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December 11, 1991

Dr. Alexander Williams
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Off-Site Branch
Division of Eastern Area Programs
Office of Environmental Restoration
U.S. Department of Energy
Washington, DC 20555

**SUBJECT: CHARACTERIZATION SURVEY OF THE BAKER AND WILLIAMS
WAREHOUSES, BUILDING 521-527, NEW YORK, NEW YORK**

Dear Dr. Williams:

Enclosed are three copies of the final characterization survey of Building 521-527, Baker and Williams Warehouses for review and comment.

If you have any questions, please contact me at FTS 626-3355.

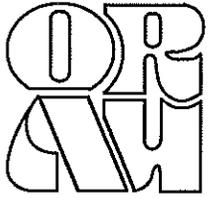
Sincerely,

A handwritten signature in cursive script that reads "Phyllis R. Cotten".

Phyllis R. Cotten
Staff Health Physicist
Environmental Survey and
Site Assessment Program

PRC:ttc

cc: J. Wagoner, DOE/HG
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M. Landis/ORAU
Site File: #336/BWW



Prepared by
Oak Ridge Associated
Universities

Prepared for the
Office of
Environmental
Restoration

U.S. Department
of Energy

**CHARACTERIZATION SURVEY
OF THE
BAKER AND WILLIAMS WAREHOUSES
BUILDING 521-527
NEW YORK, NEW YORK**

P. R. COTTEN, J. L. PAYNE, AND M. R. LANDIS

Environmental Survey and Site Assessment Program
Energy/Environment Systems Division

FINAL REPORT
NOVEMBER 1991

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Prepared for

Department of Energy
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CHARACTERIZATION SURVEY
OF THE
BAKER AND WILLIAMS WAREHOUSES
BUILDING 521-527
NEW YORK, NEW YORK

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**CHARACTERIZATION SURVEY
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INTRODUCTION AND SITE HISTORY

During the early 1940's, the Manhattan Engineer District (MED), predecessor to the Atomic Energy Commission (AEC) and the Department of Energy (DOE), shipped uranium concentrates to the former Baker and Williams Warehouses on West 20th Street, in New York, New York. The warehouses were used for short term storage of the uranium that was later distributed to U.S. Government Facilities. According to historical information, approximately 99,430 kg (219,000 lbs) of orange and yellow sodium uranate was delivered in 1942, and approximately 39,000 kg (86,000 lbs) of orange and yellow sodium uranate, 10,000 kg (22,000 lbs) of sodium uranyl carbonate, and 9,080 kg (20,000 lbs) of black uranium oxide were delivered to the Baker and Williams Warehouses in 1943. Since the 1940's, the warehouses have been leased by several businesses and are currently owned by Ralph Ferrara, Inc.

The Baker and Williams Company owned three adjacent warehouse buildings at 513-519, 521-527, and 529-535 West 20th Street during the 1940's. Historical shipping documents indicate that MED/AEC shipments of uranium concentrates were delivered to the shipping and receiving office located at Building 529-535; however, shipments may have been received, unloaded and/or stored in either of the three warehouse buildings. Adjoining doorways between Buildings 521-527 and 529-535 allowed convenient access between the two buildings.

In 1989, DOE's Office of Environmental Restoration reviewed available historical documentation that described the previous MED/AEC activities conducted at this facility, and based on this information, determined that the potential for radioactive material to be present as a result of the past activities was low. However, the information was insufficient to verify the

radiological condition of the site after MED/AEC activities were terminated. DOE decided that a radiological designation survey should be performed to determine whether additional investigations were warranted under the Formerly Utilized Sites Remedial Action Program (FUSRAP). The purpose of the radiological designation survey is to obtain sufficient radiological measurements to make a recommendation to DOE Headquarters as to whether a site should be included for remedial action or eliminated from FUSRAP.¹ DOE obtained consent from the owners to enter the property at 529-535. A preliminary site visit was performed by representatives of the Environmental Survey and Site Assessment Program (ESSAP) of Oak Ridge Associated Universities (ORAU), and it was determined that Building 521-527 would be included in the survey, based on a visual inspection and accessibility into the adjoining 529-535 building.

In August 1989, ESSAP conducted a radiological designation survey of the interior surfaces of Buildings 521-527 and 529-535.² Areas of elevated direct radiation in excess of DOE guidelines for residual activity were detected on the floor in the West Bay of the ground level of Building 521-527 and in several small areas on the floor and lower walls in the East Bay in the basement. No contamination was detected on the remaining levels in 521-527 or in Building 529-535. As a result of the ESSAP survey findings, the Baker and Williams Warehouses were designated by DOE to be addressed under the proposed expedited protocol for remedial actions at small FUSRAP sites. Under the expedited protocol, the contractor which performs the radiological designation activities also performs the characterization and verification for the project. DOE requested ESSAP to conduct a radiological characterization of the East and West Bays of the basement and the first floor Vault area of Building 521-527. A characterization survey is designed to obtain and provide all data necessary to plan and implement remedial actions. A decision was made by DOE to remove the entire surface of the ground level of the West Bay, and that additional characterization of this area would therefore, not be required. This report describes the results of the characterization survey of Building 521-527 of the Baker and Williams Warehouses.

PROJECT ORGANIZATION AND RESPONSIBILITY

DOE Headquarters provides overview and coordination for all FUSRAP activities. DOE Oak Ridge (DOE-OR) is responsible for implementation of FUSRAP and the Former Sites Restoration Division of DOE-OR, manages the daily activities.

Under the standard FUSRAP protocol, an initial investigation or designation of a potential site is performed by ORAU or Oak Ridge National Laboratory (ORNL), under contact to DOE Headquarters. If appropriate, DOE Headquarters designates the site into FUSRAP based upon the results provided by the initial investigation. DOE's Project Management Contractor (PMC) for FUSRAP is Bechtel National, Inc. (BNI). BNI is responsible for the planning and the implementation of FUSRAP activities and managing the site characterization and remedial actions. The final phase for a FUSRAP site is independent verification which is provided by ORAU or ORNL after remedial action is complete. The verification survey confirms that remedial actions at the site have been effective in meeting current guidelines and assures that documentation accurately and adequately describes the post-remedial action radiological condition of the site. DOE Headquarters uses the information developed by the remedial and verification activities to certify that a site can be released for unrestricted use.

The Baker and Williams Warehouses were selected for remediation under a proposed expedited protocol being considered within FUSRAP. In contrast to the standard protocol, under the expedited protocol, the designation contractor for this site, ORAU, functions as the organization responsible for the designation, characterization, and verification activities, while BNI is responsible for conducting the remedial action and post-remedial action survey.

FACILITY DESCRIPTION

The Baker and Williams Warehouses are located on the west side of Central New York City, in the borough of Manhattan (Figure 1). Building 521-527 has 10 levels and approximately 855 m² (9200 ft²) per level of storage space. Figure 2 provides the layout of the first floor level, including the Vault. Figure 3 illustrates the basement layout. Fireproof materials such as steel, concrete, and brick were used in the construction of the building. The floors are concrete and the interior walls are constructed of masonry brick. The basement ceiling is constructed of concrete; however, the West Bay ceiling has been covered with a 3-4 inch overlay of cork and stucco. Most of the walls in the basement have been painted.

An asphalt layer, several inches thick, had been used to surface the ground level floor. Some of the walls had been resurfaced and recently painted. In a small portion of the West Bay, a four room Vault was constructed over the asphalt material. Concrete blocks and cork paneling were used to construct the walls of the Vault; a concrete floor was poured in Rooms 1 and 2, and a wood floor was installed in Rooms 3 and 4 over the original floor. During this survey, the wall that separated Rooms 1 and 2 was removed, and all of the paneling from the walls and the wood floor were removed in Rooms 3 and 4.

PROCEDURES

Objective

During the period between March 11-22, 1991, ORAU performed a characterization survey of each bay in the basement and the Vault (ground level) in Building 521-527 West 20th Street. The objective of the survey was to characterize the radiological status of these areas and provide sufficient information for design of a remedial action work plan.

