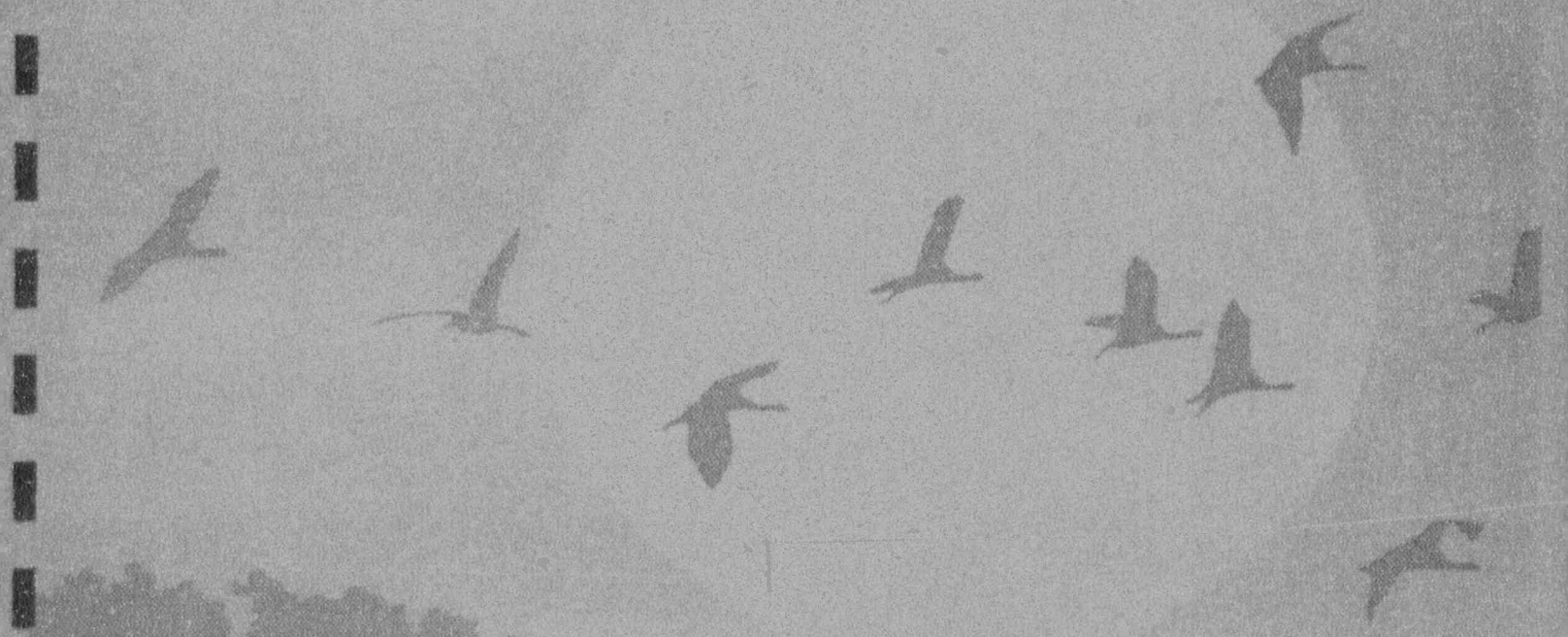
CONFIRMATORY SURVEY OF BUILDINGS 5,5A,6,6A,7,8,8A,9,11, AND 12 WESTINGHOUSE ELECTRIC CORPORATION LARGE, PENNSYLVANIA

[DOCKET 70-997]

E. W. ABELQUIST

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



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OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

Environmental Survey and Site Assessment Program
Energy/Environment Systems Division

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ORISE 93/K-143

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Sponsored by the

Office of Nuclear Materials Safety and Safeguards

NOVEMBER 1993

FINAL REPORT

This report is based on work performed under an Interagency Agreement (NRC Fin. No. A-9076) between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy. Oak Ridge Institute for Science and Education performs complementary work under contract number DE-AC05-76OR00033 with the U.S. Department of Energy.

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LARGE, PENNSYLVANIA

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ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

ASME	American Society of Mechanical Engineers
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
dpm/100 cm^2	disintegrations per minute/100 square centimeters
EML	Environmental Measurement Laboratory
EPA	Environmental Protection Agency
ESSAP	Environmental Survey and Site Assessment Program
ft	foot
GM	Geiger-Mueller
km	kilometer
m	meter
m^2	square meter
MDA	minimum detectable activity
MDL	Monitored Drain Line
NaI	sodium iodide
NERVA	Nuclear Engine for Rocket Vehicle Application
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
PIC	Pressurized Ionization Chamber
SNAP	Space Nuclear Advanced Propulsion
μR/h	microroentgen per hour
ZnS	zinc sulfide

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INTRODUCTION AND SITE HISTORY

The Westinghouse Electric Corporation established the Astronuclear Laboratory in 1959 as part of the NERVA (Nuclear Engine for Rocket Vehicle Application) program, and, by late 1961, the program was moved to the Large Site, where operations continued until the late 1960's. By 1972, this work had been completed and the process areas had been decontaminated. The fuel for this program was highly enriched uranium (93% U-235, by weight) and this project represents the major use of radioactive material on the site.

Other programs that used radioactive material at the Large Site include the SNAP 23A Isotope Powered Generation System (encapsulated Sr-90), the Artificial Heart-Blood Pump (encapsulated Pu-238), and the Heat Source Demonstration Project (encapsulated Co-60).

During the late 1970's through the 1980's, use of radioactive material on the site was very limited. In 1991, the decision was made to terminate the Nuclear Regulatory Commission (NRC) License No. SNM-951 [Docket No. 70-997] on the site. Initial decommissioning efforts were directed towards the removal of the Monitored Drain Line (MDL) system and this effort was successfully completed by late 1991. Following removal of the Monitored Drain Line system, the trenches were backfilled and covered as appropriate. Preliminary surveys of the buildings were conducted in early 1992 and the final survey of the buildings and site grounds was completed in June 1993.

The results of the licensee's final radiological survey were submitted to the NRC from January through July 1993 as surveys were completed for a given section of the facility. At the request of the NRC's Region I Office, the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute of Science and Education (ORISE) conducted an independent confirmatory survey of Buildings 5, 5A, 6, 6A, 7, 8, 8A, 9, 11, and 12 and outdoor areas,

during the period of August 30 through September 2, 1993. This report summarizes the procedures and results of the survey.

SITE DESCRIPTION

The Westinghouse Site is located in Large, Pennsylvania (Figure 1). Pennsylvania State Route 51 runs along the south side of the site. Two streams, Lewis Run and Peters Creek, run along the edge of the Large Site and join just south of the site. Peters Creek flows northward along the eastern side of the site. There are two storm sewer outfalls from the site into this creek. Lewis Run flows eastward along the southern side of the site and one storm sewer outfall from the site empties into this stream. The site is generally level with a slight downward slope towards Peters Creek. Behind the buildings is a steep embankment which rises well above the height of all the buildings.

Buildings 5, 5A, 6, 6A, 7, 8, 8A, and 9 (Figure 2) are all interconnected and have been used for various operations throughout their history. Building 11 is located south of Building 5 and there has been no known use of radioactive material in this building. Building 12 is adjacent to Building 5A and is currently being used as a machine shop. The surveyed buildings constitute approximately 25,000 m^2 of floor space and the area of the site grounds included in the survey is approximately 50,000 m^2. A storm drain system, consisting of a long catch basin that spans the width of each building, runs beneath Buildings 5, 6, and 8. The first floor of Building 9 contains a system of concrete trenches (pipe chases) in the floor covered by steel plates. These pipe chases contained various service and process piping lines, including the MDL piping for the building. Most of the buildings are occupied and not all of the building areas were accessible to survey.

OBJECTIVE

The objective of the confirmatory survey is to provide independent document reviews and radiological data for use by the NRC in evaluating the adequacy and accuracy of the licensee's radiological status report relative to established guidelines.

DOCUMENT REVIEW

ESSAP reviewed the licensee's documentation associated with the decommissioning survey and analytical procedures and methods utilized by the licensee were reviewed for adequacy and appropriateness.[1] The post-remedial action data were reviewed for accuracy and completeness.

PROCEDURES

During the period from August 30 through September 2, 1993, ESSAP performed a confirmatory survey of Buildings 5, 5A, 6, 6A, 7, 8, 8A, 9, 11, and 12 and the outdoor areas. The survey was conducted in accordance with a survey plan that was submitted to and approved by the NRC, Region I Office.[2] The hydrogen facility was not surveyed because it had been demolished and paved over prior to ESSAP's arrival. The survey of outdoor areas included the main storm drain catch basin (east parking lot), storm drain outfall to Peters Creek, and areas adjacent to the fenceline that surrounds the site.

INTERIOR

ESSAP used the following procedures for the interior portions of the survey.

Reference Grid

The existing 1 m^2 reference grid established by the licensee was used by ESSAP for survey reference. The licensee's reference system included (1) a section identifier that specifically located the survey area by building and floor, and (2) survey unit and subunit identifiers that specified a particular room or building area. The point of origin for floors and ceilings was the northwest corner of the surface and the upper left corner for walls. The survey point locations were measured from the point of origin and given X and Y dimensions (in meters) with the same signs as the standard Cartesian coordinate system (e.g., typical survey point locations were positive in the X direction and negative in the Y direction).

The measurement and sampling locations for the Monitored Drain Line system and pipe chases were consistently numbered by defining the zero point to be the north or east end of that section. Distances (in meters) were then measured from that point towards the south or west as appropriate.

Surface Scans

Floor and lower wall surfaces were scanned for alpha, beta, and gamma activity using large-area gas proportional and NaI scintillation detectors. A 100% floor scan was performed on the first floors of Buildings 5, 6, 6A, 7, 8A, and 9 and the tank pit in Building 9. Scans of the pipe chases and other areas not accessible with the large-area detectors were performed using smaller hand-held detectors. All detectors were coupled to ratemeter-scalers or ratemeters with audible indicators. Locations of elevated direct radiation identified by surface scans were marked for further investigation.

Surface Activity Measurements

Measurements to determine total alpha and beta surface activity levels were performed on randomly selected grid locations on the floor and lower walls in each of the areas surveyed. Approximately 500 direct measurements were performed in the surveyed areas. Direct measurements were performed using ZnS scintillation and thin-window GM detectors, coupled to ratemeter-scalers. A smear sample for determining removable activity was obtained at each direct measurement location. Measurement and sampling locations for total and removable activity are illustrated in Figures 3 through 22.

Exposure Rate Measurements

Background exposure rate measurements at 1 m above the surface, were obtained from locations within Building 4 and the Firehouse. These buildings exhibit similar construction as the surveyed buildings and their site history indicates no use of radiological materials. Exposure rate measurements were performed at one meter above surfaces at 23 interior locations using a

pressurized ionization chamber (PIC). Measurement locations are shown in Figures 3 through 22.

Miscellaneous Sampling

Twenty soil samples were selected for confirmatory analysis from those collected and archived by the licensee from the monitored drain line system remediation (Figure 23).

A smear sample was collected by passing cloth media through a section of pipe running between Buildings 6 and 6A. This pipe was from a section of the MDL that was left in place. A section of this pipe, approximately one foot long, was cut in half by the licensee and provided to ESSAP for survey measurements (i.e., direct measurements and smears).

EXTERIOR

ESSAP used the following procedures for outdoor portions of the survey area.

Reference Grid

ESSAP measurement and sampling locations were referenced to prominent site features and recorded on appropriate drawings.

Surface Scans

Surface scans of outdoor locations were performed using NaI scintillation detectors, coupled to ratemeters with audible indicators. Areas of elevated direct radiation, suggesting the presence of surface or near surface contamination, were marked for further investigation.

Exposure Rate Measurements

Background exposure rate measurements were made at 6 off-site locations within 0.5 to 10 km of the site using a PIC. Measurement locations are indicated on Figure 24.

Exposure rate measurements were performed at 1 meter above the surface at each soil sampling location using a PIC. Measurement locations are indicated on Figure 25.

Soil Sampling

Background soil samples were collected from 6 off-site locations within 0.5 to 10 km of the site. Measurement locations are indicated on Figure 24.

Surface soil (0-15 cm) samples were collected from 6 randomly selected locations around the site (Figure 25). Additionally, an archived soil sample was selected from the east parking lot area where packaged radioactive waste was staged.

Miscellaneous Sampling

Sediment samples were collected from the main storm drain outfall to Peters Creek and from the storm drain catch basin in the east parking lot. Sampling locations are shown in Figure 25.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and survey data were returned to the ESSAP Oak Ridge laboratory for analyses and interpretation. Smears were analyzed for gross alpha and gross beta activity. Direct measurement and smear data were converted to units of disintegrations per minute per 100 cm^2 (dpm/100 cm^2), and exposure rate measurements were reported in microroentgens per hour (μR/h). Soil and miscellaneous samples were analyzed by gamma spectrometry and/or alpha spectrometry. Spectra were reviewed for U-235, U-238, and any other identifiable photopeaks. Soil sample results were reported in units of picocuries per gram (pCi/g). Additional

information concerning major instrumentation, sampling equipment, and analytical procedures is provided in Appendices A and B. Results were compared to NRC guidelines which are provided in Appendix C.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP reviewed the licensee's radiological survey data and comments were provided to the NRC.[3,4,5] The licensee provided the NRC with a response to those comments made in references 3 and 4. The ESSAP comments expressed in Reference 5 were forwarded to NRC Headquarters for resolution. In ESSAP's opinion, the licensee's documents provide an adequate description of the radiological condition of the facility relative to the NRC guidelines for release to unrestricted use.

INTERIOR

Surface Scans

Surface scans identified two locations of elevated direct radiation at the following locations: the floor on the first floor of Building 6 (13,000 beta dpm/100 cm^2) and adjacent to the pipe chase in Room 10-3-1 of Building 9 (23,000 beta dpm/100 cm^2). The licensee remediated each location by scabbling. ESSAP then performed post-remedial action scans and direct measurements to confirm the decontamination.

Surface Activity Levels

Results of total and removable surface activity levels are summarized in Table 1. Total activity measurements ranged from <69 dpm/100 cm^2 to 3000 dpm/100 cm^2 for alpha and <1400 dpm/100 cm^2 to 4800 dpm/100 cm^2 for beta. Grid block averages were determined for the two direct measurements within the pipe chases that exceeded 5000 dpm/100 cm^2 beta

activity. The grid block averages for alpha were 260 and 1000 dpm/100 cm^2, and for beta activity were 2700 and 2900 dpm/100 cm^2. Removable activity ranged from <12 to 300 dpm/100 cm^2 for alpha and from <16 to 67 dpm/100 cm^2 for beta.

Exposure Rate Measurements

The background exposure rates averaged 9 μR/h.

Exposure rate measurements are summarized in Table 2. The measurements ranged from 7 μR/h to 13 μR/h.

Uranium Concentrations in Archived MDL Soil Samples

Concentrations of U-235, U-238, and total uranium measured by ESSAP in MDL soil samples (collected by the licensee and provided to ESSAP for confirmatory analysis) ranged from 0.1 to 2.3 pCi/g, 0.1 to 3.2 pCi/g, and 3.0 to 69.0 pCi/g, respectively (Table 3). Based on a paired comparison *t*-test, there are no statistically significant differences ($p = 0.6$) between the licensee's and the ESSAP gamma spectrometry data for U-235 (licensee U-238 concentrations were not available for all soil samples).

