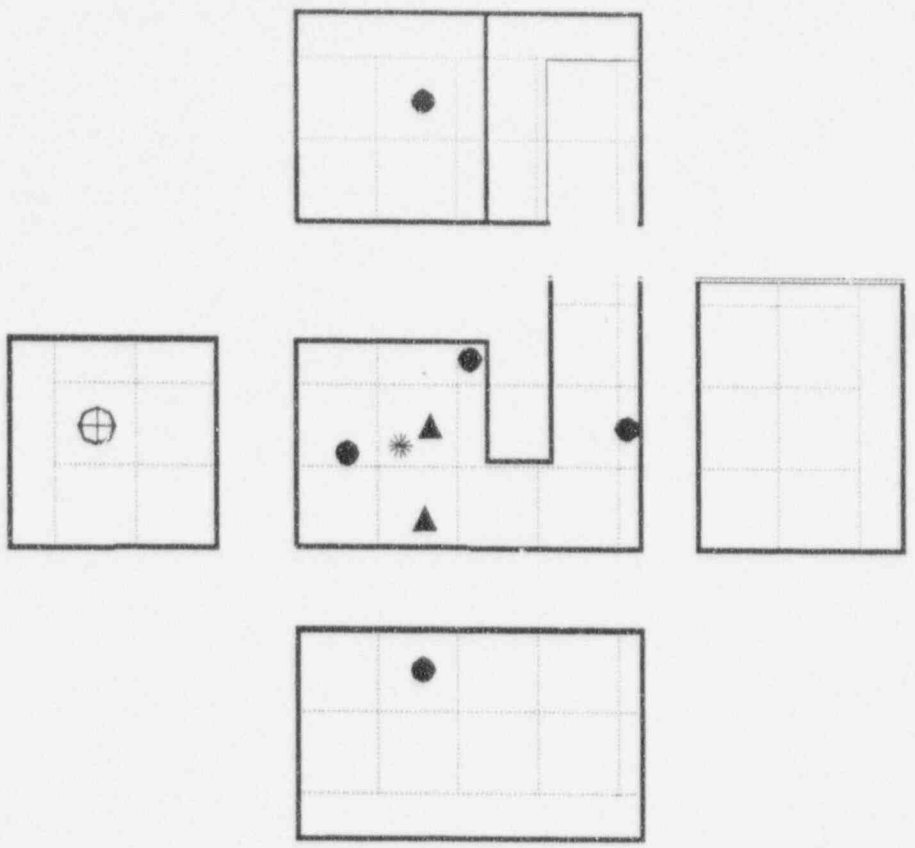


FIGURE 6: Building 1, Room 4 – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SINGLE-POINT LOWER WALLS AND FLOOR
- SINGLE-POINT > 300 dpm/100 cm^2 ALPHA
- SINGLE-POINT UPPER WALLS AND CEILING
- EXPOSURE RATE