Reference Grid

A 1 m x 1 m alphanumeric reference grid system was established on the floors, walls, and ceilings of both bays in the basement, and on the floors and lower walls (up to 2 m) in the Vault. Measurements were referenced to this grid or to prominent building features.

Surface Scans

Surface scans were performed on all gridded surfaces (floor, walls, ceilings), on overhead piping in the basement bays, and on the floors and lower walls in the Vault. The scans were used to identify locations of residual activity for which the boundaries were later defined by direct measurements. Gamma scans were performed using NaI(Tl) gamma scintillation detectors. A large-area gas-proportional detector was used to perform alpha plus beta scans of the floor, walls, and ceiling. Locations with limited accessibility such as overhead piping, ducts, and ledges were scanned using ZnS scintillation detectors and GM "pancake" detectors. All detectors were coupled to countrate meters with audible signal outputs.

Measurement of Surface Activity Levels

The radionuclide of concern is processed natural uranium, i.e. uranium separated from its long lived daughter products, but in its naturally occurring isotopic abundances. Processed natural uranium emits both alpha and beta radiation in approximately equal proportions; either beta activity levels or alpha activity levels may therefore, be measured for determining uranium surface contamination.

To define the boundaries of those areas which exceeded the guidelines, measurements to determine surface activity levels were performed in grid blocks with elevated activity identified during the scans. An additional 5% of the grid blocks in the West Bay of the basement were selected for direct measurements to provide information to support previous survey findings.

These additional measurements were considered necessary to corroborate limited data obtained during the initial designation survey, because material stored in the area made the surfaces inaccessible.

Previous survey results indicate that measurements for beta activity levels, rather than alpha activity, provide a more accurate representation of uranium surface activity, due to conditions of the building surfaces (e.g. dusty, porous, or rough), which may selectively attenuate the alpha activity. Therefore, beta activity levels were used for comparison with the guideline values. Measurements for total beta activity levels in grid blocks (5-points) were systematically performed at the center and four points, midway between the center and grid block corners. Single point measurements were also performed at locations of elevated activity within each block and at other randomly selected measurement locations. A GM "pancake" detector was used to obtain these measurements.

A smear sample for determining removable activity was obtained for each set of five-point measurements at the location corresponding to the maximum direct measurement and from each single-point measurement location.

A total of twenty-five, five-point measurements and eight single-point measurements were collected in the West Bay basement of Building 521-527 (Figures 4 and 5). In the East Bay basement, fifty-six five-point measurements and fifty-nine single-point measurements were performed on the floor, walls, and overhead surfaces (Figures 6 and 7). In the Vault, a total of sixty-eight five-point measurements and fifteen single-point measurements were performed. Measurements in the Vault were primarily on the floor surface (Figures 8-10).

Miscellaneous Samples

To assist in identifying the contaminant, three samples of dust were collected in the East Bay basement. Dust was collected from a floor crack in grid block E,22 and two composite

samples were collected; one from the brick ledges in grid block D,26.4, 1 m above the floor surface, and the other sample from floor sweepings from the west side of the East Bay (Figure 11).

Sample Analysis and Data Interpretation

All samples and data were returned to the ESSAP laboratory in Oak Ridge, TN for analysis and interpretation. Surface activity measurements were converted to units of disintegrations per minute per 100 cm² (dpm/100 cm²). Smears were analyzed for gross alpha and gross beta activity and miscellaneous samples were analyzed using gamma spectrometry. Additional information concerning major instrumentation, sampling equipment, and analytical procedures is provided in Appendices A and B. Findings and results were compared to the DOE guidelines outlined in Appendix C.

SITE RELEASE GUIDELINES

The detailed DOE guidelines for residual radioactive material are included as Appendix C. The radionuclide of concern at the Baker and Williams Warehouses is processed natural uranium. The DOE surface activity guideline levels for uranium are as follows:

Total Activity

5,000 dpm α /100 cm², averaged over a 1 m² area
15,000 dpm α /100 cm², maximum in a 100 cm² area

Removable Activity

1,000 dpm α /100 cm², removable

FINDINGS AND RESULTS

Basement-East Bay

Surface scans identified elevated direct radiation levels on overhead piping, on horizontal surfaces such as ledges and platforms, and on the floor of the East Bay basement.

Surface activity measurements in the East Bay of the basement, exceeding the DOE guidelines, are summarized in Table 1. Direct measurements identified two grid blocks in which the average activity over 1 m² area was 19,000 dpm/100 cm² (grid block E,11) and 10,000 dpm/100 cm² (grid block L,21). Two small isolated locations of elevated activity were identified in grid blocks N,20 (16,000 dpm/100 cm²) and F,6 (34,000 dpm/100 cm²), refer to Figure 11. Surface activity ranged from <320 to 13,000 dpm/100 cm² in the remaining areas in the East Bay (Table 2). The highest activity (13,000 dpm/100cm²) was detected on the overhead piping. The activity detected on the overhead piping does not exceed the maximum guideline for 100 cm² and does not exceed the average guideline due to the dimension of the piping.

Removable activity ranged from <6 to 29 dpm/100 cm² and <13 to 33 dpm/100 cm² for alpha and beta, respectively. This activity is less than the guideline value of 1000 dpm/100².

Basement-West Bay

Surface scans identified elevated direct radiation levels on overhead piping and on the east wall of the West Bay in the basement. Surface activity measurements collected in the West Bay are summarized in Table 2. These measurements range from <330 to 9,900 dpm/100 cm² and no removable activity was detected. All measurements were within the average and maximum guideline.

Ground Floor-Vault

Surface scans of Vault Rooms 1 and 2 did not identify any areas of elevated activity. No detectable activity was initially identified in Vault Rooms 3 and 4; however, after the wood flooring was removed in Rooms 3 and 4, surface scans identified elevated activity over much of the floor area (Figures 12 and 13).

Direct measurements identified 11 grid blocks in Vault Rooms 3 and 4 with activity levels ranging from 5,000 to 13,000 dpm/100 cm² that exceeded the average guideline. These measurements are summarized in Table 1. Direct activity measurements in Vault Rooms 1 and 2 were, for the most part, less than the detection sensitivity of the instrumentation (Refer to Table 2). No removable activity was detected.

Miscellaneous Measurements and Samples

Table 2 summarizes the results of additional single-point measurements performed in the basement East and West Bays, and in the Vault on the ground level. Total beta activity levels ranged from <320 to 13,000 dpm/100 cm²; removable activity ranged from <6 to 35 dpm/100 cm² for alpha and from <13 to 39 dpm/100 cm² for beta.

Analyses of the dust samples from horizontal surfaces, identified the presence of uranium. Gamma spectrometry indicate concentrations of uranium which ranged from 11 pCi/g to 100 pCi/g. These results are semi-quantitative due to the small amount of dust that could be collected.

Removable activity levels on smear samples collected from horizontal surfaces are less than the detector sensitivity.

SUMMARY

On March 11-22, 1991, the Environmental Survey and Site Assessment Program of ORAU conducted a characterization survey in Building 521-527 of the East and West Bays in the basement and in the Vault located on the ground floor. The survey included surface scans and activity measurements on the floor, wall, and ceiling surfaces. Direct measurements and smears were compared to the DOE surface contamination guidelines for uranium (Appendix C). Only two grid blocks in the East Bay of the Basement were identified as exceeding the 5,000 dpm/100 cm² guideline (L,21 and E,11). Two locations exceeding the hot spot guideline were also identified in the East Bay of the Basement, N +.5,21 and F,6. Residual contamination exceeding the average guideline for a 1 m² area was identified in 11 floor grid blocks in Rooms 3 and 4 of the Vault. Removable activity levels were within the guidelines. Dust on horizontal surfaces of these areas was found to contain elevated concentrations of uranium. The survey did not detect any areas that exceeded the guidelines in the West Bay of the Basement or in Rooms 1 and 2 of the Vault; however, general elevated locations were detected.