Four MDL soil samples were analyzed by alpha spectrometry to evaluate the appropriateness of the total-uranium-to-U-235 ratio established by the licensee (Table 4). The uranium activity in these samples was not sufficient to establish such a ratio. The ratio of total uranium to U-235 (30) established by the licensee appears to be a reasonable value in calculating total uranium concentrations based on knowledge of the material used and the ESSAP limited soil results.

Miscellaneous Samples

Results of gross alpha and gross beta activity on the smear taken from inside the section of pipe between Buildings 6 and 6A was <12 dpm/100 cm^2 for alpha and <16 dpm/100 cm^2 for beta.

Review of the gamma spectrometry data resulted in no identifiable photopeaks other than those from naturally occurring radionuclides.

Direct measurements on fragments removed from the pipe were < 78 and < 1400 cpm/100 cm^2, for alpha and beta activity, respectively. Removable activity on the pipe fragments was < 12 dpm/100 cm^2 for alpha and < 16 dpm/100 cm^2 for beta.

EXTERIOR

Surface Scans

Surface scans for gamma activity were within the range of ambient background levels.

Exposure Rate Measurements

Background exposure rates for outdoor areas ranged from 8 to 9 μR/h and averaged 9 μR/h (Table 5).

Exposure rate measurements for on-site outdoor areas are presented in Table 6. On-site exposure rates ranged from 9 to 11 μR/h.

Uranium Concentrations in Soil Samples

Total uranium concentration in background soil samples ranged from 2.4 to 4.8 pCi/g (Table 5).

Uranium concentrations in soil samples collected from around the site are presented in Table 7. Concentrations of U-235, U-238, and total uranium in samples collected from the site area ranged from 0.1 to 0.3 pCi/g, 1.1 to 2.9 pCi/g, and 3.0 to 9.0 pCi/g, respectively.

Miscellaneous Samples

The uranium concentrations in the two sediment samples were 1.2 pCi/g for U-238 for both samples, 0.2 to 0.4 pCi/g for U-235, and 6.0 and 12.0 pCi/g for total uranium. Since only two samples were collected, the results do not appear in a separate table.

COMPARISON OF RESULTS WITH GUIDELINES

The NRC guidelines for surface contamination and residual concentrations of radionuclides in soil, established for license termination or release of a facility for unrestricted use are presented in Appendix C. The primary contaminant of concern at this site is enriched uranium. The surface contamination guidelines for natural uranium, U-235, U-238 and associated decay products are:[6]

Total Activity

5,000 α dpm/100 cm^2, averaged over a 1 m^2 area

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

Removable Activity

1,000 α dpm/100 cm^2

Surface activity measurements for total and removable activity in all interior areas surveyed were within these guidelines.

The soil concentration guideline for enriched uranium is 30 pCi/g above natural background.[7] With one exception (MDL pit behind Building 5, NW corner; 69.0 pCi/g), the uranium concentrations in soil samples collected were within this limit. This same soil sample was also analyzed by alpha spectrometry and determined to have a total uranium concentration of 21.3 pCi/g (Table 4). The reason for this difference is unknown; however, it is believed to be the result of incomplete sample homogenization prior to alpha spectroscopy analysis.

The NRC guideline for exposure rate at 1 m above the surface is 5 μR/h above background.[8] All interior and exterior exposure rates were within this limit.

SUMMARY

During the period August 30 through September 2, 1993, at the request of the NRC Region I Office, the Environmental Survey and Site Assessment Program of ORISE performed a confirmatory survey of Buildings 5, 5A, 6, 6A, 7, 8, 8A, 9, 11, and 12 and outdoor areas at the Westinghouse Electric Corporation in Large, Pennsylvania. The interior survey activities consisted of surface scans of the floor and lower wall surfaces for alpha, beta, and gamma activity, measurements of total and removable activity, exposure rate measurements, soil and miscellaneous sampling. Exterior survey activities included gamma surface scans, exposure rate measurements, and soil and sediment sampling.

Total and removable surface activity measurements were all below the guideline values. Interior and exterior exposure rate measurements were all within the 5 μR/h above background criterion.

The total uranium concentration in soil and sediment samples, with one exception, was below the guideline value of 30 pCi/g. The total uranium concentration in the soil sample collected below the northwest corner of the MDL pit was determined to be 69.0 pCi/g by gamma spectrometry.

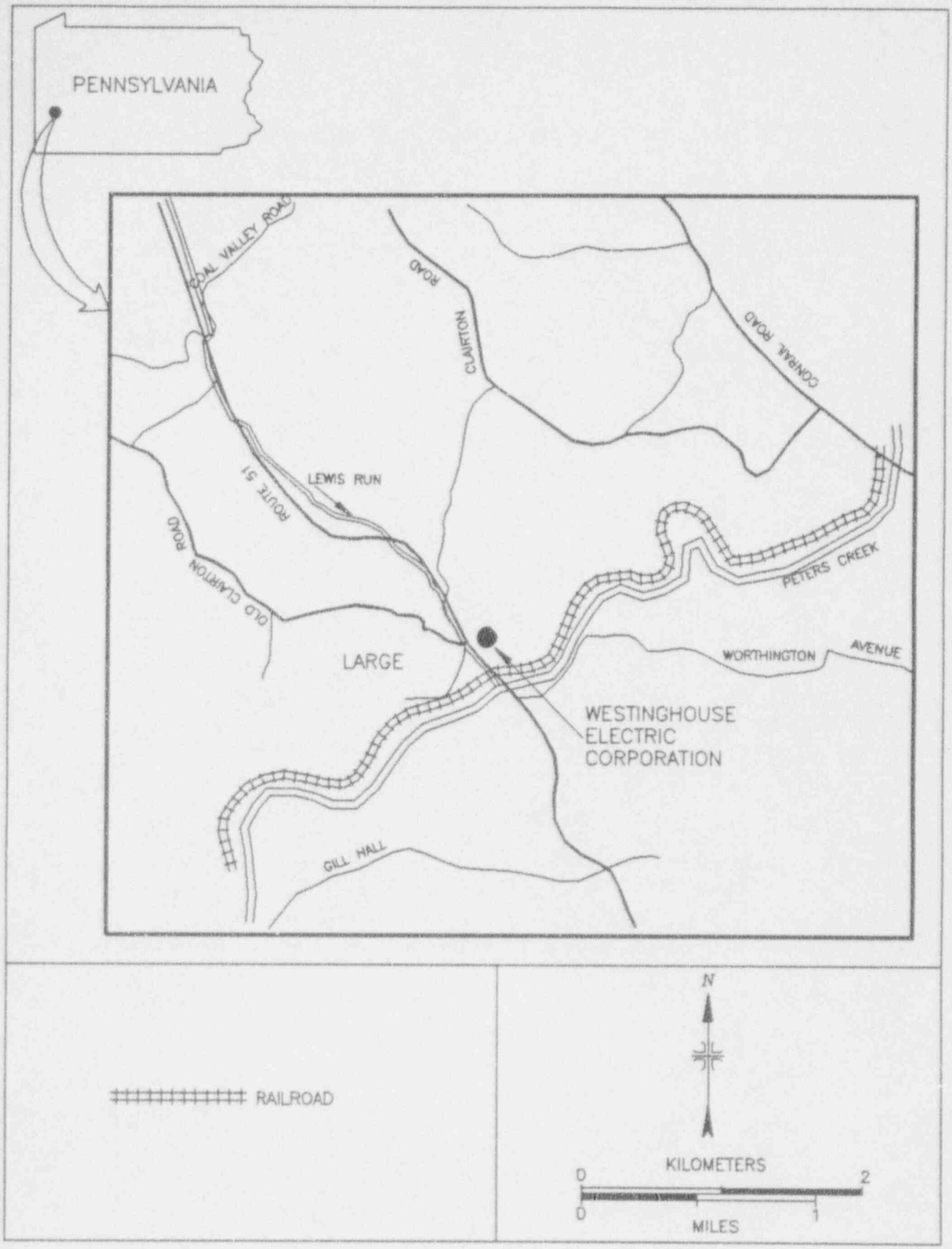


FIGURE 1: Location of the Westinghouse Electric Corporation, Large, Pennsylvania

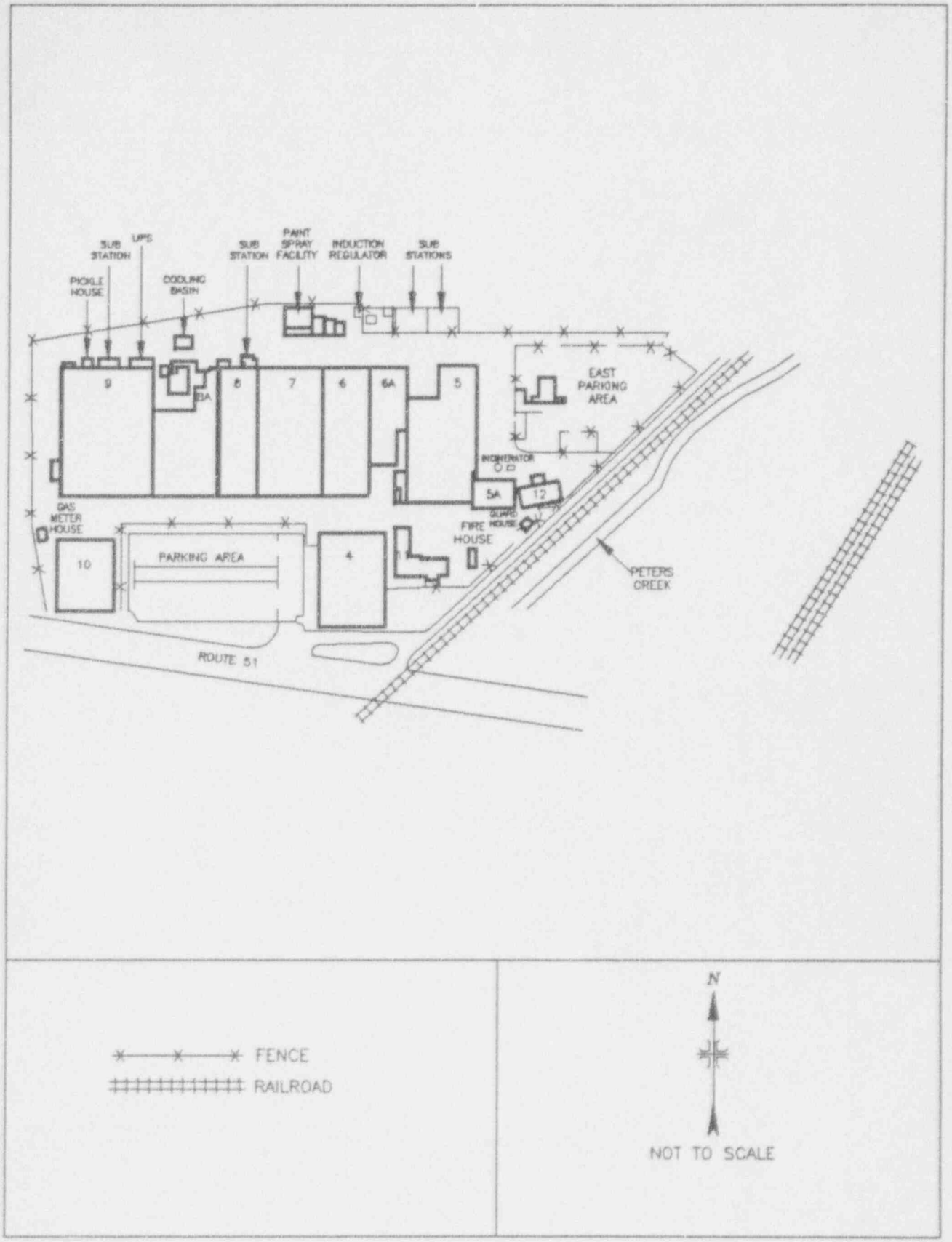
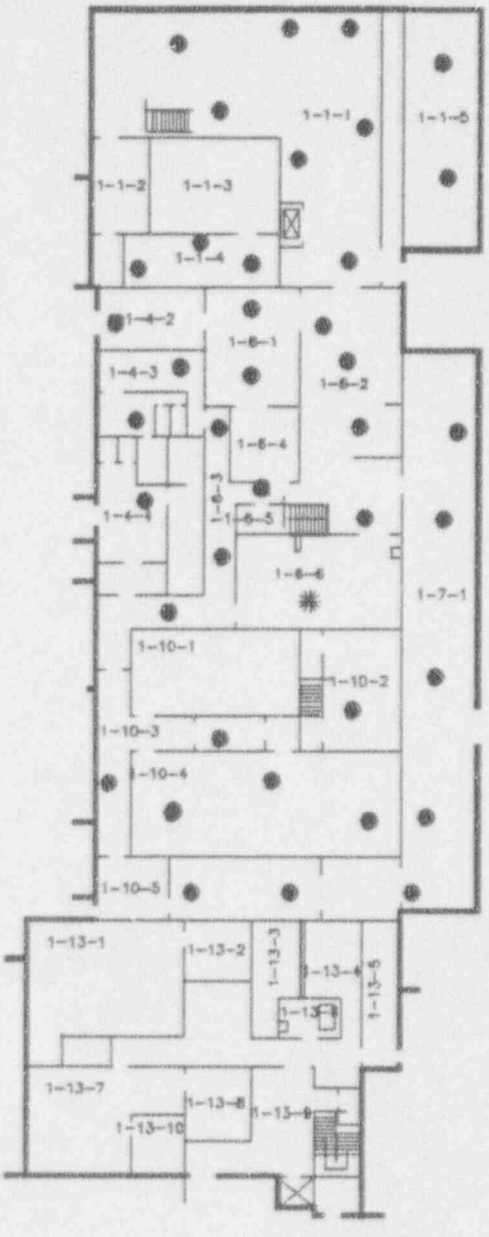


FIGURE 2: Site Plot Plan



MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY LOWER WALLS AND FLOOR
- EXPOSURE RATE

N

FEET
0 20
0 6
METERS

FIGURE 3: Building 5, First Floor, Eastern Portion – Measurement and Sampling Locations