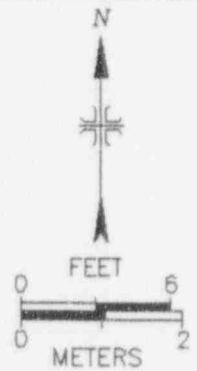
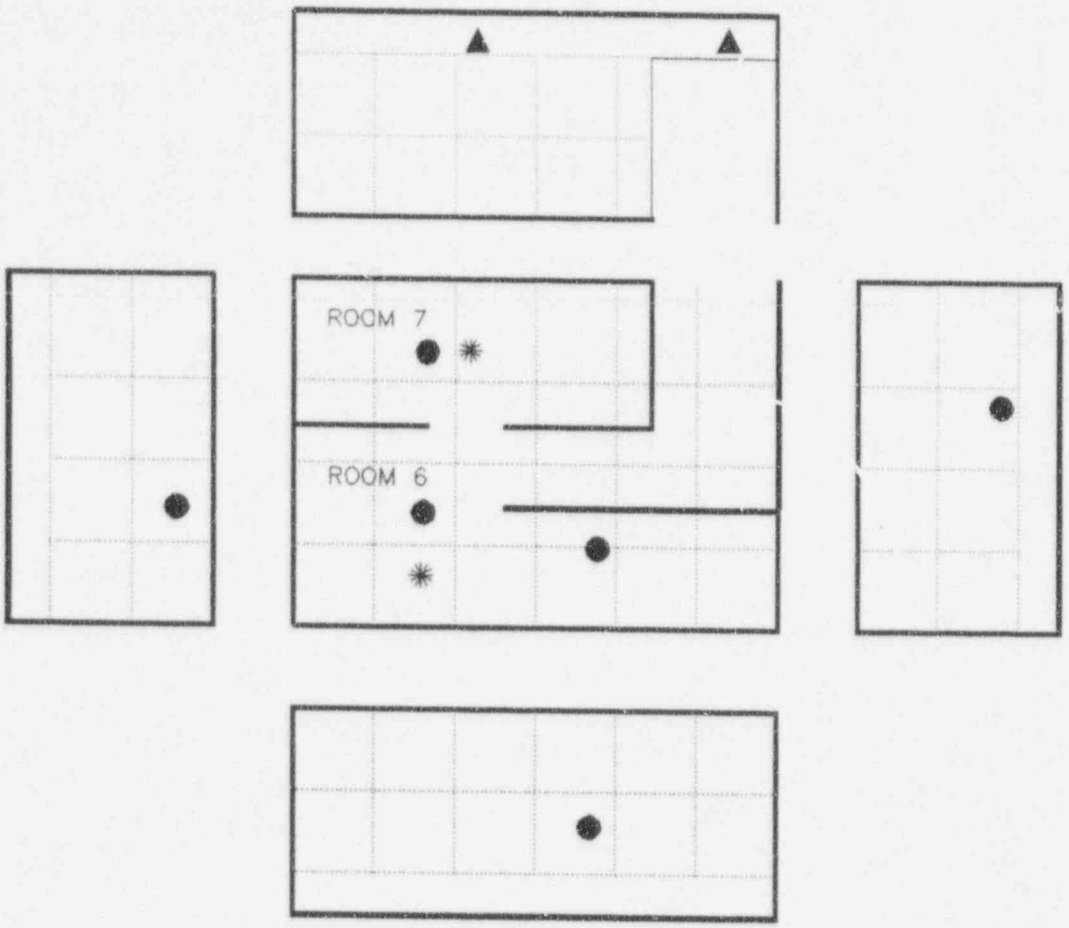


FIGURE 7: Building 1, Room 5 – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