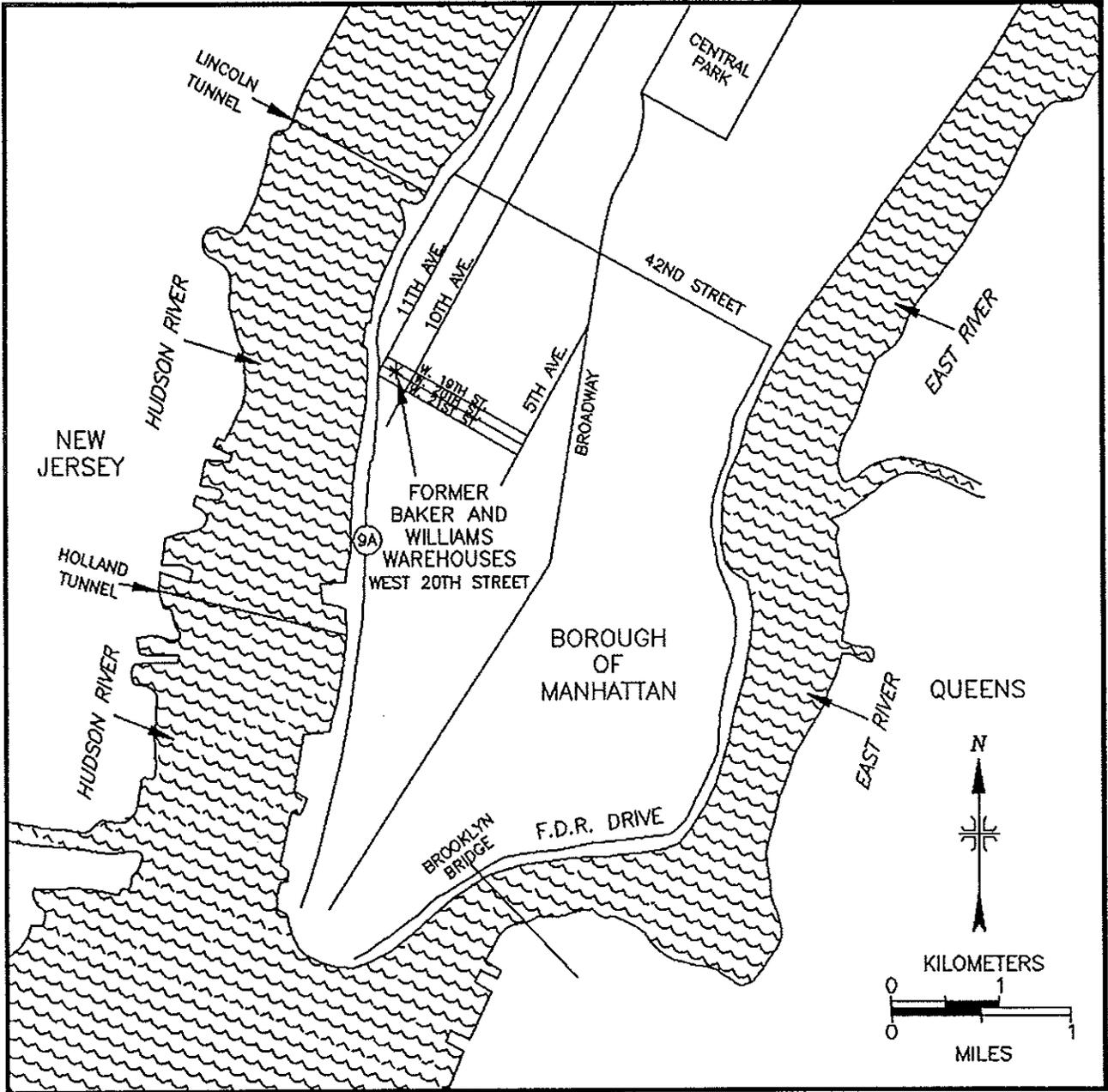


FIGURE 1: Location of the Baker and Williams Warehouses

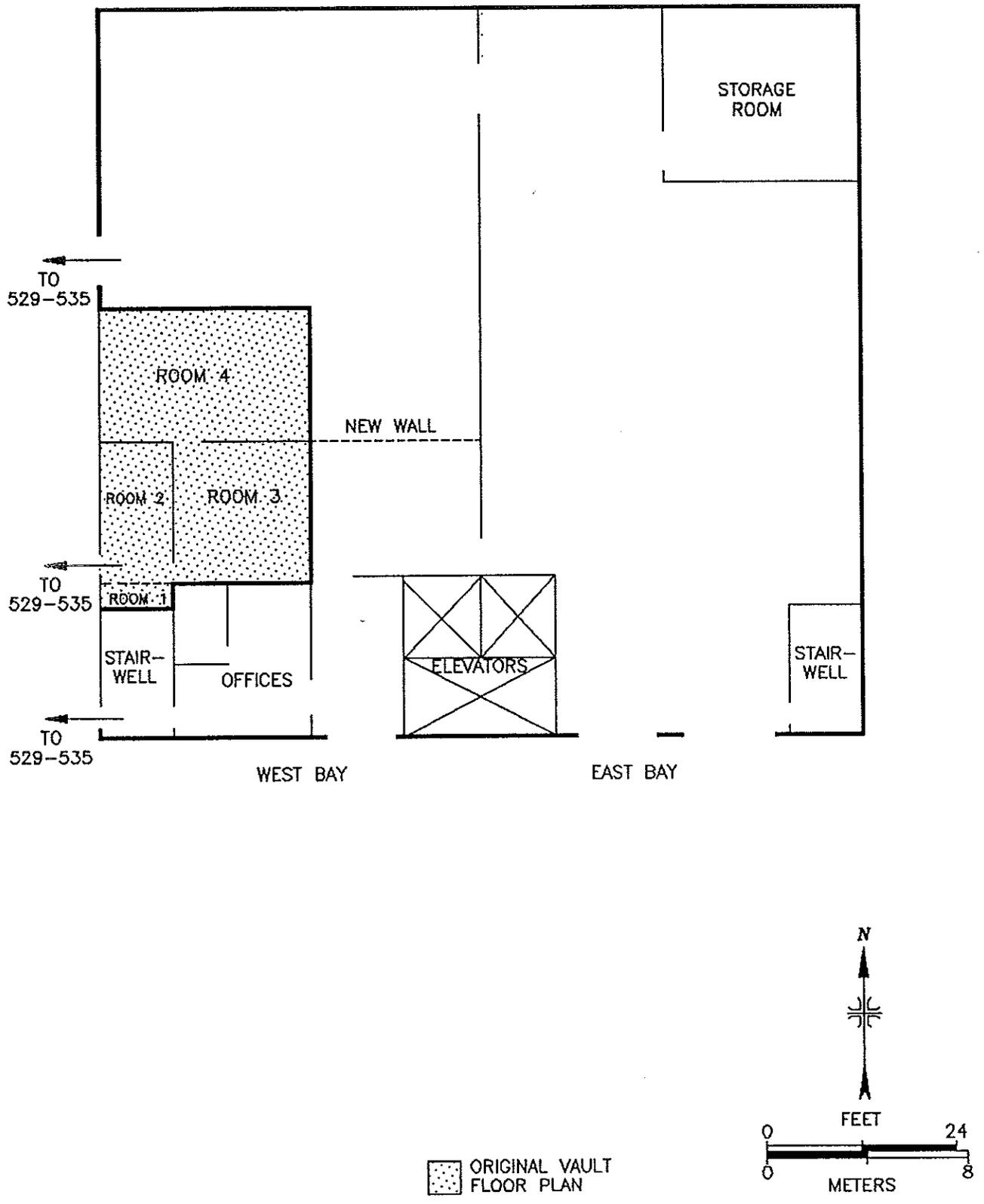


FIGURE 2: Floor Plan of Building 521-527 - Ground Level