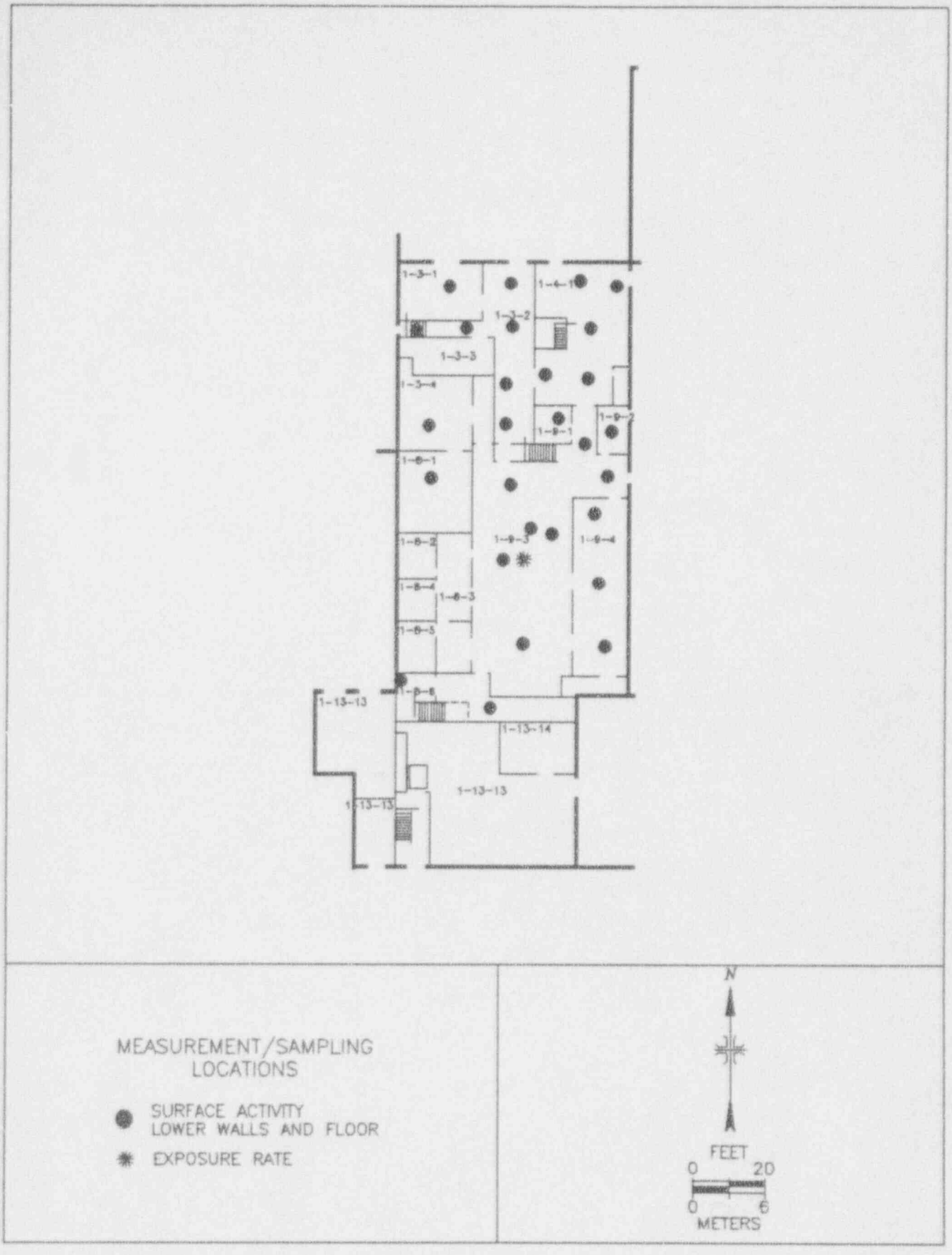


FIGURE 4: Building 5, First Floor, Western Portion – Measurement and Sampling Locations

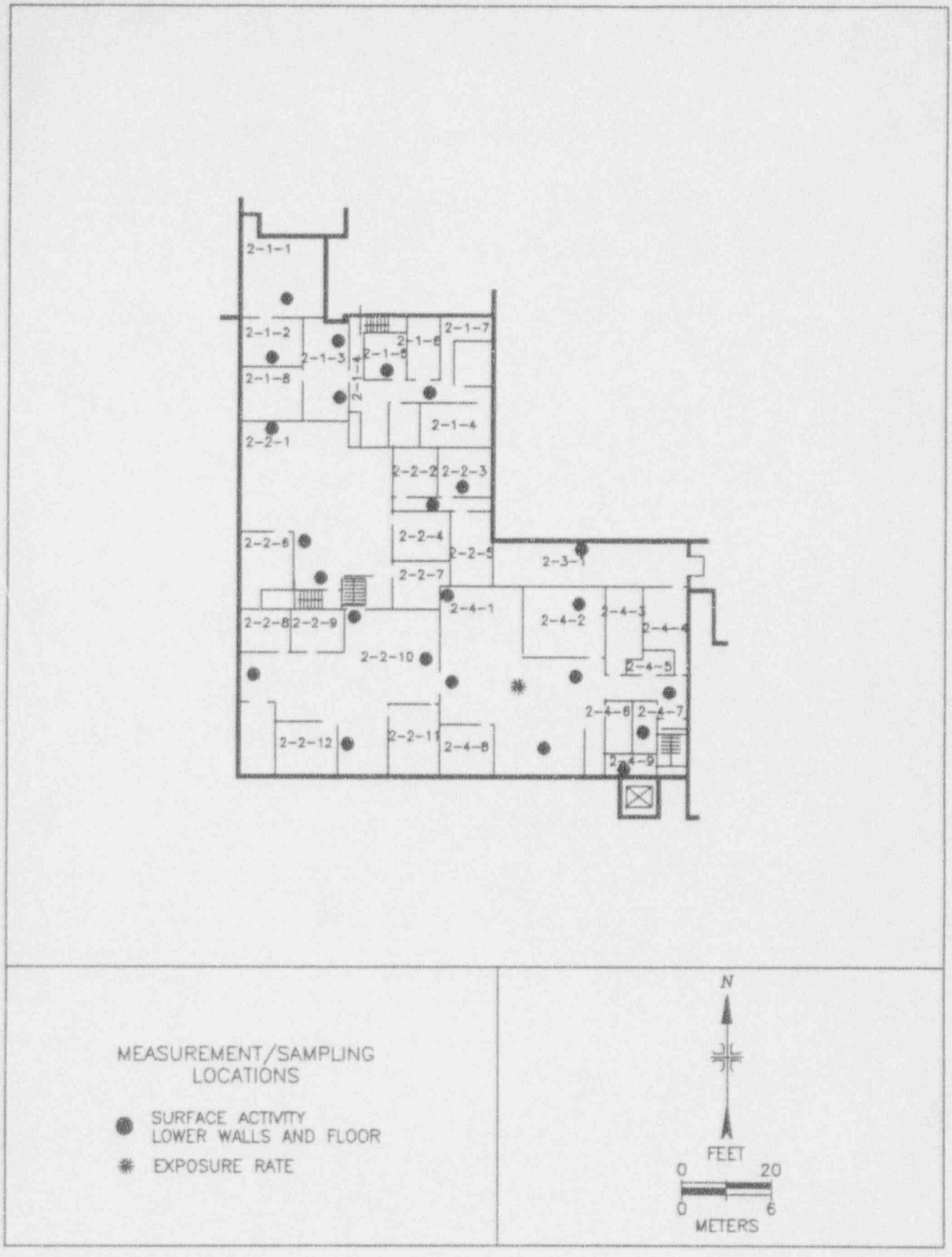


FIGURE 5: Building 5, Second Floor – Measurement and Sampling Locations

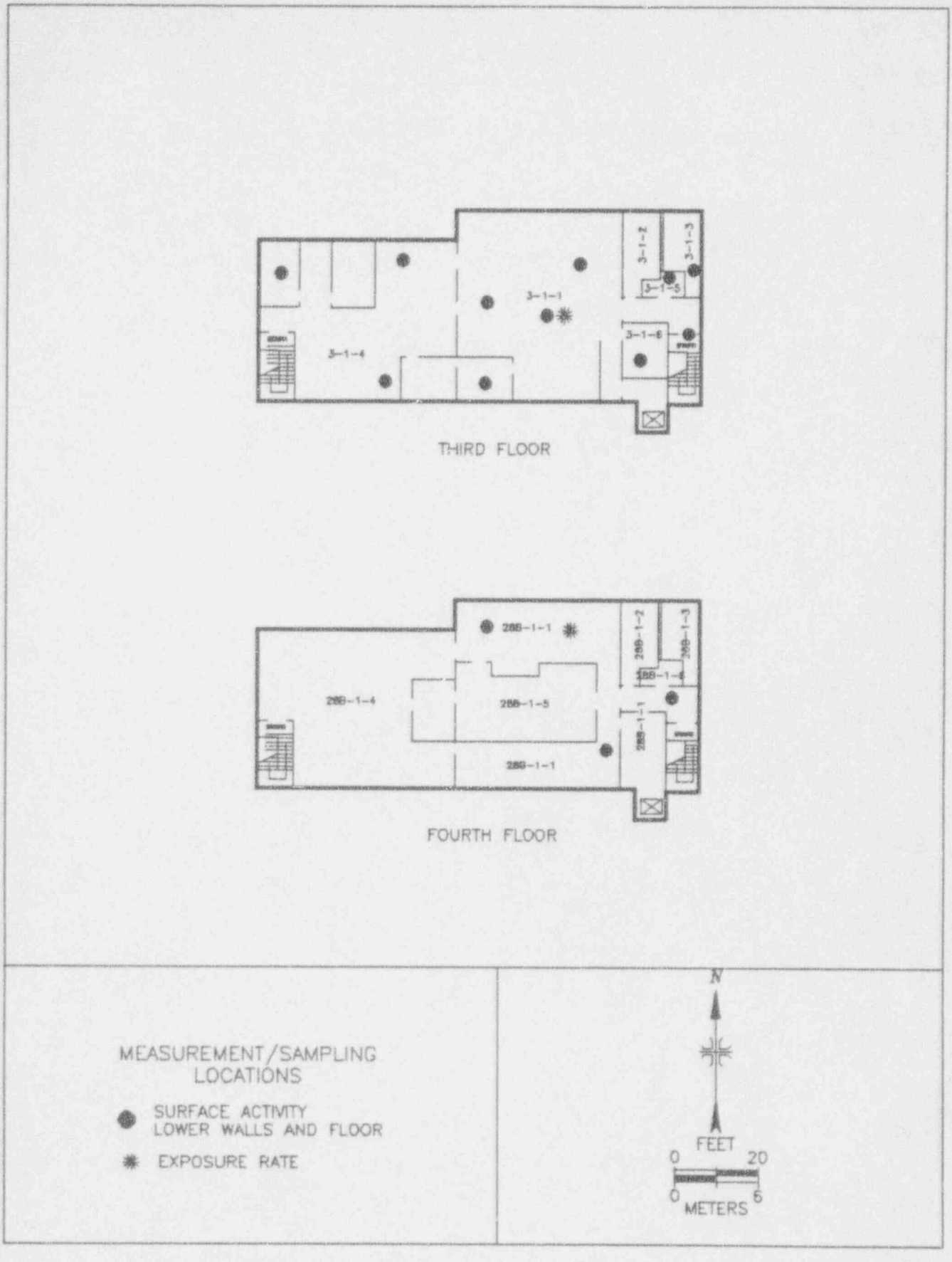
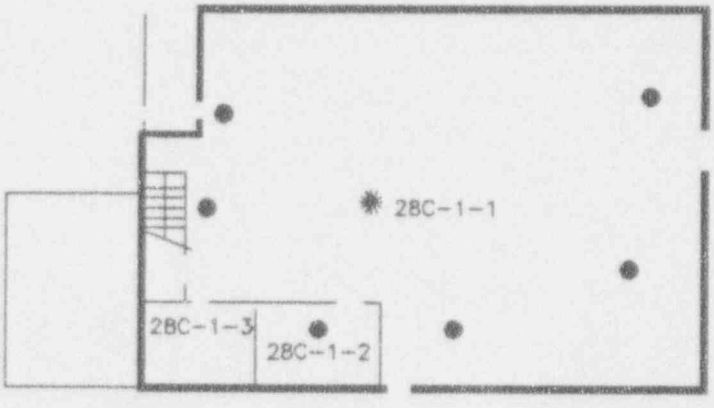


FIGURE 6: Building 5, Third and Fourth Floors – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY LOWER WALLS AND FLOOR
- EXPOSURE RATE

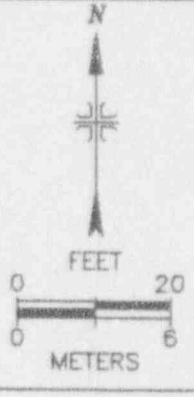
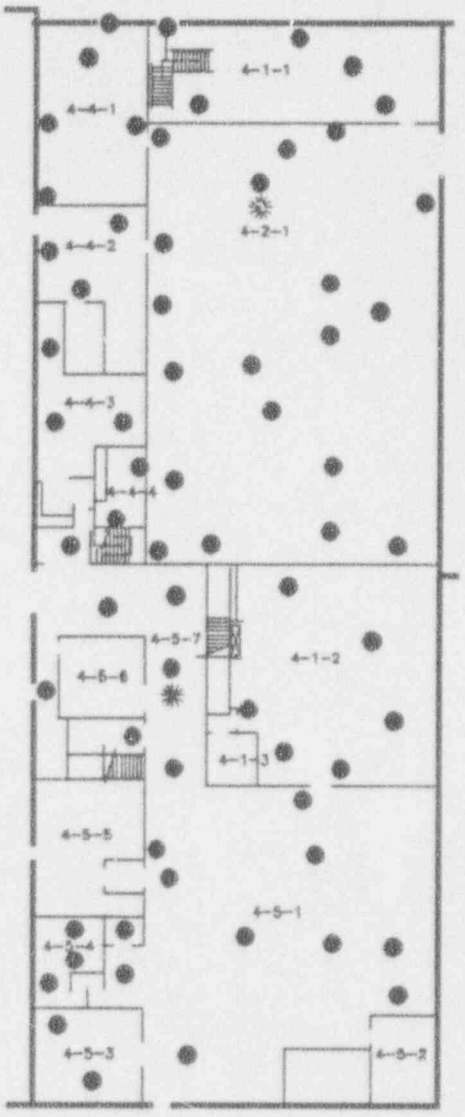


FIGURE 7: Building 5A, First Floor – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY LOWER WALLS AND FLOOR
- EXPOSURE RATE