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

FIGURE 8: Building 1, Rooms 6 & 7 – Measurement and Sampling Locations

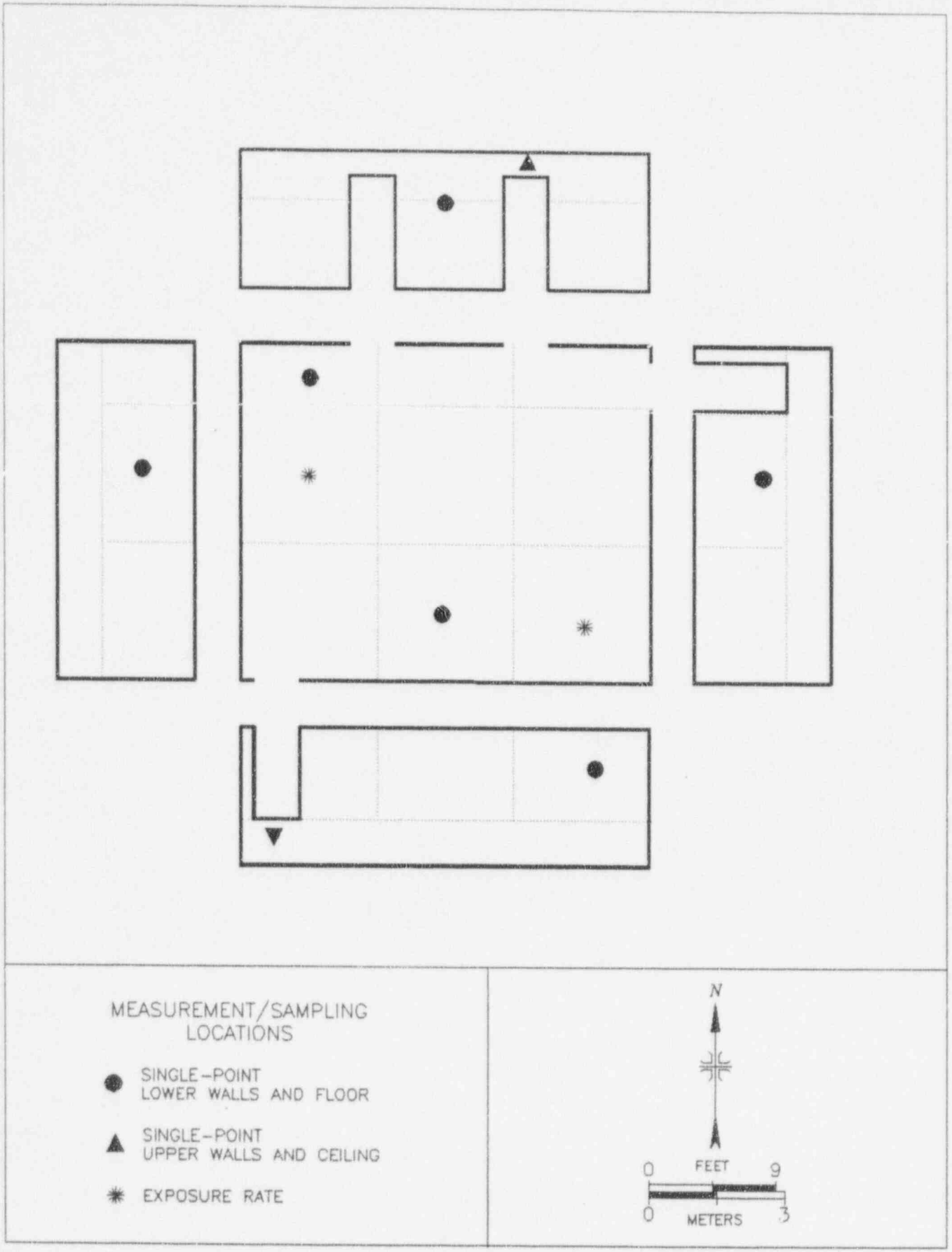


FIGURE 9: Building 2, Affected Area – Measurement and Sampling Locations

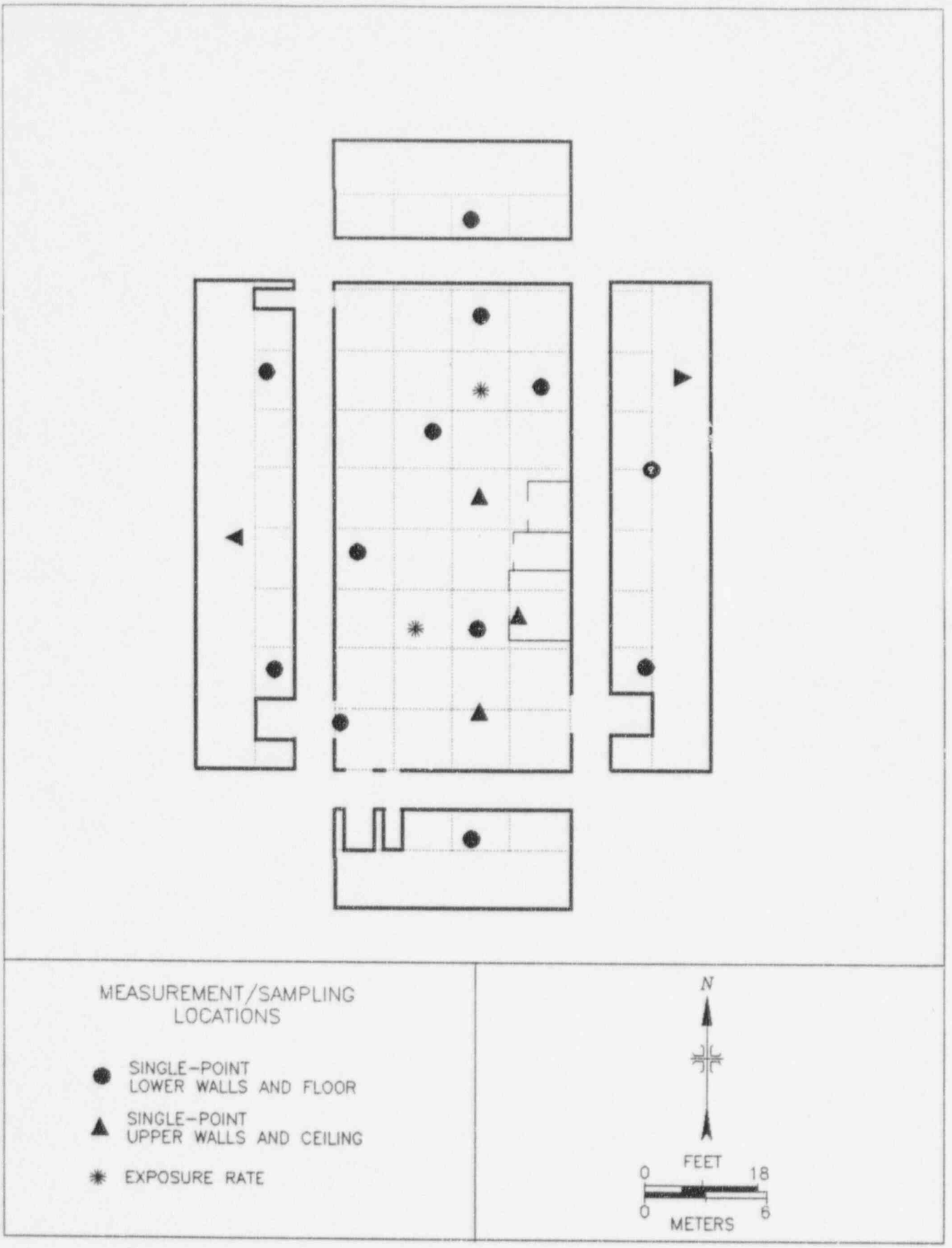


FIGURE 10: Building 3 – Measurement and Sampling Locations

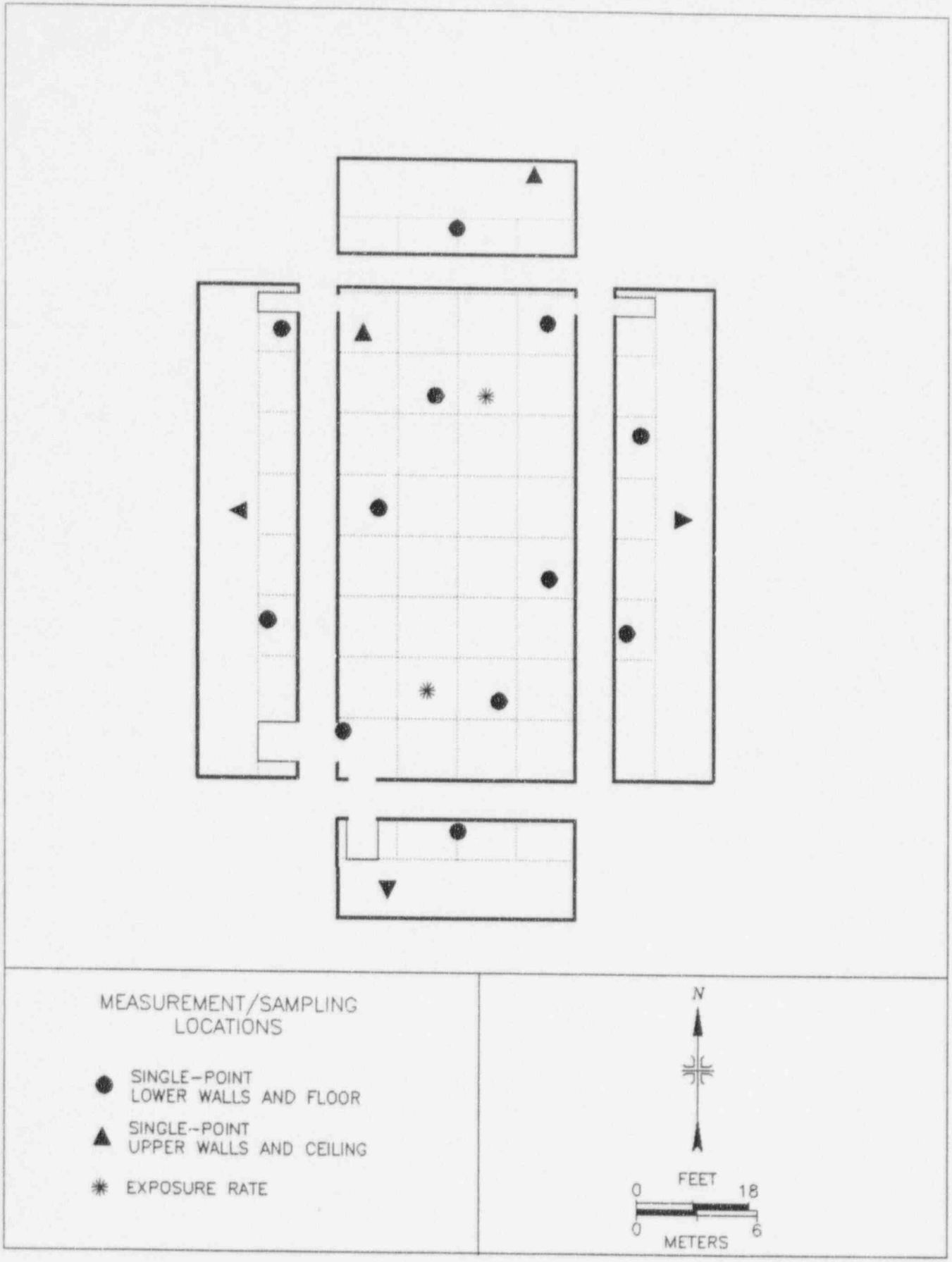


FIGURE 11: Building 4 – Measurement and Sampling Locations

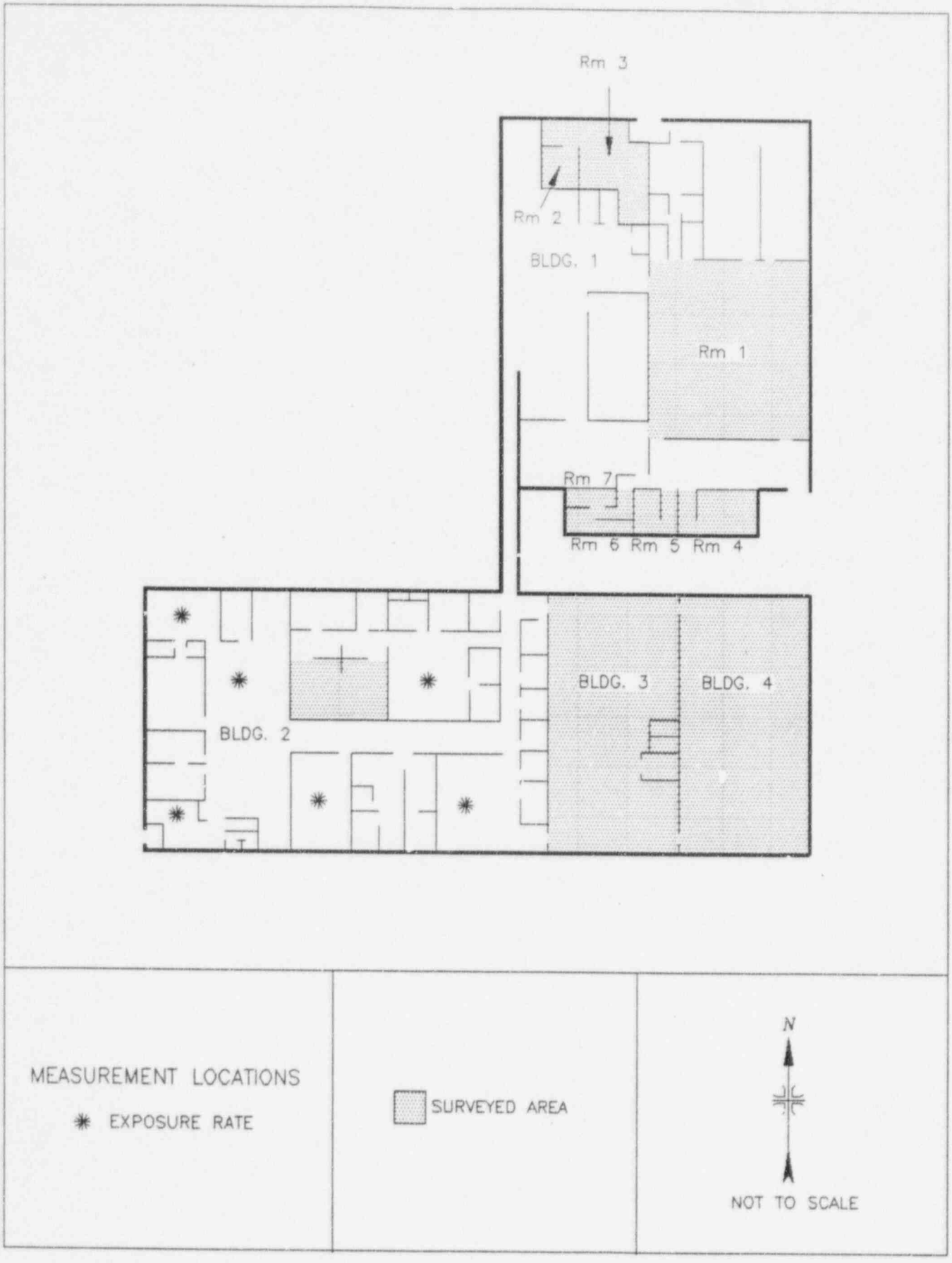