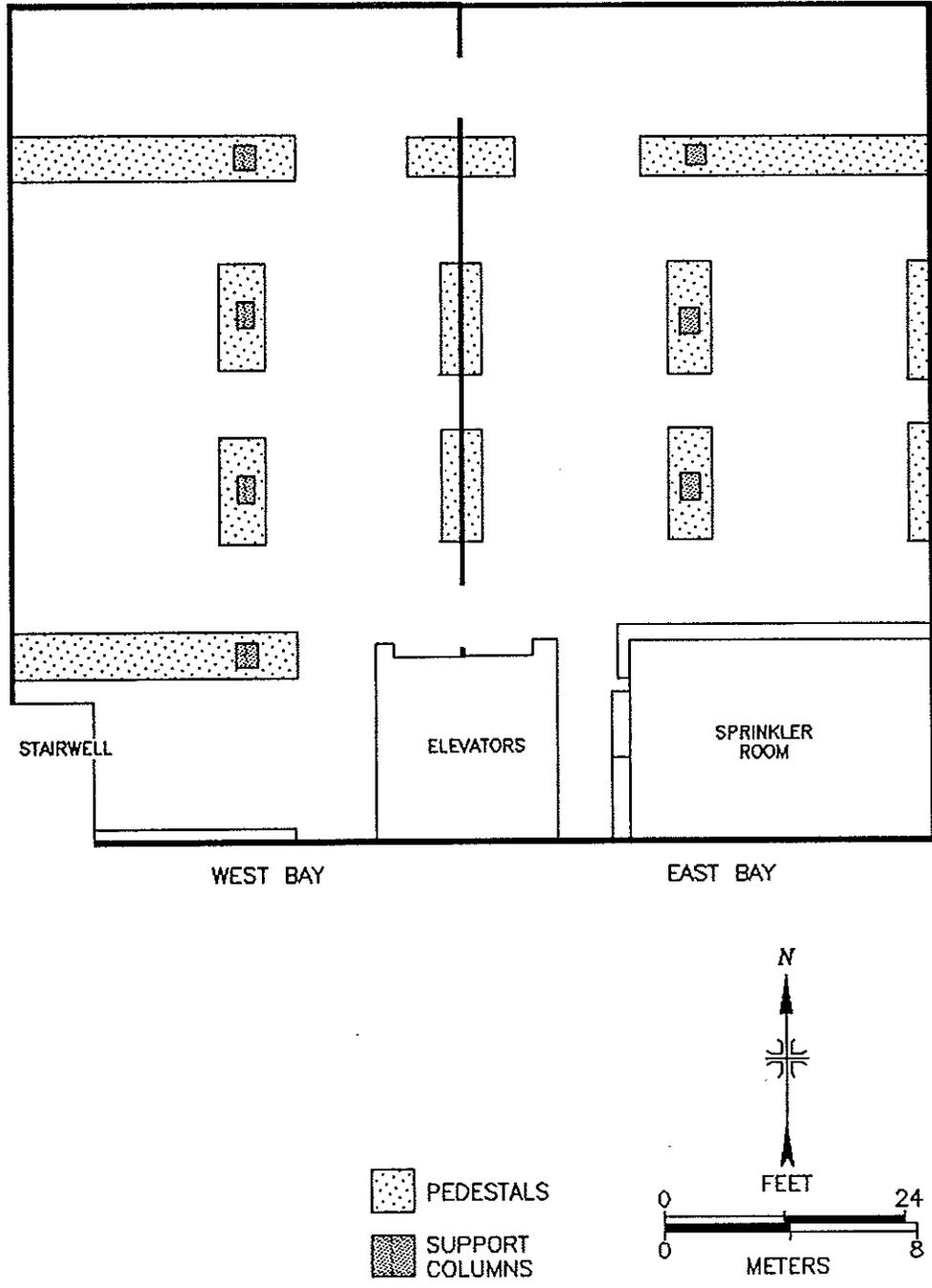


FIGURE 3: Floor Plan of Building 521-527 – Basement Level

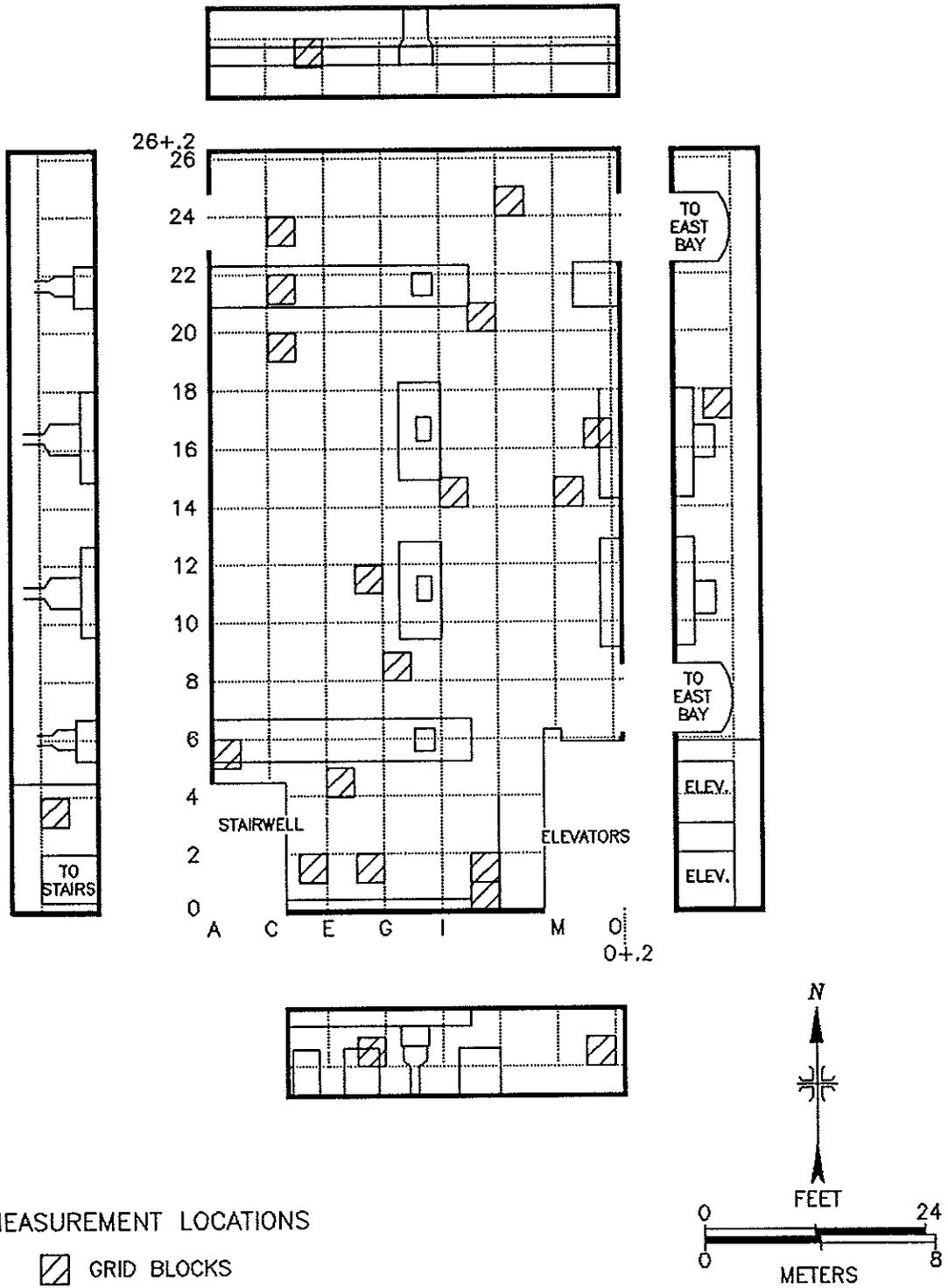


FIGURE 4: West Bay Basement – Grid Block Measurement Locations