N

FEET
0 20
0 6
METERS

FIGURE 8: Building 6, First Floor – Measurement and Sampling Locations

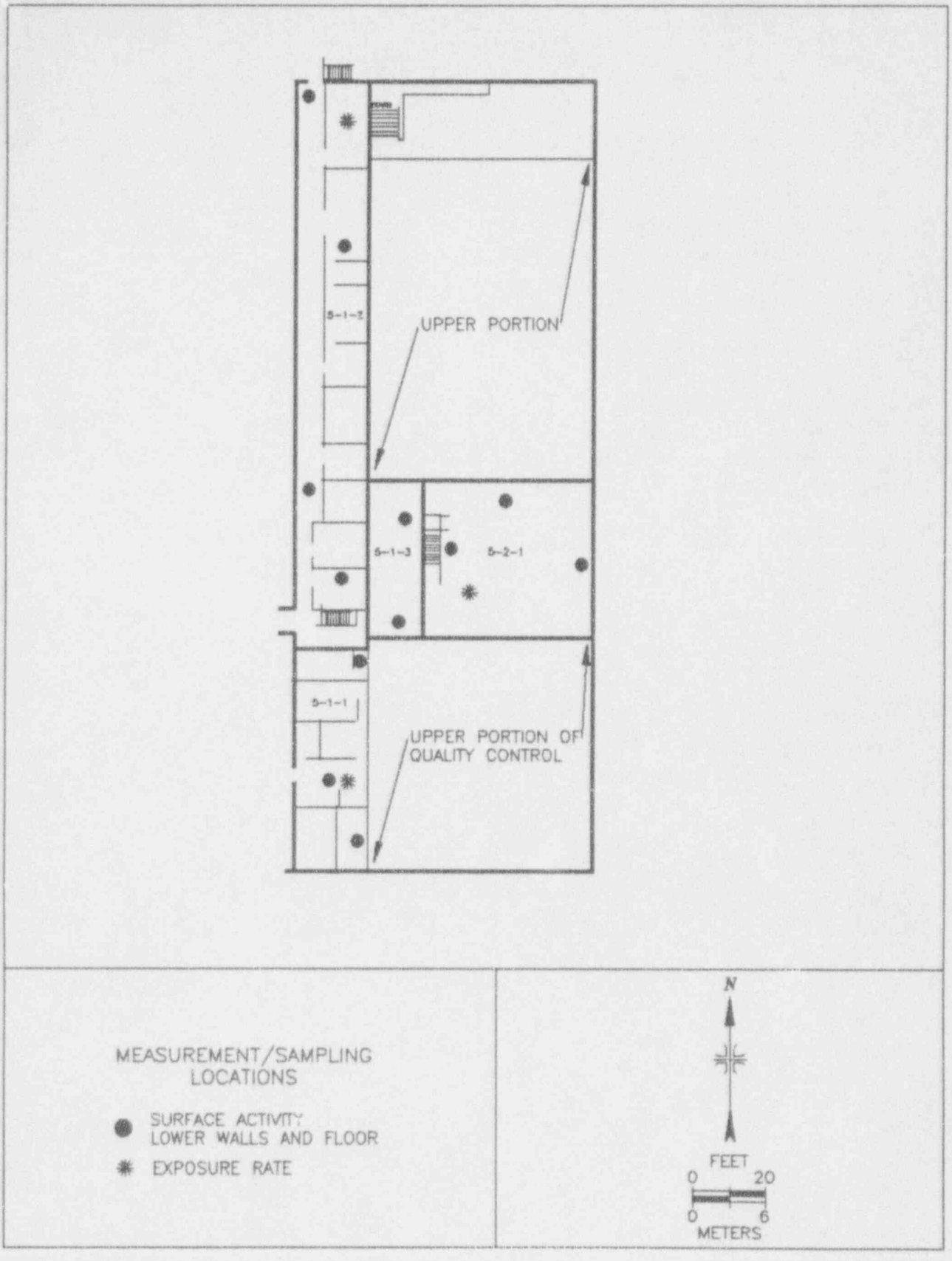


FIGURE 9: Building 6, Second Floor – Measurement and Sampling Locations

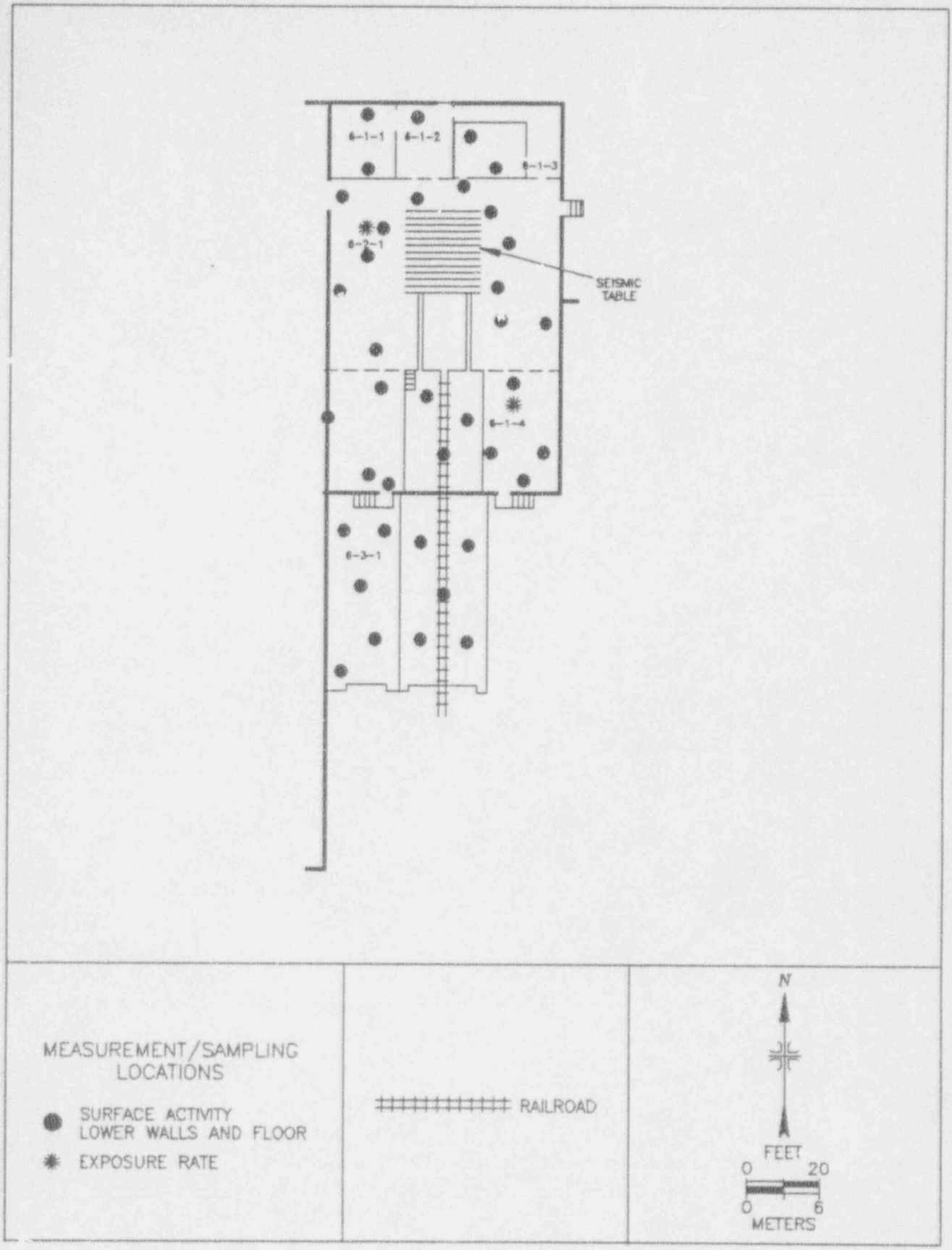
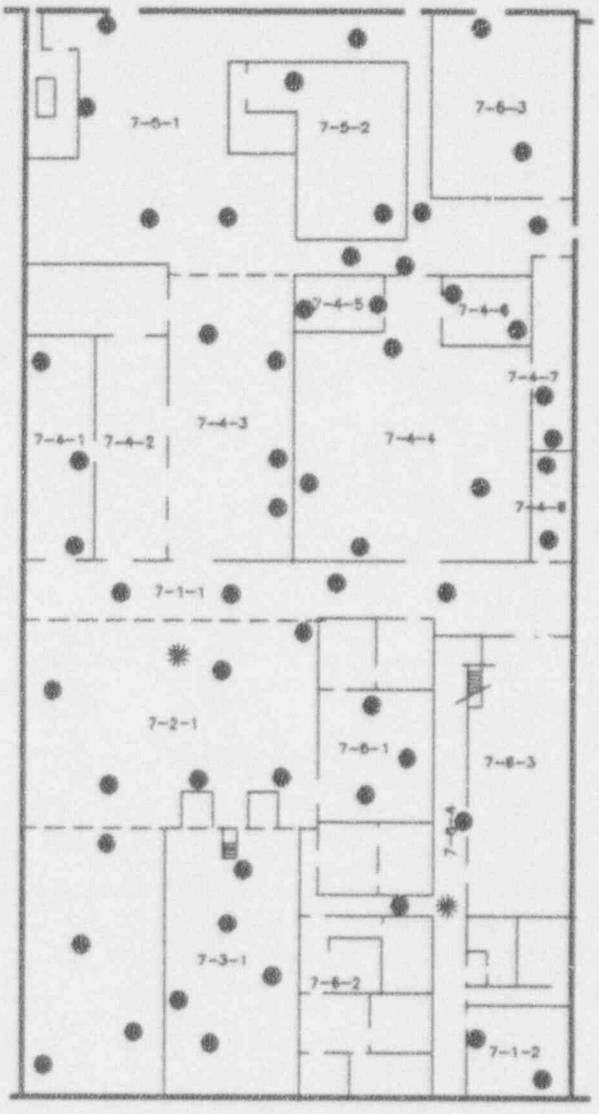


FIGURE 10: Building 6A, First Floor – Measurement and Sampling Locations



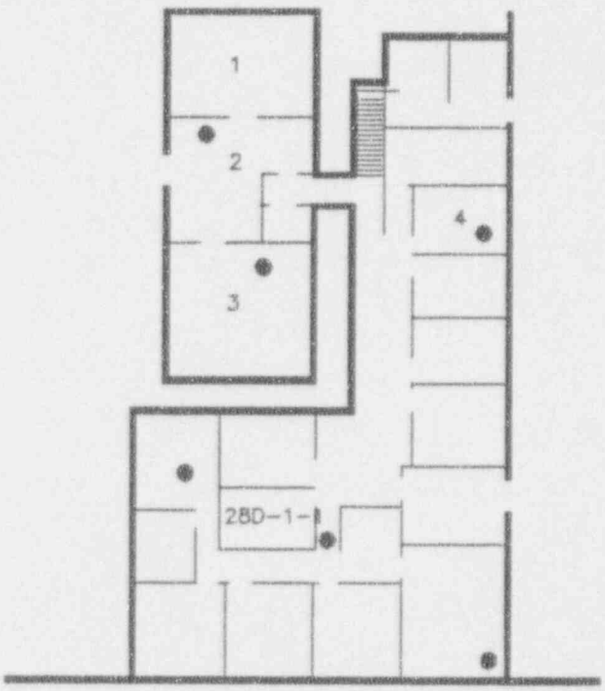
MEASUREMENT/SAMPLING LOCATIONS

- SURFACE ACTIVITY LOWER WALLS AND FLOOR
- EXPOSURE RATE

N

FEET
0 20
0 6
METERS

FIGURE 11: Building 7, First Floor – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY LOWER WALLS AND FLOOR