FIGURE 12: Dosimeter Corporation of America – Background Exposure Rate Measurement Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY LEVELS
FORMER DOSIMETER CORPORATION OF AMERICA SITE
CINCINNATI, OHIO

Location[a]	Number of Measurement Locations	Total Activity Range (dpm/100 cm^2)		Removable Activity Range (dpm/100 cm^2)	
		Single Point Measurement			
	Single-Point	Alpha	Beta	Alpha	Beta
BUILDING 1, ROOM 1					
Floor	4	<85	<240	<9	<15
Lower Wall	4	<61 to <94	<210 to <310	<9	<15
Upper Surfaces	3	<94	<310 to 600	<9	<15
BUILDING 1, ROOM 2					
Floor	1	<61	<210	<9	<15
Lower Wall	2	<61	<210	<9	<15
BUILDING 1, ROOM 3					
Floor	2	<61	<210	<9	<15
Lower Wall	1	<61	<210	<9	<15
BUILDING 1, ROOM 4					
Floor	3	<85	<240	<9	<15
Lower Wall	3	<85	<240	<9	<15
Upper Surfaces	2	<85	<240	<9	<15
BUILDING 1, ROOM 5					
Floor	3	<85	<240	<9	<15
Lower Wall	3	<85 to 640	<240	<9 to 9	<15
Upper Surfaces	2	<61	<210	<9	<15

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
FORMER DOSIMETER CORPORATION OF AMERICA SITE
CINCINNATI, OHIO

Location[a]	Number of Measurement Locations	Total Activity Range (dpm/100 cm²)		Removable Activity Range (dpm/100 cm²)	
		Single Point Measurement			
	Single-Point	Alpha	Beta	Alpha	Beta
BUILDING 1, ROOM 6 & 7					
Floor	3	<85	<240	<9	<15
Lower Wall	3	<94	<310	<9	<15
Upper Surfaces	2	<94	<310	<9	<15
BUILDING 2					
Floor	2	<61	<210	<9	<15
Lower Wall	4	<61	<210	<9	<15
Upper Surfaces	2	<61	<210	<9	<15
BUILDING 3					
Floor	6	<85	<240	<9	<15
Lower Wall	6	<94	<310	<9	<15
Upper Surfaces	5	<61	<210	<9	<15
BUILDING 4					
Floor	6	<85	<240	<9	<15
Lower Wall	6	<94	<310	<9	<15
Upper Surfaces	5	<94	<310	<9	<15

[a]Refer to Figures 3 through 11.