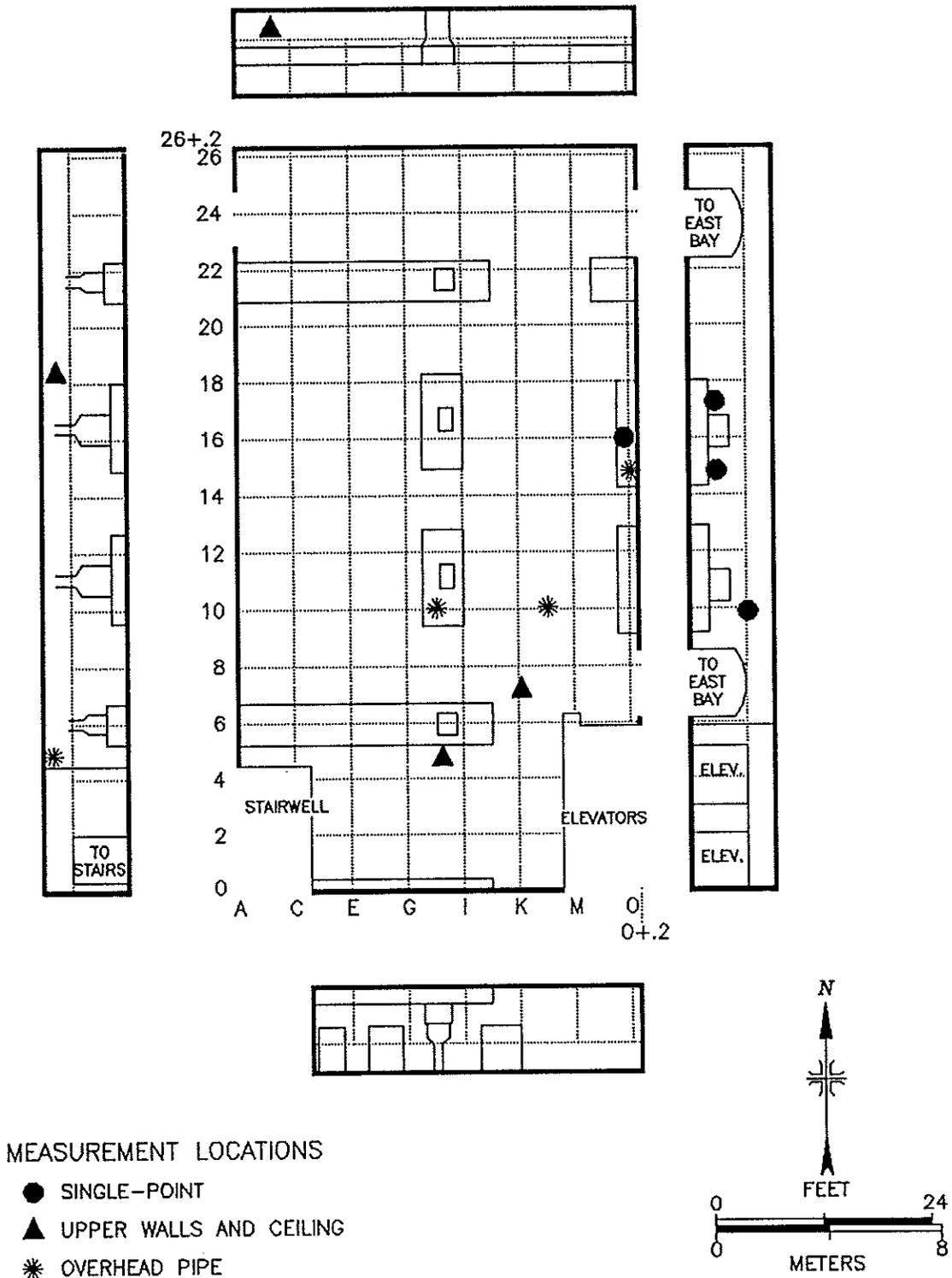


FIGURE 5: West Bay Basement – Measurement Locations

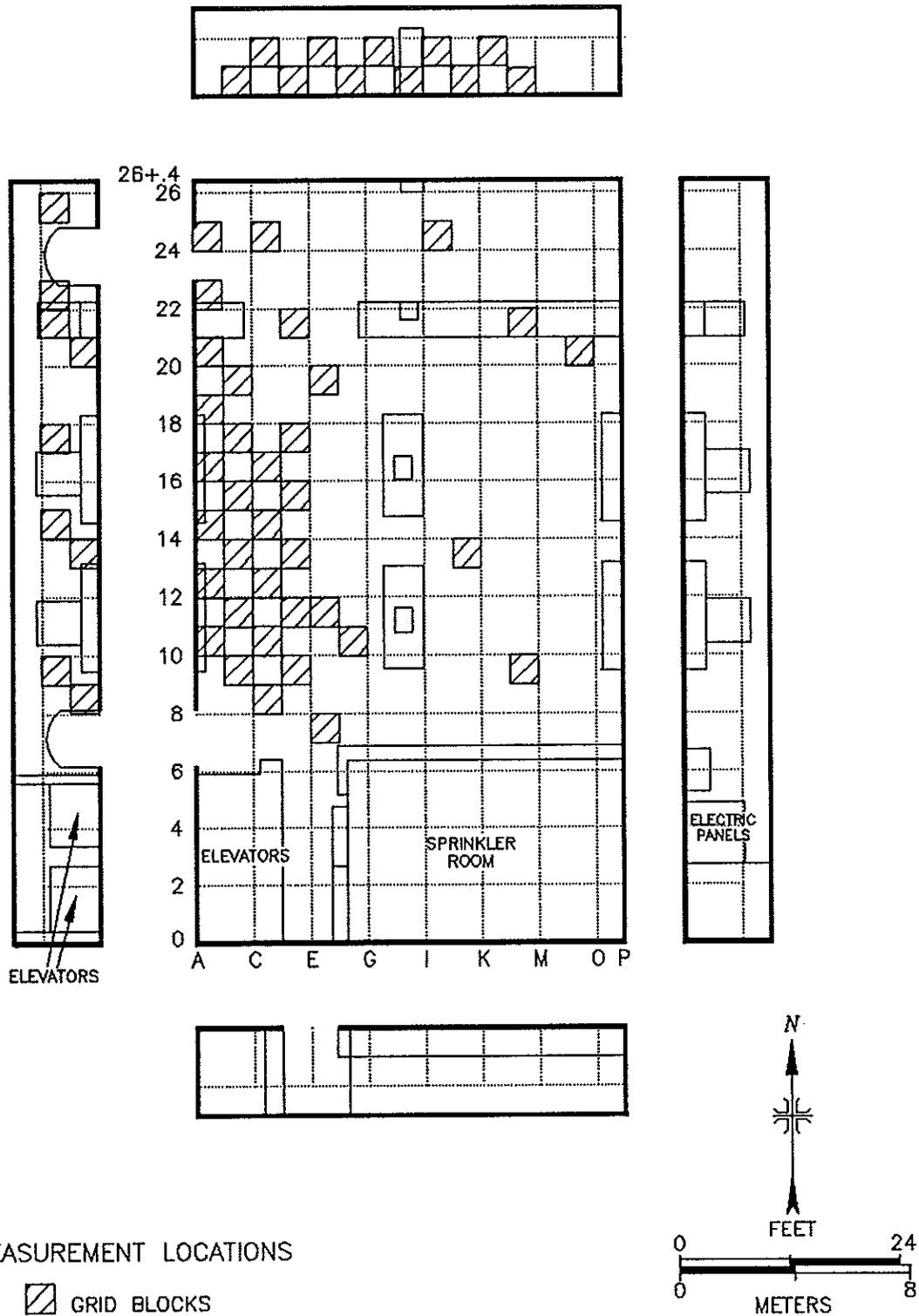


FIGURE 6: East Bay Basement – Grid Block Measurement Locations