N

FEET
0 20
0 6
METERS

FIGURE 12: Building 7, Second Floor – Measurement and Sampling Locations

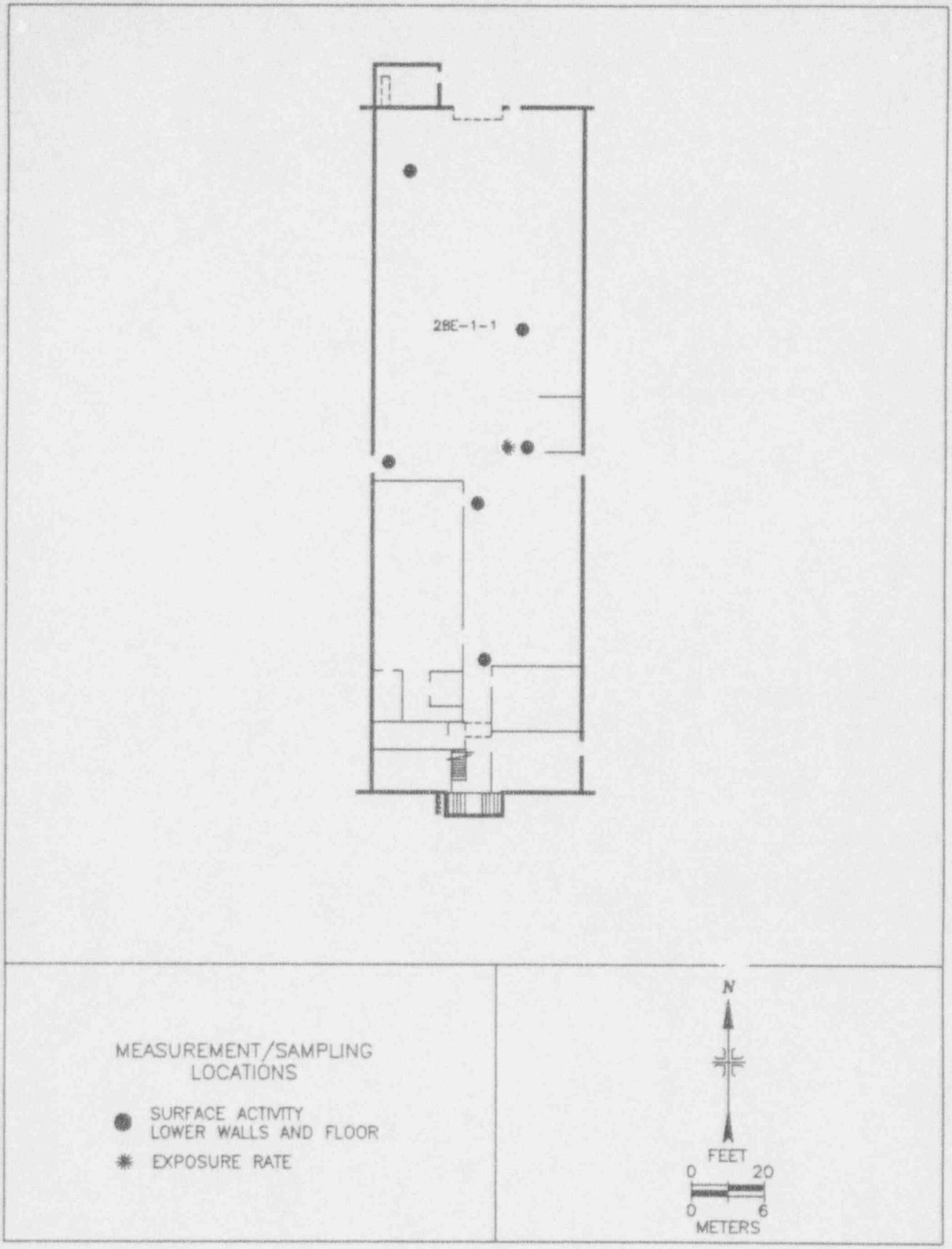


FIGURE 13: Building 8, First Floor – Measurement and Sampling Locations

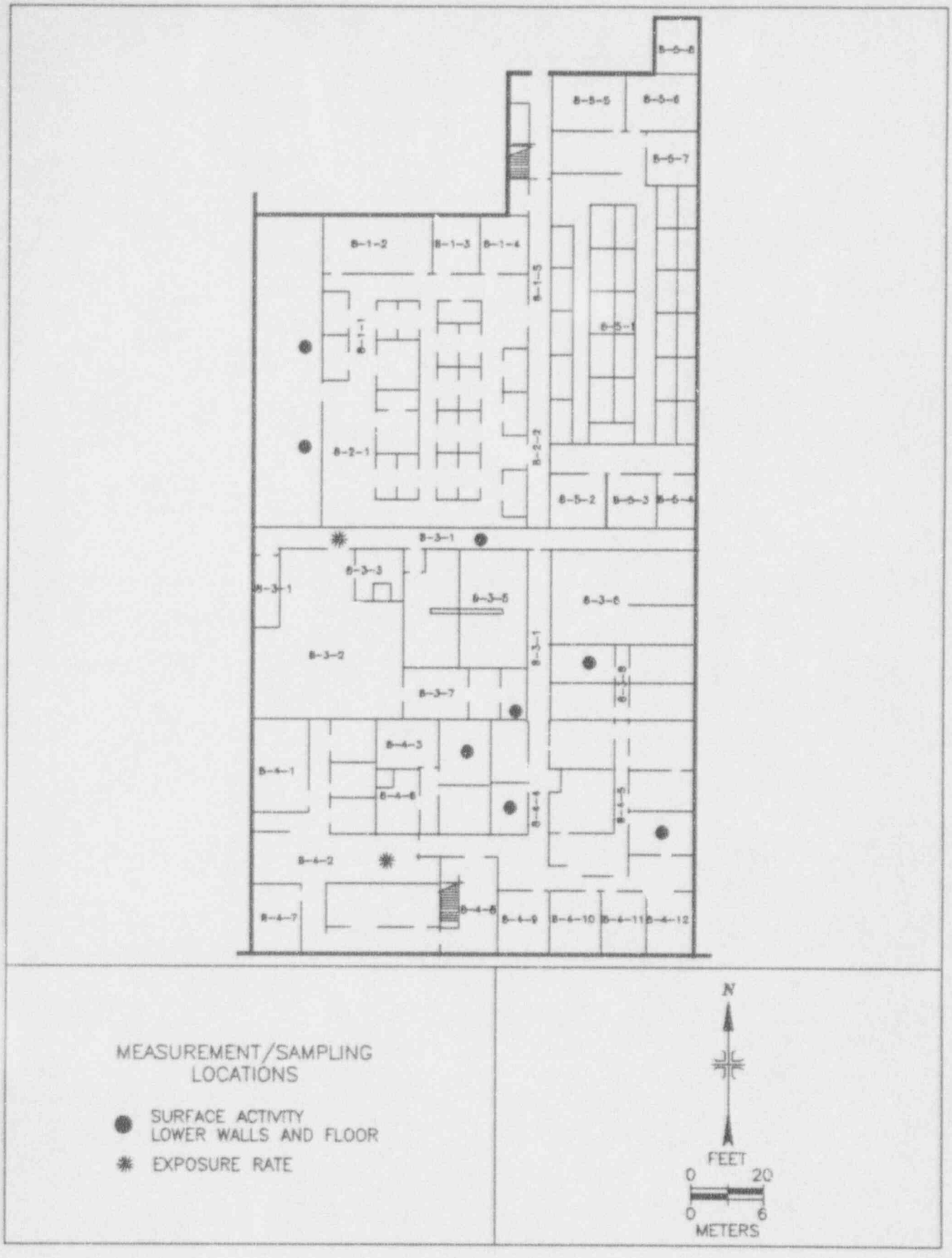
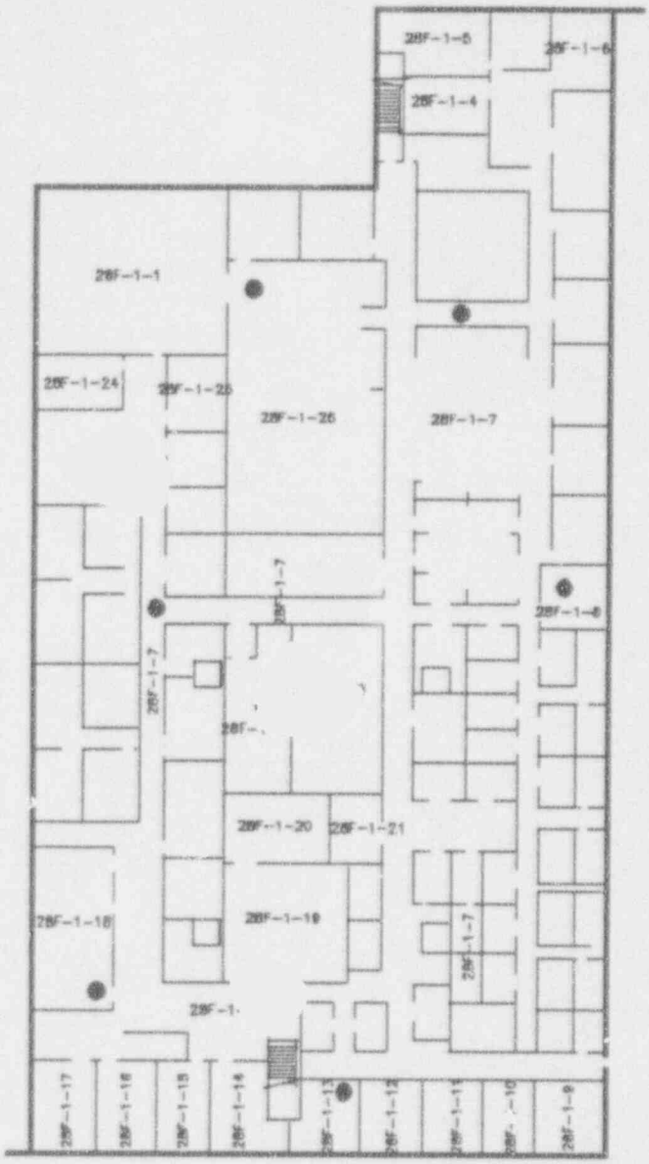


FIGURE 14: Building 8A, First Floor – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

● SURFACE ACTIVITY LOWER WALLS AND FLOOR

N

FEET
0 20
0 6
METERS

FIGURE 15: Building 8A, Second Floor – Measurement and Sampling Locations

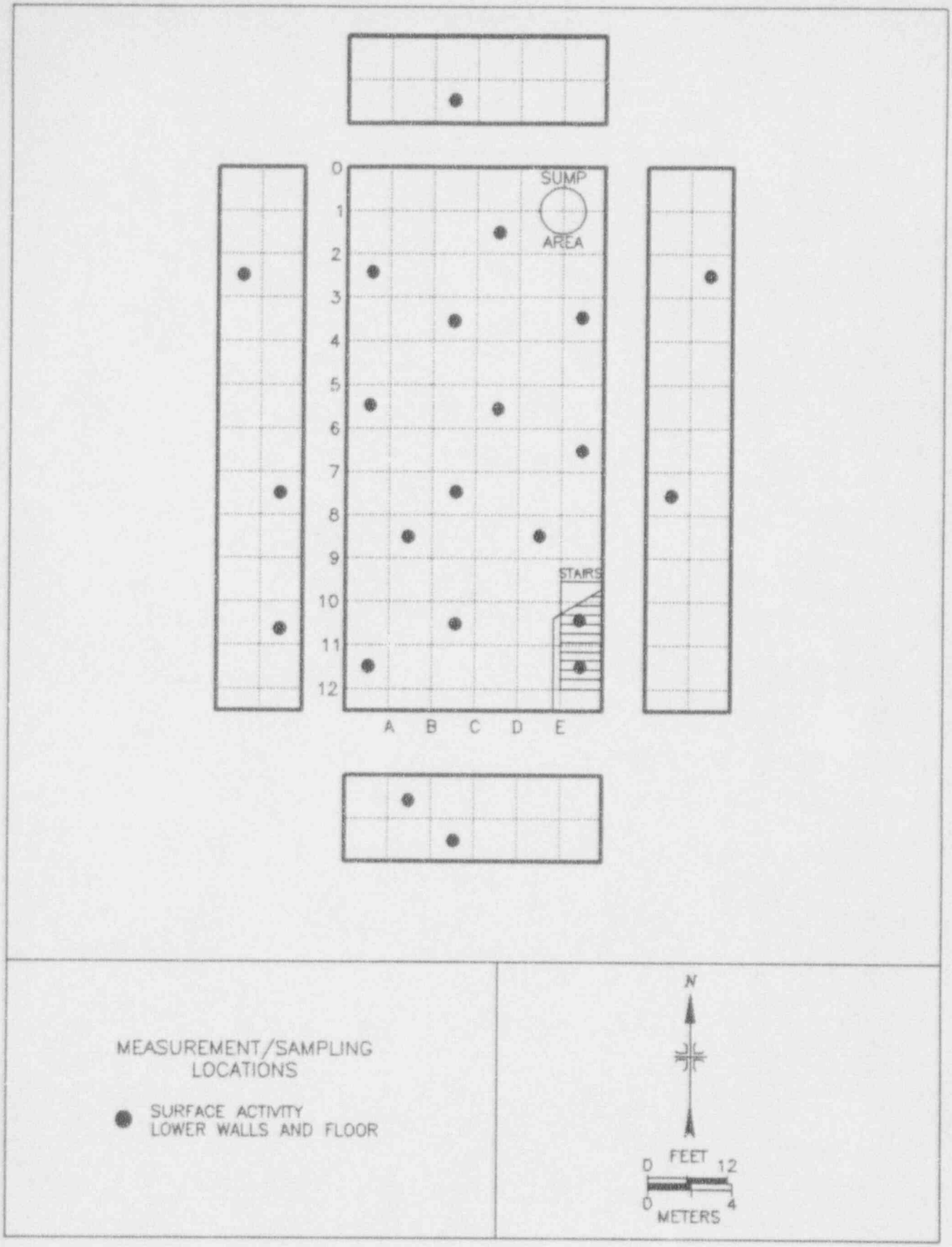


FIGURE 16: Building 9, Tank Pit – Measurement and Sampling Locations

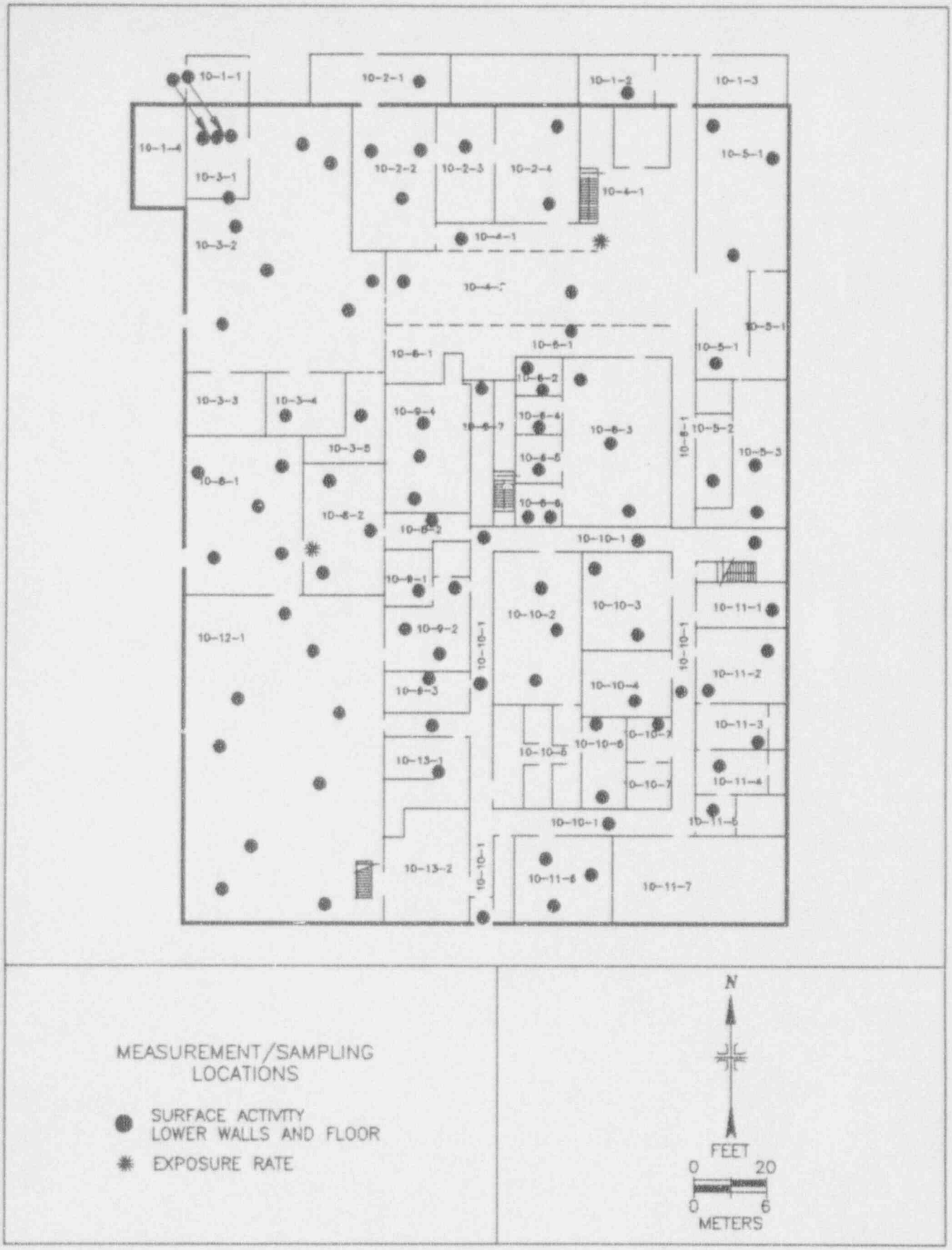


FIGURE 17: Building 9, First Floor – Measurement and Sampling Locations

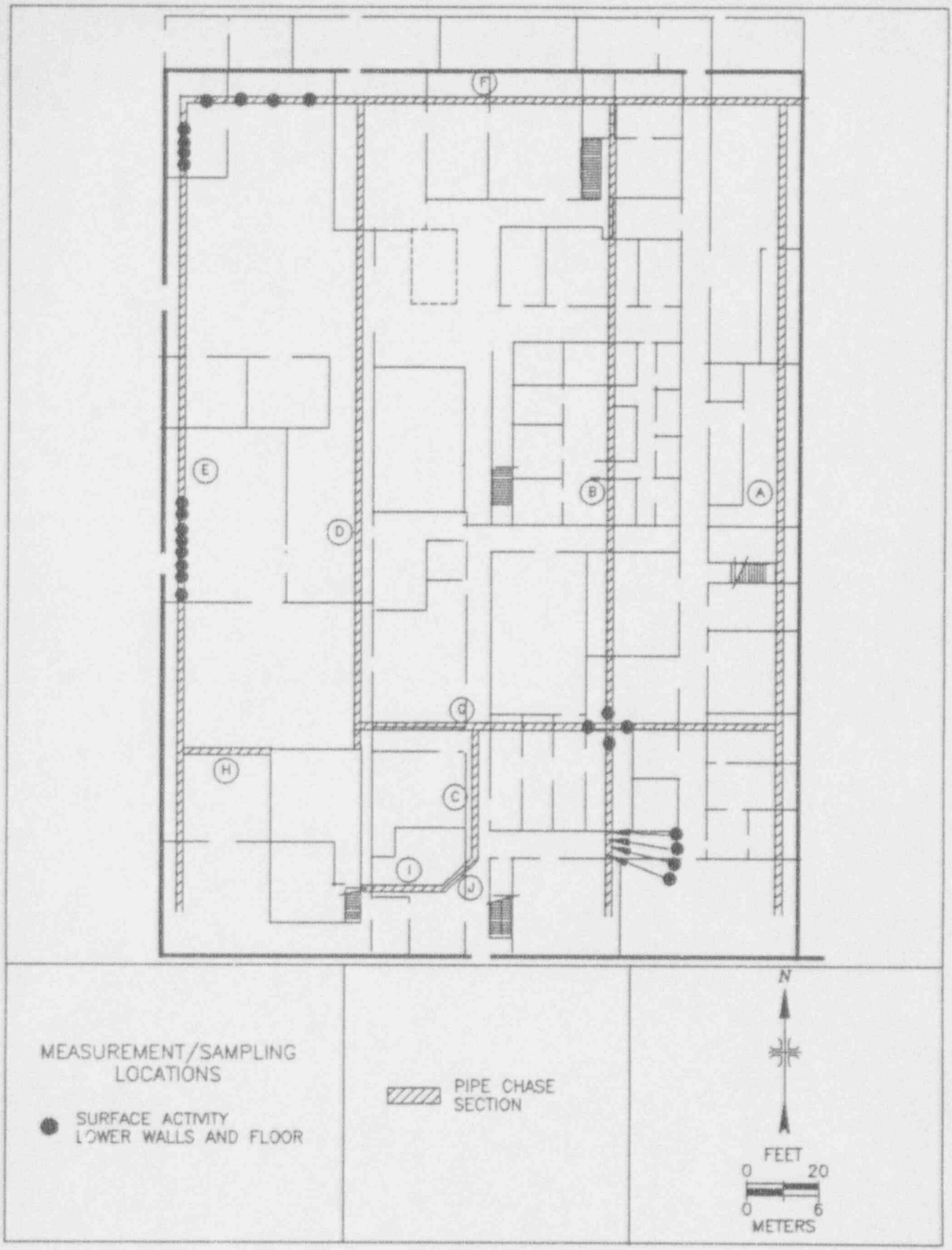


FIGURE 18 Building 9, First Floor Pipe Chases – Measurement and Sampling Locations