TABLE 2

EXPOSURE RATES
FORMER DOSIMETER CORPORATION OF AMERICA SITE
CINCINNATI, OHIO

Location[a]	Number of Measurements	Exposure Rates at 1 m Above Surface (μR/h)
Building 1, Room 1	2	9
Building 1, Room 2	1	9
Building 1, Room 3	1	9
Building 1, Room 4	1	9
Building 1, Room 5	1	8
Building 1, Room 6 & 7	2	8 to 9
Building 2	2	9
Building 3	2	10
Building 4	2	9 to 10
Building 2, Background	6	9 to 12

[a]Refer to Figures 3 through 12.

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

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

Detectors

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

Ludlum Gas Proportional Detector
Model 43-68
Effective 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

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. 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 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

Beta — gas proportional detector with ratemeter-scaler

Gamma — NaI scintillation detector with ratemeter

Surface Activity Measurements

Measurements of total alpha and beta activity levels were performed using gas proportional detectors with portable 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 4π efficiency 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 of similar construction and having no known radiological history. The alpha activity background count rates for the gas proportional detectors ranged from 5 cpm for sheet rock to 14 cpm for concrete block. Alpha efficiency factors were 0.17 for the gas proportional detectors calibrated to Th-230. The beta activity background count rates for the proportional detectors ranged from 240 cpm for sheet rock walls to 510 cpm for concrete block. The beta efficiency factor was 0.28 for the gas proportional detectors calibrated to Tc-99. The effective window for the gas proportional detectors 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 (PIC). The instrument is adjusted to one meter above the surface and allowed to stabilize. The measurement is read directly in μR/h.

ANALYTICAL PROCEDURES

Removable Activity

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

UNCERTAINTIES AND DETECTION LIMITS

The analytical data presented in the tables of this report represent the 95% confidence level for that data. These data were calculated based on both the gross sample count levels and the associated background count levels. Detection limits, refered to as minimum detectable concentration (MDC), were based on 2.71 + 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 and measurement efficiencies, the detection limits differ from sample to sample and instrument to instrument. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

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

APPENDIX C

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE OR SPECIAL NUCLEAR MATERIALS

APPENDIX C

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIALS

U.S. Nuclear Regulatory Commission
Division of Fuel Cycle & Material Safety
Washington, D.C. 20555

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The instructions in this guide, in conjunction with Table 1, specify the radionuclides and radiation exposure rate limits which should be used in decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. The limits in Table 1 do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release of such facilities or items from regulatory control is considered on a case-by-case basis.

1. The licensee shall make a reasonable effort to eliminate residual contamination.

2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table 1 prior to the application of the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or ductwork. Surfaces or premises, equipment, or scrap which are likely to be contaminated, but are such size, construction, or location as to make the surface inaccessible for purposes of measurement, shall be presumed to be contaminated in excess of the limits.

4. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to special circumstances such as razing of buildings, transfer from premises to another organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests must:

   a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent, and degree of residual surface contamination.

   b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations such as prospective use of the premises, equipment, or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

5. Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table 1. A copy of the survey report shall be filed with the Division of Fuel Cycle, Medical, Academic, and Commercial Use Safety, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, and also the Administrator of the NRC Regional Office having jurisdiction. The report should be filed at least 30 days prior to the planned date of abandonment. The survey report shall:

a. Identify the premises.

b. Show that reasonable effort has been made to eliminate residual contamination.

c. Describe the scope of the survey and general procedures followed.

d. State the findings of the survey in units specified in the instruction.

Following review of the report, the NRC will consider visiting the facilities to confirm the survey.

TABLE 1

ACCEPTABLE SURFACE CONTAMINATION LEVELS

Nuclides[a]	Average[b,c,f]	Maximum[b,d,f]	Removable[b,e,f]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/100 cm^2

[a]Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta- gamma-emitting nuclides 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 observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c]Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

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

[e]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f]The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h at 1 cm and 1.0 mrad/h at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.