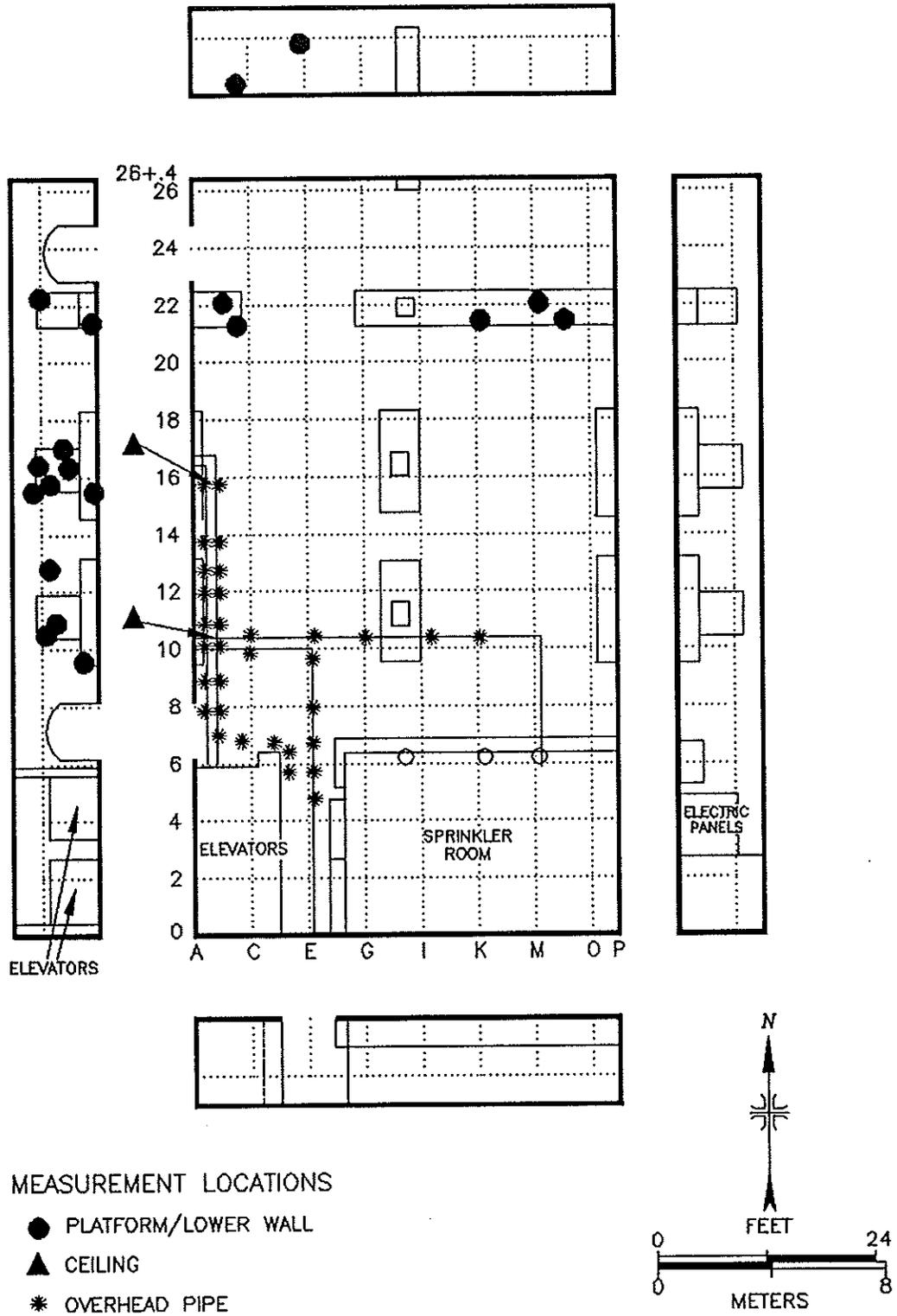


FIGURE 7: East Bay Basement – Measurement Locations

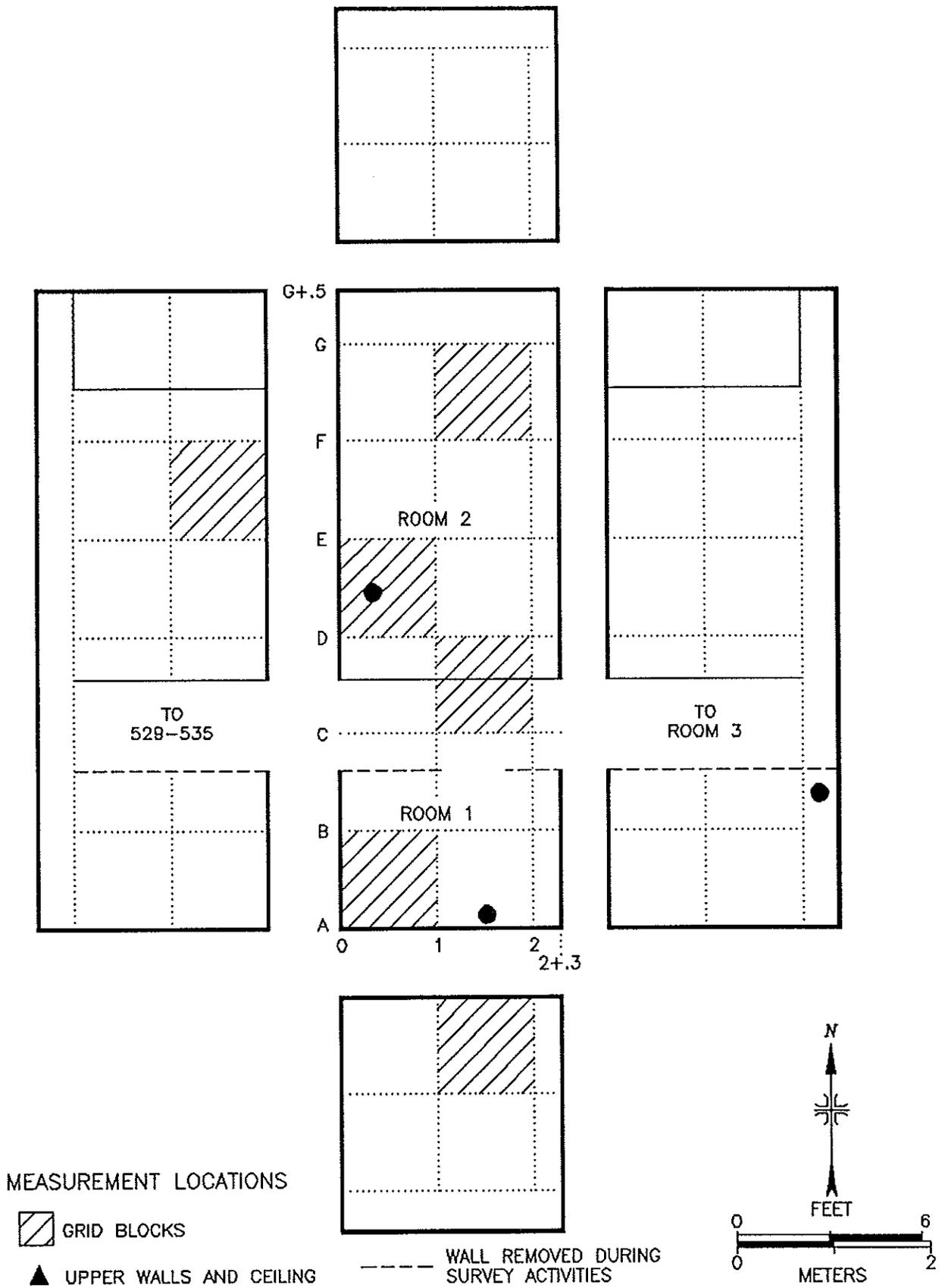


FIGURE 8: Vault, Rooms 1 and 2 – Measurement Locations