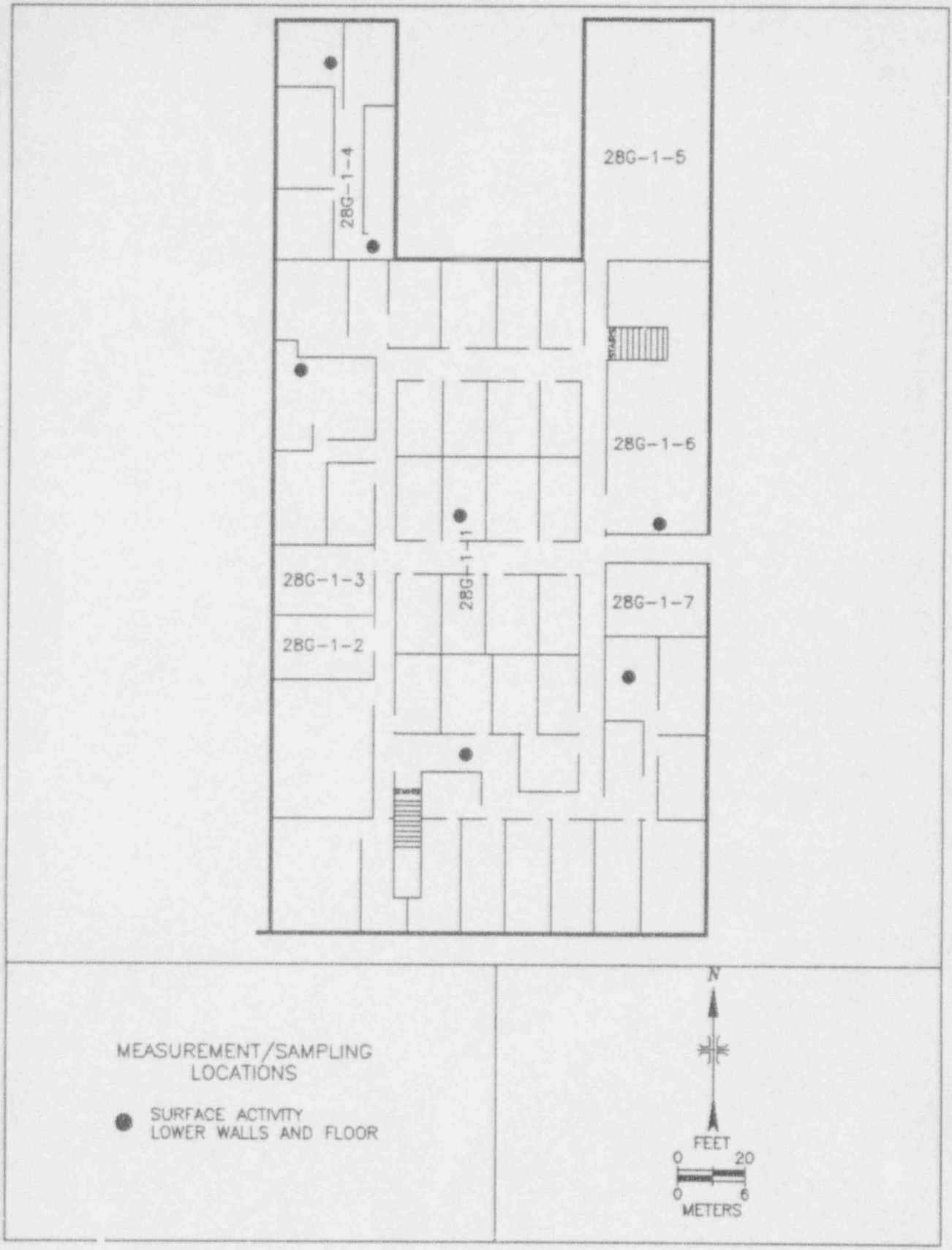


FIGURE 9: Building 9, Second Floor – Measurement and Sampling Locations

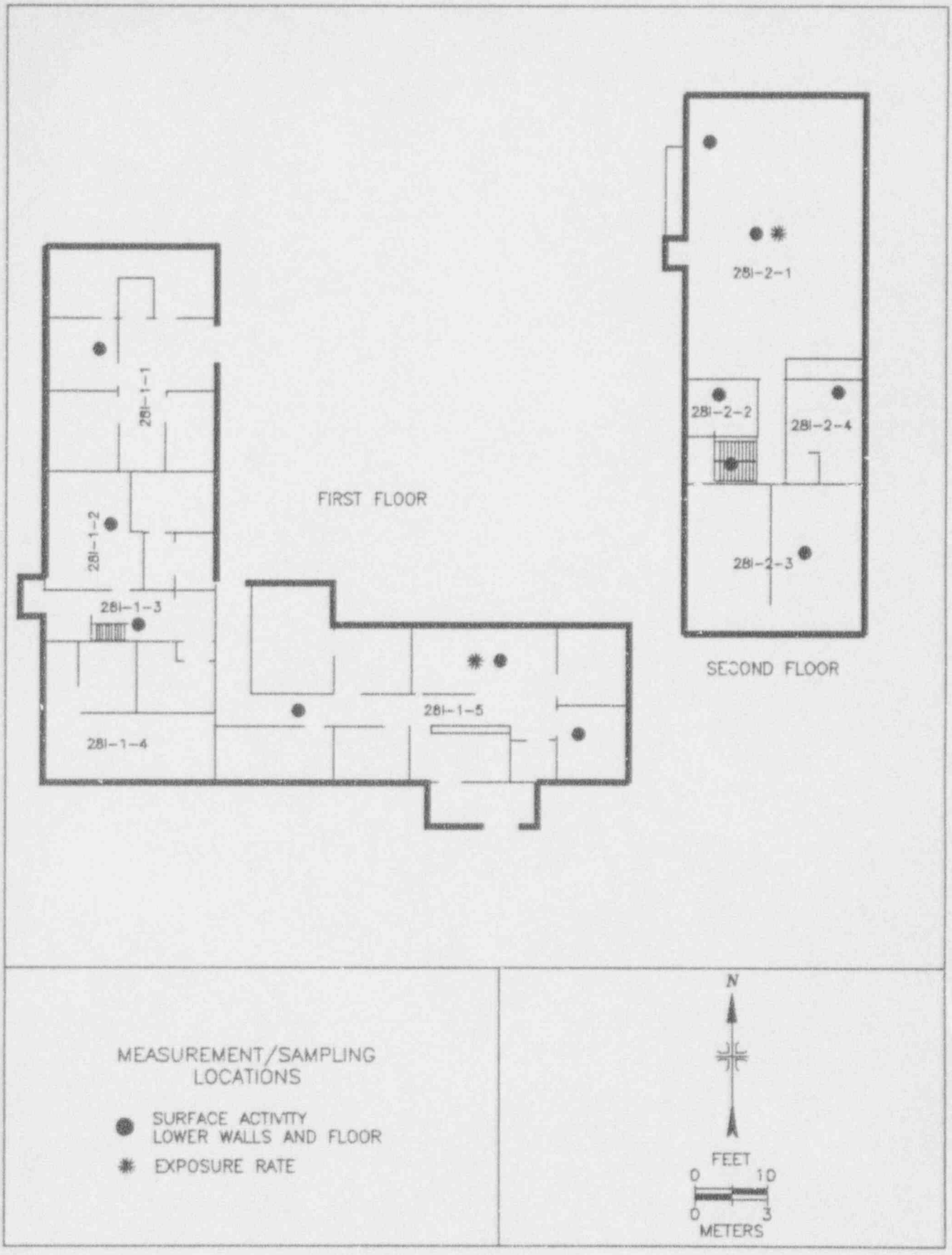


FIGURE 20: Building 11, First and Second Floors – Measurement and Sampling Locations

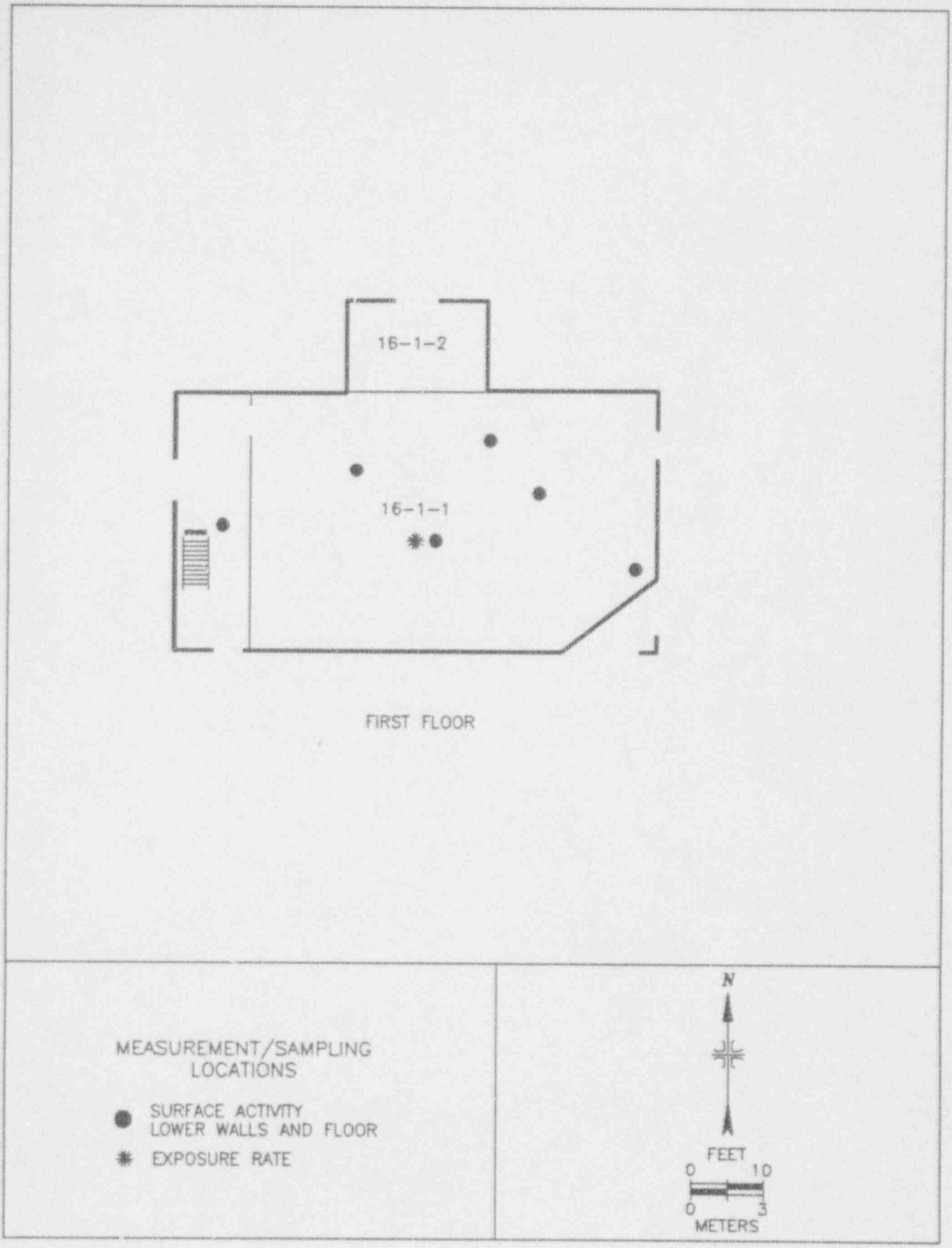


FIGURE 21: Building 12, First Floor – Measurement and Sampling Locations

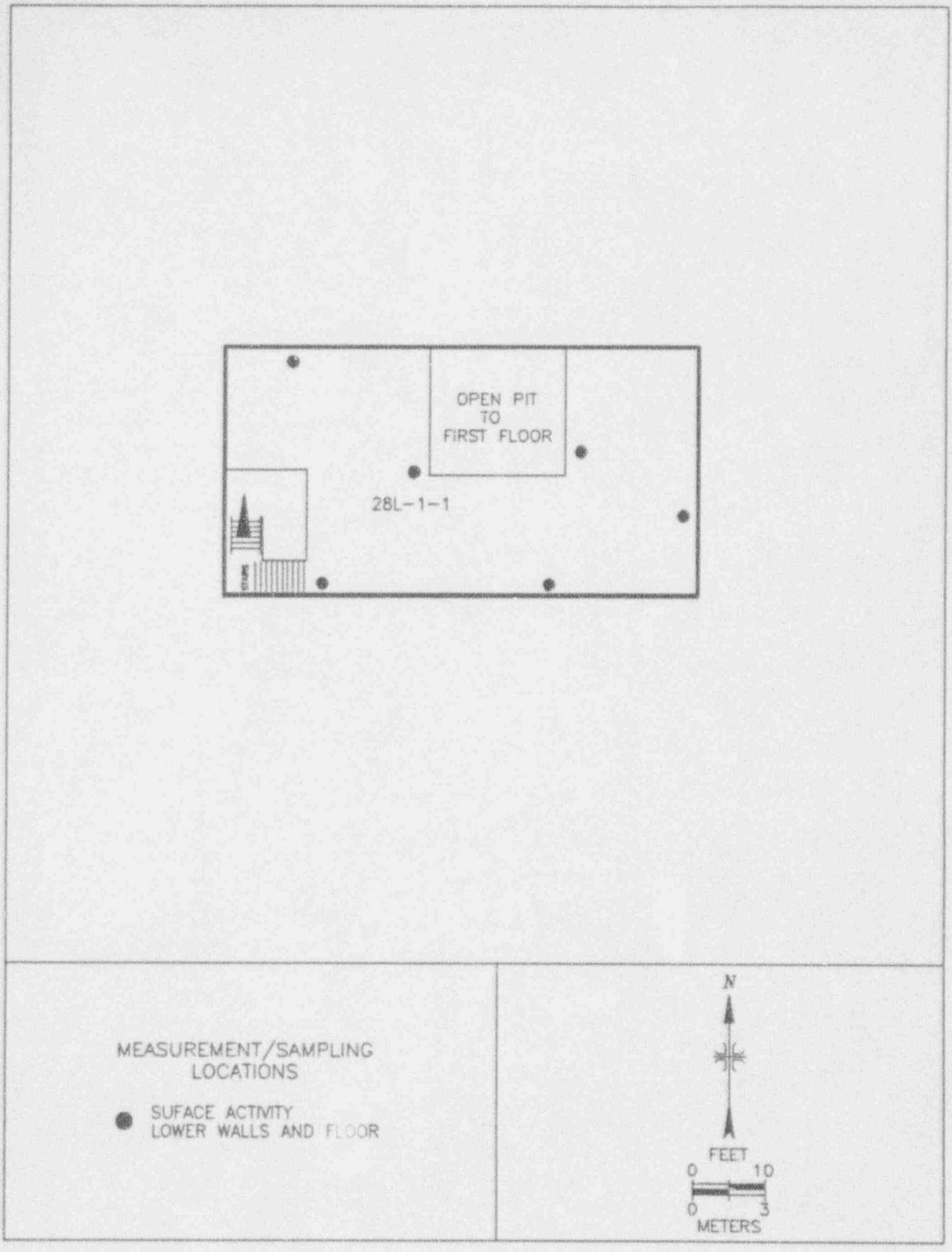


FIGURE 22: Building 12, Second Floor – Measurement and Sampling Locations

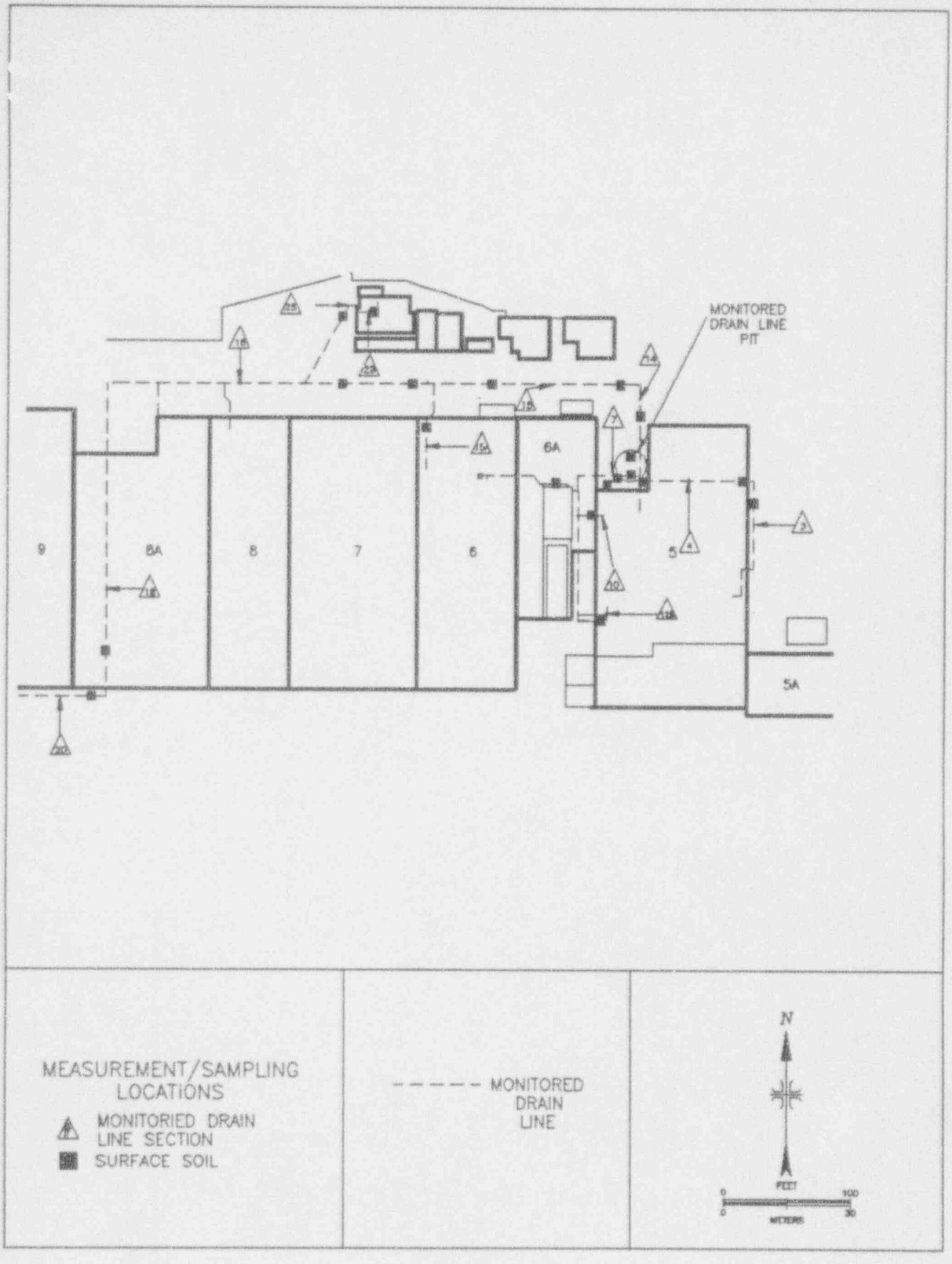


FIGURE 23: Monitored Drain Line – Sampling Locations

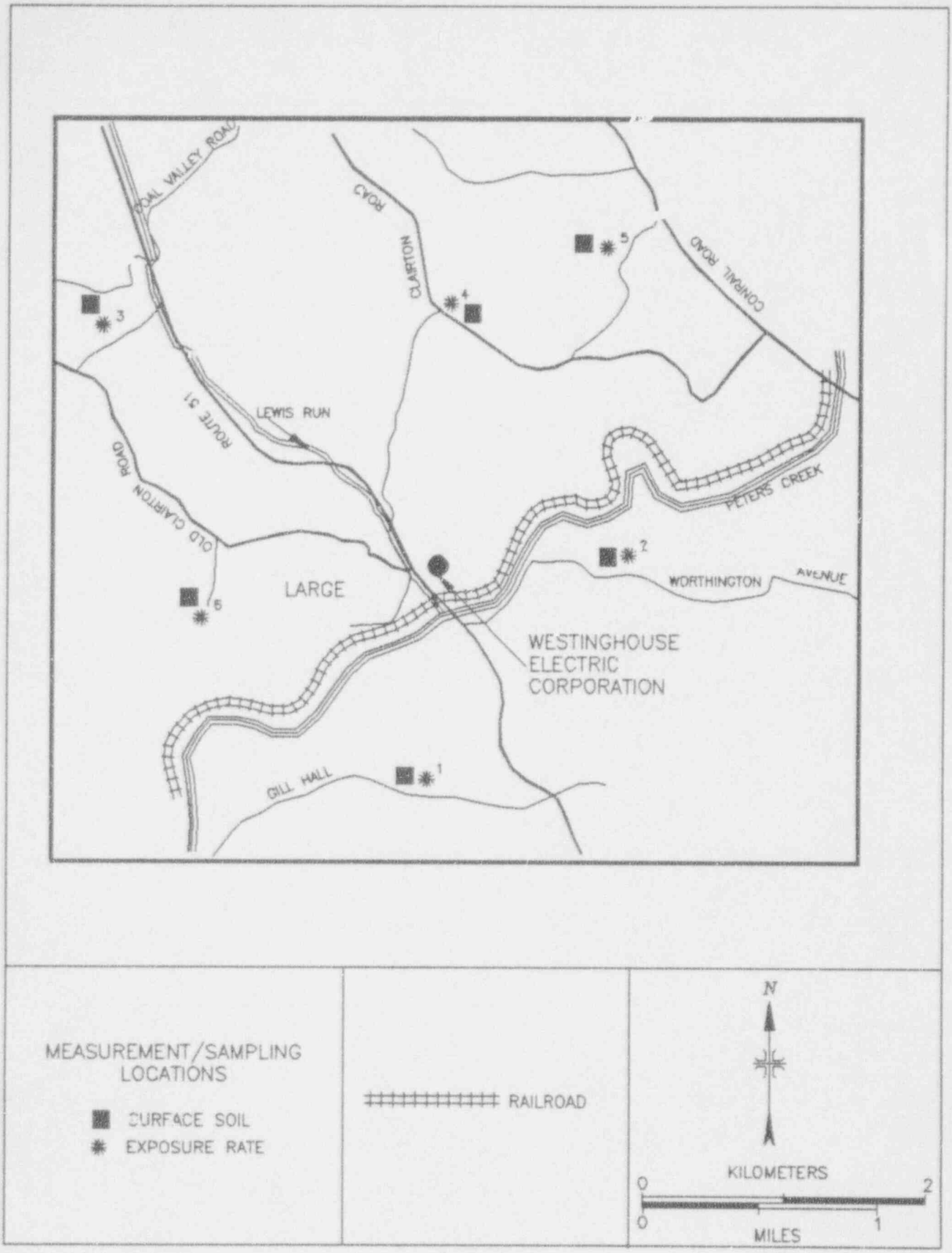


FIGURE 24: Backgroud Exposure Rate Measurement and Soil Sampling Locations

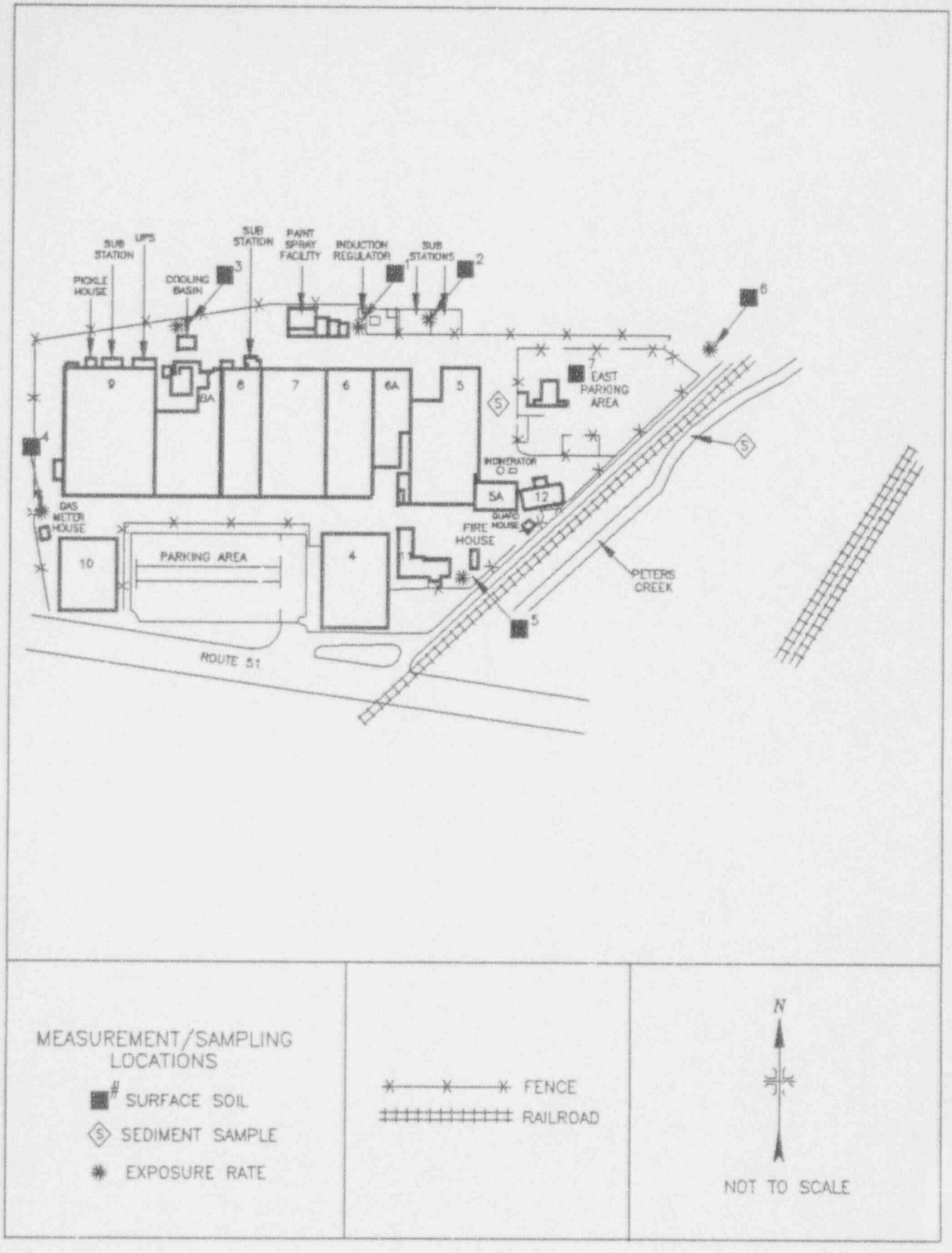


FIGURE 25: Exterior Exposure Rate Measurements and Soil and Sediment Sampling Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
WESTINGHOUSE ELECTRIC CORPORATION
LARGE, PENNSYLVANIA

Location	Figure(s)	Number of Individual Measurements	Range of Total Activity (dpm/100 cm^2)		Range of Removable Activity (dpm/100 cm^2)	
			Alpha	Beta	Alpha	Beta
Building 5 1st Floor	3,4	67	73	<1500-1900	<12	<16
Building 5 2nd Floor	5	24	<78-1400	<1400	<12-160	<16-38
Building 5 3rd Floor	6	11	<78	<1400	<12	<16
Building 5 4th Floor	6	3	<78	<1400	<12	<16
Building 5A 1st Floor	7	6	<78	<1400	<12	<16
Building 6 1st Floor	8	66	<73	<1400-4800	<12	<16
Building 6 2nd Floor	9	12	<78	<1400	<12	<16
Building 6A 1st Floor	10	38	<73	<1500	<12	<16
Building 7 1st Floor	11	58	<73	<1500	<12	<16
Building 7 2nd Floor	12	6	<78	<1400	<12	<16
Building 8 1st Floor	13	6	<78	<1400	<12	<16
Building 8A 1st Floor	14	8	<69	<1400	<12	<16

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
WESTINGHOUSE ELECTRIC CORPORATION
LARGE, PENNSYLVANIA

Location	Figure(s)	Number of Individual Measurements	Range of Total Activity (dpm/100 cm^2)		Range of Removable Activity (dpm/100 cm^2)	
			Alpha	Beta	Alpha	Beta
Building 8A 2nd Floor	15	6	<78	<1400	<12	<16
Building 9 Tank Pit	16	22	<73-780	<1500	<12	<16
Building 9 1st Floor	17	97	<69-2200	<1400-2300	<12	<16
Building 9 Pipe Chases	18	24	<69-3000	<1400-5300[a]	<12-300	<16-67
Building 9 2nd Floor	19	7	<78	<1400	<12-29	<16
Building 11 1st Floor	20	6	<78	<1400	<12	<16
Building 11 2nd Floor	20	6	<78	<1400	<12	<16
Building 12 1st Floor	21	6	<78	<1400	<12	<16
Building 12 2nd Floor	22	6	<78	<1400	<12	<16

[a]Averages over 1 m^2 were calculated for two locations within the pipe chases that exceeded 5000 dpm/100 cm^2 beta activity. Resulting grid block averages were 2700 and 2900 dpm/100 cm^2 for total beta activity.