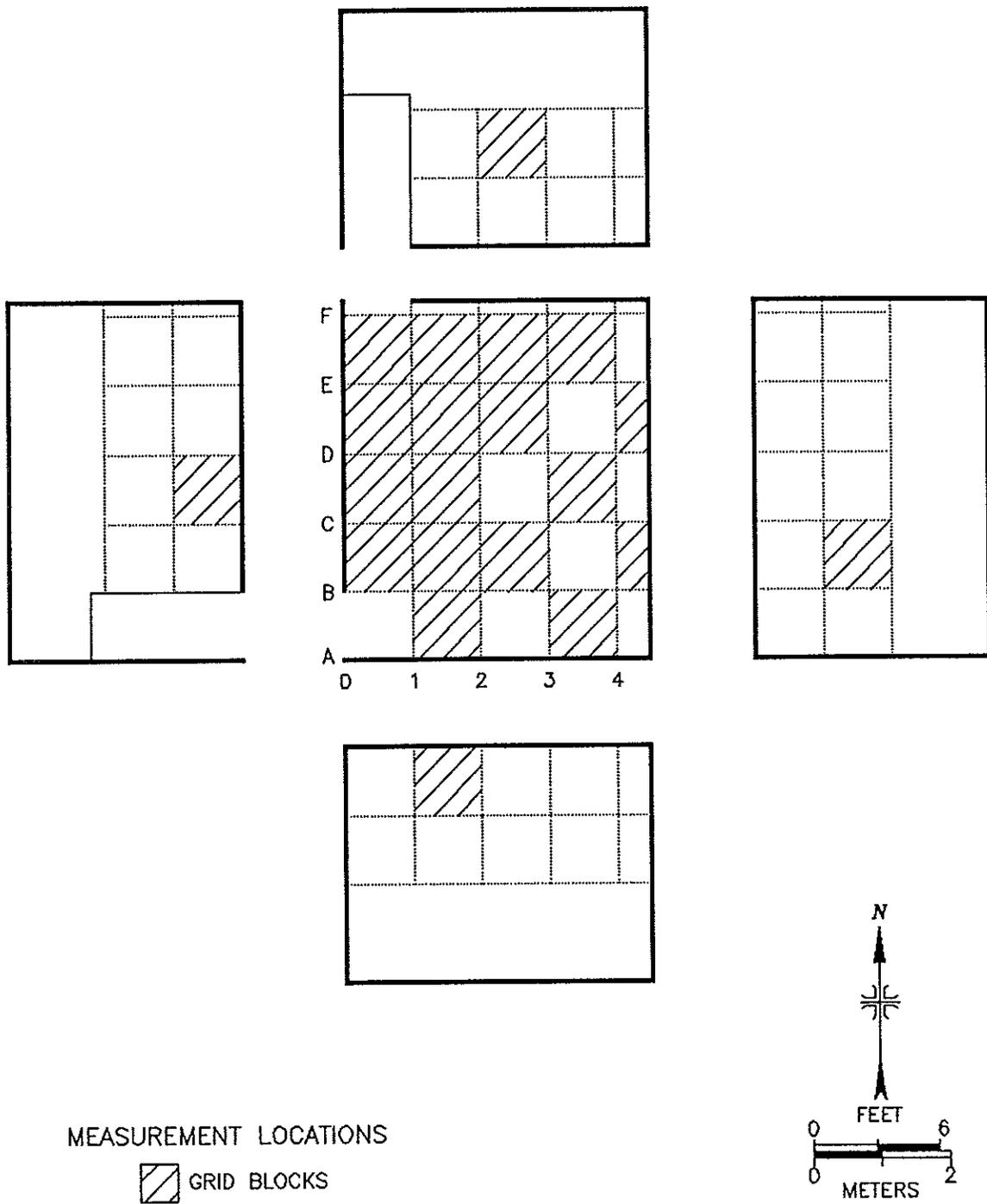


FIGURE 9: Vault, Room 3 – Grid Block Measurement Locations

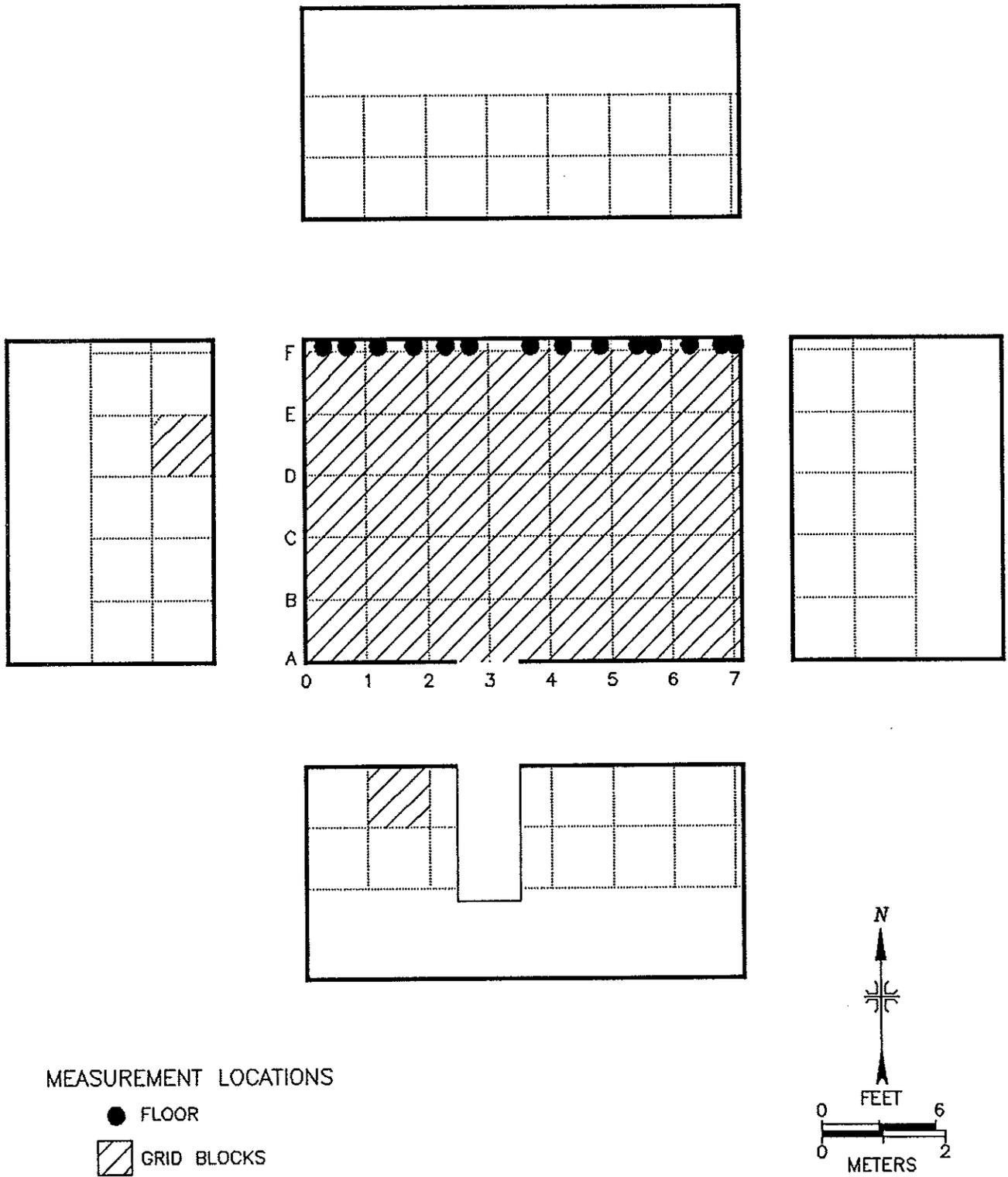


FIGURE 10: Vault Room 4 – Measurement Locations