TABLE 2

INTERIOR EXPOSURE RATE MEASUREMENTS
WESTINGHOUSE ELECTRIC CORPORATION
LARGE, PENNSYLVANIA

Location	Figure	Exposure Rate (μR/h) at 1 m Above Surface
Bldg 9, 1st Floor, 10-8-2	17	9
Bldg 9, 1st Floor, 10-4-1	17	8
Bldg 8A, 1st Floor, 8-3-1	14	8
Bldg 8A, 1st Floor, 8-4-2	14	8
Bldg 7, 1st Floor, 7-2-1	11	9
Bldg 7, 1st Floor, 7-6-4	11	11
Bldg 6A, 1st Floor, 6-2-1	10	7
Bldg 6A, 1st Floor, 6-1-4	10	9
Bldg 6, 1st Floor, 4-5-7	8	9
Bldg 6, 1st Floor, 4-2-1	8	9
Bldg 5, 1st Floor, 1-9-3	4	8
Bldg 5, 1st Floor, 1-6-6	3	10
Bldg 8, 1st Floor, 28E-1-1	13	8
Bldg 5A, 1st Floor, 28C-1-1	7	9
Bldg 12, 1st Floor, 16-1-1	21	10
Bldg 11, 1st Floor, 28I-1-5	20	10
Bldg 11, 2nd Floor, 28I-2-1	20	9
Bldg 5, 2nd Floor, 2-4-1	5	9
Bldg 5, 3rd Floor, 3-1-1	6	9
Bldg 5, 4th Floor, 28B-1-1	6	10
Bldg 6, 2nd Floor, 5-2-1	9	9
Bldg 6, 2nd Floor, 5-1-1	9	10
Bldg 6, 2nd Floor, 5-1-2	9	13

TABLE 3

URANIUM CONCENTRATIONS IN ARCHIVED MDL SOIL SAMPLES
WESTINGHOUSE ELECTRIC CORPORATION
LARGE, PENNSYLVANIA

Location[a]	Uranium Concentration (pCi/g)			
	U-235	U-238	Total Uranium[b]	Licensee U-235[c]
MDL Pit, NW Corner	2.3 ± 0.2	1.7 ± 1.4	69.0	1.48 ± 0.24
MDL Pit, SW Corner	0.3 ± 0.1	1.6 ± 0.9	9.0	0.586 ± 0.18
Beneath Clay Pipe From MDL Pit	0.1 ± 0.1	0.9 ± 0.5	3.0	<0.19
MDL Section 3, 16.5	0.2 ± 0.1	1.7 ± 1.6	6.0	0.127 ± 0.067
MDL Section 4, 62.0	0.4 ± 0.1	1.4 ± 1.2	12.0	<0.25
MDL Section 7, 23.0	0.2 ± 0.1	1.7 ± 1.6	6.0	<0.40
MDL Section 10, 8.0	0.2 ± 0.1	1.3 ± 1.1	6.0	0.381 ± 0.22
MDL Section 12B, 3.0	0.2 ± 0.1	2.1 ± 0.8	6.0	0.190 ± 0.084
MDL Section 14, 20.0	0.2 ± 0.1	3.2 ± 1.8	6.0	<0.16
MDL Section 14, 51.0	0.1 ± 0.1	2.5 ± 2.0	3.0	<0.40
MDL Section 15, 66.0	0.3 ± 0.1	1.7 ± 1.1	9.0	0.237 ± 0.22
MDL Section 15, 149.0	0.2 ± 0.1	1.2 ± 0.7	6.0	<0.26
MDL Section 15A, 44.0	0.2 ± 0.1	1.7 ± 1.2	6.0	<0.40
MDL Section 16, 175.0	0.2 ± 0.1	2.5 ± 1.3	6.0	<0.27
MDL Section 16, 248.0	0.3 ± 0.1	1.4 ± 1.2	9.0	0.311 ± 0.23
MDL Section 18, 128.0	0.2 ± 0.1	1.6 ± 0.9	6.0	0.204 ± 0.17
MDL Section 20, 124.0	0.1 ± 0.1	0.7 ± 0.5	3.0	0.281 ± 0.13
MDL Section 25, 4.0	0.2 ± 1.0	1.3 ± 1.1	6.0	<0.15
MDL Section 28, 12.0	0.3 ± 0.1	0.7 ± 0.6	9.0	<0.34
MDL Piping Remaining Beneath Bldg 6A	<0.3	0.1 ± 1.9	<9.0	<0.44

[a]Refer to Figure 23.
[b]Total uranium concentrations are calculated based on a total uranium to U-235 ratio of 30, as established by the licensee.
[c]U-235 concentration reported by the licensee.

TABLE 4

URANIUM CONCENTRATIONS IN ARCHIVED MDL SOIL SAMPLES
(DETERMINED BY ALPHA SPECTROMETRY)
WESTINGHOUSE ELECTRIC CORPORATION
LARGE, PENNSYLVANIA

Location[a]	Uranium Concentration (pCi/g)			
	U-234	U-235	U-238	Total Uranium[b]
MDL Pit, NW Corner	19.5 ± 0.6	1.2 ± 0.2	0.7 ± 0.1	21.3
MDL Pit, SW Corner	3.3 ± 0.2	0.2 ± 0.1	0.8 ± 0.1	4.3
Beneath Clay Pipe From MDL Pit	1.4 ± 0.2	0.1 ± 0.1	1.0 ± 0.1	2.4
MDL Section 4, 62.0	4.4 ± 0.3	0.3 ± 0.1	1.1 ± 0.2	5.8

[a]Refer to Figure 23.
[b]Total uranium concentrations are calculated based on the sum of the U-234, U-235 and U-238 concentrations, as determined by alpha spectrometry.

TABLE 5

BACKGROUND
EXPOSURE RATES AND
URANIUM CONCENTRATIONS IN SOIL
WESTINGHOUSE ELECTRIC CORPORATION
LARGE, PENNSYLVANIA

Measurement Location[a]	Exposure Rate (μR/h) at 1 m Above Surface	Total Uranium Concentration (pCi/g)[b]
1 Scotia Pump Station,Ridge Rd.	9	3.4
2 St. Clares Cemetery	8	4.8
3 Elliot Rd Across from Drive-In	9	3.6
4 Hwy 885 and Clairton Rd.	9	2.5
5 Wall Rd and Wall Ave.	9	2.4
6 End of Red Cliff Dr.	8	2.5

[a]Refer to Figure 24.
[b]Total uranium concentrations are calculated based on natural isotopic abundances of U-234 and U-238.

TABLE 6

EXTERIOR EXPOSURE RATE MEASUREMENTS
WESTINGHOUSE ELECTRIC CORPORATION
LARGE, PENNSYLVANIA

Location[a]	Exposure Rate at 1 m Above Surface (μR/h)
1 15 m N. of Building 6A	9
2 33 m N. of Building 5	11
3 Fenceline N. of Building 8A	11
4 Fenceline N. of Gas Meter House	10
5 Fenceline S. of Firehouse	11
6 N. E. Perimeter of East Parking Lot	10

[a]Refer to Figure 25.

TABLE 7

URANIUM CONCENTRATIONS IN SOIL SAMPLES, EXTERIOR LOCATIONS
WESTINGHOUSE ELECTRIC CORPORATION
LARGE, PENNSYLVANIA

Location[b]	Uranium Concentration (pCi/g)[a]			
	U-235	U-238	Total Uranium[c]	
Gamma Spectrometry				
1 15 m N. or Building 6A	0.3 ± 0.1	2.7 ± 1.3	9.0	
2 33 m N. of Building 5	0.1 ± 0.1	1.1 ± 0.9	3.0	
3 Fenceline N. of Building 8A	0.2 ± 0.1	2.2 ± 1.3	6.0	
4 Fenceline N. of Gas Meter House	0.2 ± 0.1	1.1 ± 0.7	6.0	
5 Fenceline S. of Firehouse	0.2 ± 0.1	2.3 ± 1.2	6.0	
6 N. E. Perimeter of East Parking Lot	0.3 ± 0.1	2.9 ± 1.6	9.0	
7 East Parking Lot[e]	0.3 ± 0.1	1.7 ± 1.3	9.0	
Alpha Spectrometry	**U-234**	**U-235**	**U-238**	**Total U[d]**
7 East Parking Lot[e]	2.3 ± 0.3	0.1 ± 0.1	2.0 ± 0.3	4.4

[a]Uncertainties represent the 95% confidence level, based only on counting statistics.
[b]Refer to Figure 25.
[c]Total uranium concentrations are calculated based on a total uranium to U-235 ratio of 30, as established by the licensee.
[d]Total uranium concentrations are calculated based on the sum of the U-234, U-235 and U-238 concentrations.
[e]Archived sample, originally collected by the licensee.

REFERENCES

1. Westinghouse Electrical Corporation, License Termination Reports # 001 - #042, dated from November 2, 1992 to July 9, 1993.

2. Oak Ridge Institute for Science and Education, "Proposed Confirmatory Survey Plan for Buildings 5, 5A, 6, 6A, 7, 8, 8A, 9, 11, 12 and the Hydrogen Facility, Westinghouse Electric Corporation, Large, PA," August 19, 1993.

3. Oak Ridge Institute for Science and Education, letter from M. R. Landis to J. D. Kinneman, Region I, U.S. NRC, "License Termination Reports #002, #004, #007, and #009 for Westinghouse Electric Corporation, Large, PA," July 23, 1993.

4. Oak Ridge Institute for Science and Education, letter from A. J. Ansari to J. D. Kinneman, Region I, U.S. NRC, "Additional Comment—License Termination Reports for Westinghouse Electric Corporation, Large, PA," August 3, 1993.

5. Oak Ridge Institute for Science and Education, letter from E. W. Abelquist to J. D. Kinneman, Region I, U.S. NRC, "Additional Comment—License Termination Reports for Westinghouse Electrical Corporation, Large, PA," August 24, 1993.

6. U.S. Nuclear Regulatory Commission, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear Materials," August, 1987.

7. U.S. Nuclear Regulatory Commission, "Disposal of Onsite Storage of Thorium and Uranium Wastes from Past Operations," 46 FR 52061, Washington, D.C., October 23, 1981.

8. U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, "Review Plan: Evaluating Decommissioning Plans for Licenses Under 10 CFR Parts 30, 40, and 70," Washington, D.C., 1991.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

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

DIRECT RADIATION MEASUREMENT

Instruments

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

Eberline "Rascal" Ratemeter-Scaler
Model PRS-1
(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

Eberline GM Detector
Model HP-260
Effective Area, 15.5 cm^2
(Eberline, Santa Fe, NM)

Eberline ZnS Scintillation Detector
Model AC-3-7
Effective Area, 59 cm^2
(Eberline, Santa Fe, NM)

APPENDIX A

MAJOR INSTRUMENTATION

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DIRECT RADIATION MEASUREMENT

Instruments

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

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

Detectors

Eberline GM Detector
Model HP-260
Effective Area, 15.5 cm^2
(Eberline, Santa Fe, NM)

Eberline ZnS Scintillation Detector
Model AC-3-7
Effective Area, 59 cm^2
(Eberline, Santa Fe, NM)

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

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

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

LABORATORY ANALYTICAL INSTRUMENTATION

Alpha Spectrometry System
Tennelec Electronics Model
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Surface Barrier and Ion Implanted Detectors
(Canberra, Meriden, CT and
Tennelec, Oak Ridge, TN) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden,CT)

High Purity Extended Range Intrinsic Detectors
Model No: ERVDS30-25195
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Detector
Model GMX-23195-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

LABORATORY ANALYTICAL INSTRUMENTATION (Continued)

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 (15.5 cm^2 or 59 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	—	ZnS scintillation detector with ratemeter-scaler
	—	gas proportional detector with ratemeter-scaler
Beta	—	thin-window GM detector with ratemeter-scaler
	—	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 ZnS scintillation and thin-window GM detectors with ratemeter-scalers.

Count rates (cpm), which were integrated over 1 minute in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net rate by the 4π efficiency and correcting for the active area of the detector. The alpha activity background count rates for the ZnS scintillation

detectors averaged 1 cpm for each detector. Alpha efficiency factors averaged 0.17 for the ZnS scintillation detectors. The beta activity background count rates for the GM detectors averaged 50 cpm. Beta efficiency factors ranged from 0.15 - 0.17 for the GM detectors. The effective windows for the ZnS scintillation and GM detectors were 59 cm^2 and 15.5 cm^2, respectively.

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 1 m above the surface, using a pressurized ionization chamber (PIC).

Miscellaneous Samples

Soil Samples

Approximately 1 kg of soil was collected at each sample location. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ESSAP survey procedures.

Sediment Samples

Approximately 1 kg of sediment was collected at each sample location. Collected samples were placed in a plastic container sealed and labeled in accordance with ESSAP survey procedures.

ANALYTICAL PROCEDURES

Removable Activity

Gross Alpha/Beta

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

Miscellaneous Samples

Gamma Spectrometry

Samples of soil and sediment were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights were determined and the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. Energy peaks used for determination of radionuclides of concern were:

U - 235 0.186 MeV

U - 238 0.063 MeV or 0.093 MeV from Th-234*

*Secular equilibrium assumed.

Spectra were also reviewed for other identifiable photopeaks.

Alpha Spectrometry

Soil samples were crushed, homogenized and analyzed for isotopic uranium. Samples were dissolved by potassium fluoride and pyrosulfate fusion and the elements of interest were precipitated with barium sulfate. Barium sulfate precipitate was redissolved and the specific

elements of interest were individually separated by liquid-liquid extraction and re-precipitated with a cerium fluoride carrier. The precipitate was then counted using surface barrier and ion implanted detectors (Tennelec and Canberra), alpha spectrometers (Tennelec and Canberra), and a multichannel analyzer (Canberra).

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data based only on counting statistics. Additional uncertainties associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

Detection limits, referred to as minimum detectable activity (MDA), were based on 2.71 plus 4.66 times the standard deviation of the background count. When the activity was determined to be less than the MDA of the measurement procedure, the result was reported as less than MDA. 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.

CALIBRATION AND QUALITY ASSURANCE

Analytical and field survey activities were conducted in accordance with procedures from the following ESSAP documents:

- Survey Procedures Manual, Revision 7 (May 1992)
- Laboratory Procedures Manual, Revision 8 (July 1993)
- Quality Assurance Manual, Revision 6 (July 1993)

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.

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 was used. Calibration of pressurized ionization chambers was performed by the manufacturer.

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

AND

GUIDELINES FOR RESIDUAL CONCENTRATIONS OF THORIUM AND URANIUM WASTES IN SOIL

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

August 1987

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.

Guidelines for Residual Concentrations of Thorium and Uranium Wastes in Soil

On October 23, 1981, the Nuclear Regulatory Commission published in the Federal register a notice of Branch Technical Position on "Disposal or Onsite Storage of Thorium and Uranium Wastes from Past Operations." This document established guidelines for concentrations of uranium and thorium in soil, that will limit maximum radiation received by the public under various conditions of future land usage. These concentrations are as follows:

Material	Maximum Concentrations (pCi/g) for various options			
	1[a]	2[b]	3[c]	4[d]
Natural Thorium (Th-232 + Th-228) with daughters present and in equilibrium	10	50	--	500
Natural Uranium (U-238 + U-234) with daughters present and in equilibrium	10	--	40	200
Depleted Uranium:				
Soluble	35	100	--	1,000
Insoluble	35	300	--	3,000
Enriched Uranium:				
Soluble	30	100	--	1,000
Insoluble	30	250	--	2,500

[a]Based on EPA cleanup standards which limit radiation to 1 mrad/yr to lung and 3 mrad/yr to bone from ingestion and inhalation and 10 μR/h above background from direct external exposure.
[b]Based on limiting individual dose to 170 mrem/yr.
[c]Based on limiting equivalent exposure to 0.02 working level or less.
[d]Based on limiting individual dose to 500 mrem/yr and in case of natural uranium, limiting exposure to 0.02 working level or less.