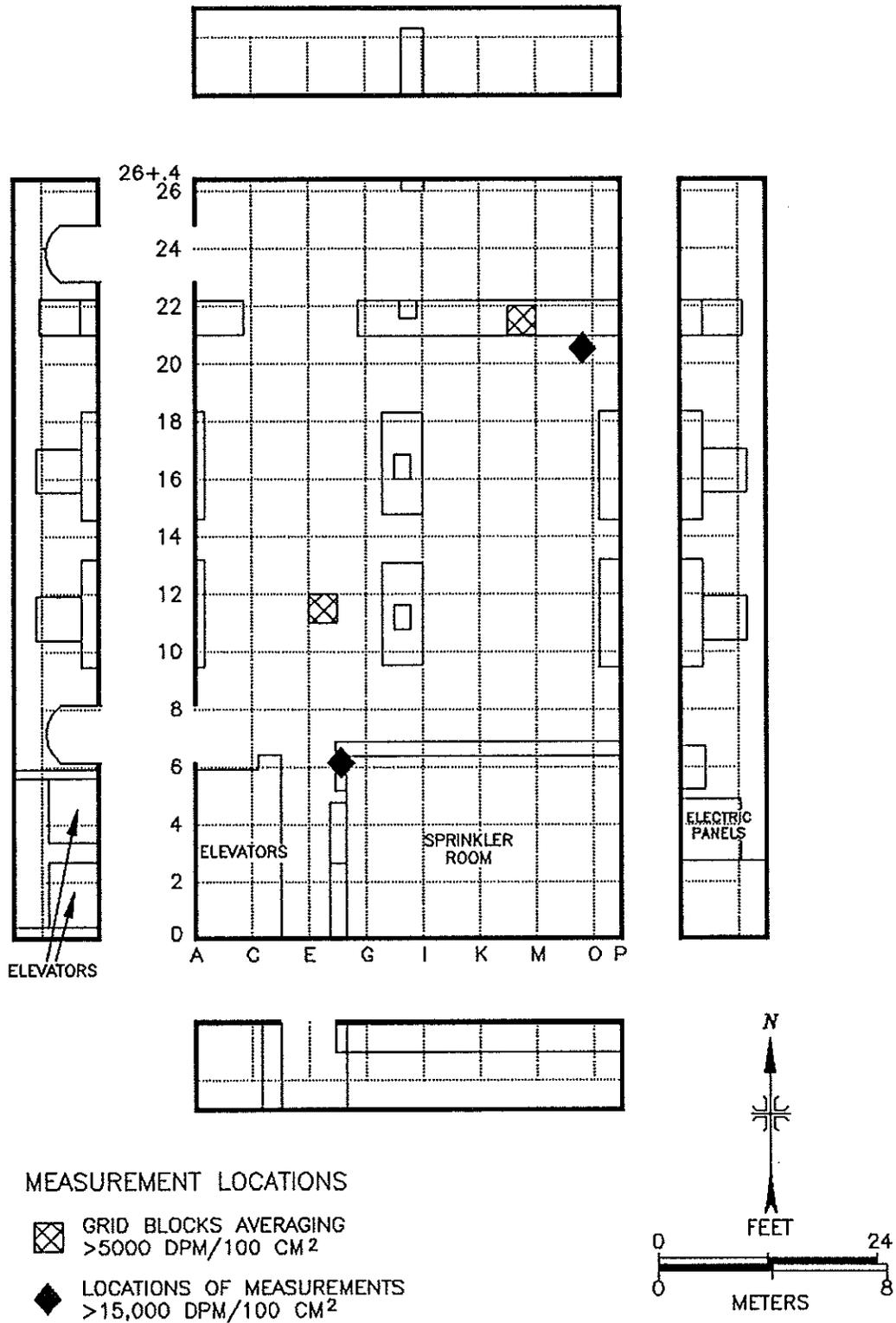


FIGURE 11: East Bay – Locations Exceeding Guidelines

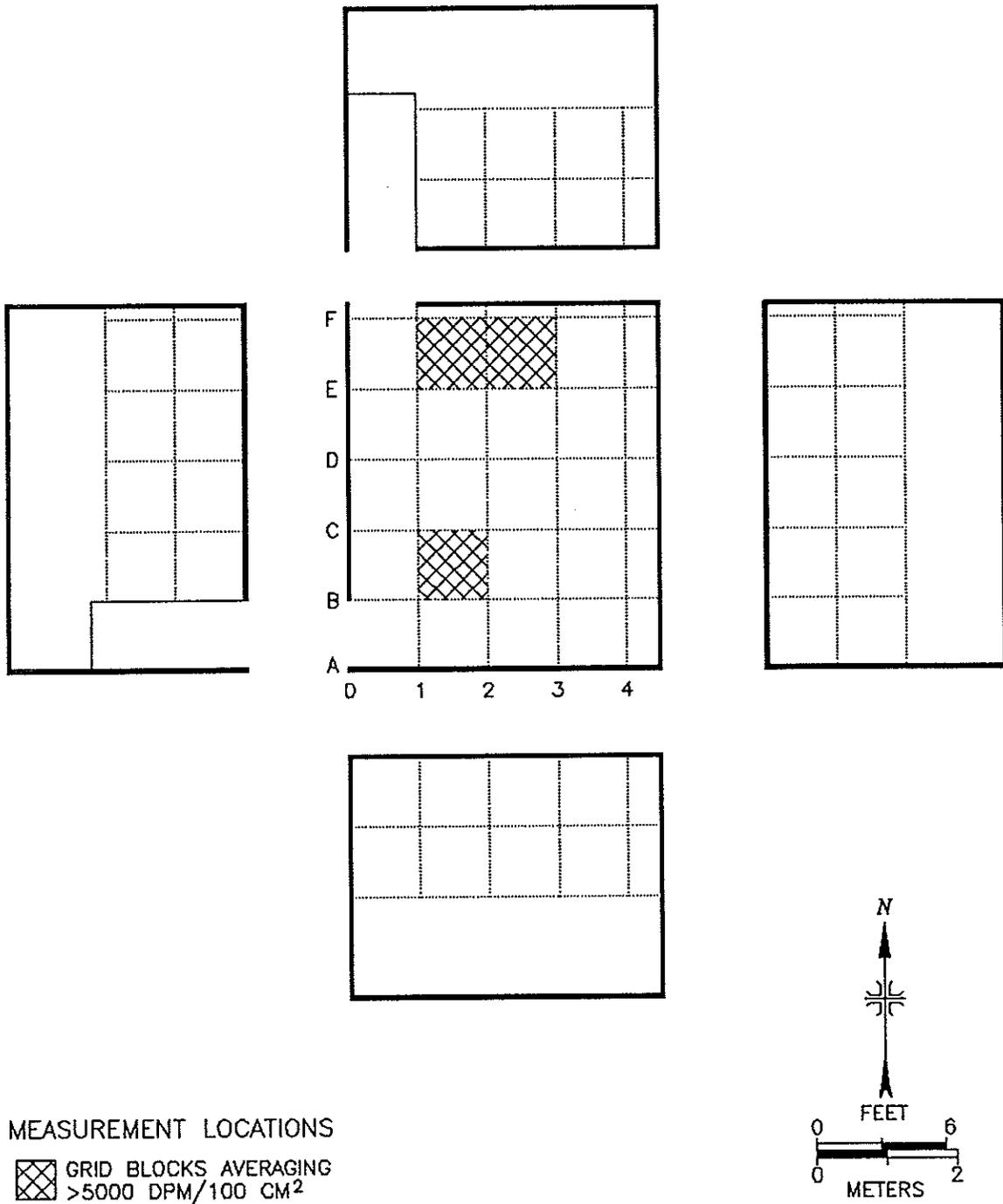


FIGURE 12: Vault, Room 3 – Grid Blocks Exceeding Guidelines

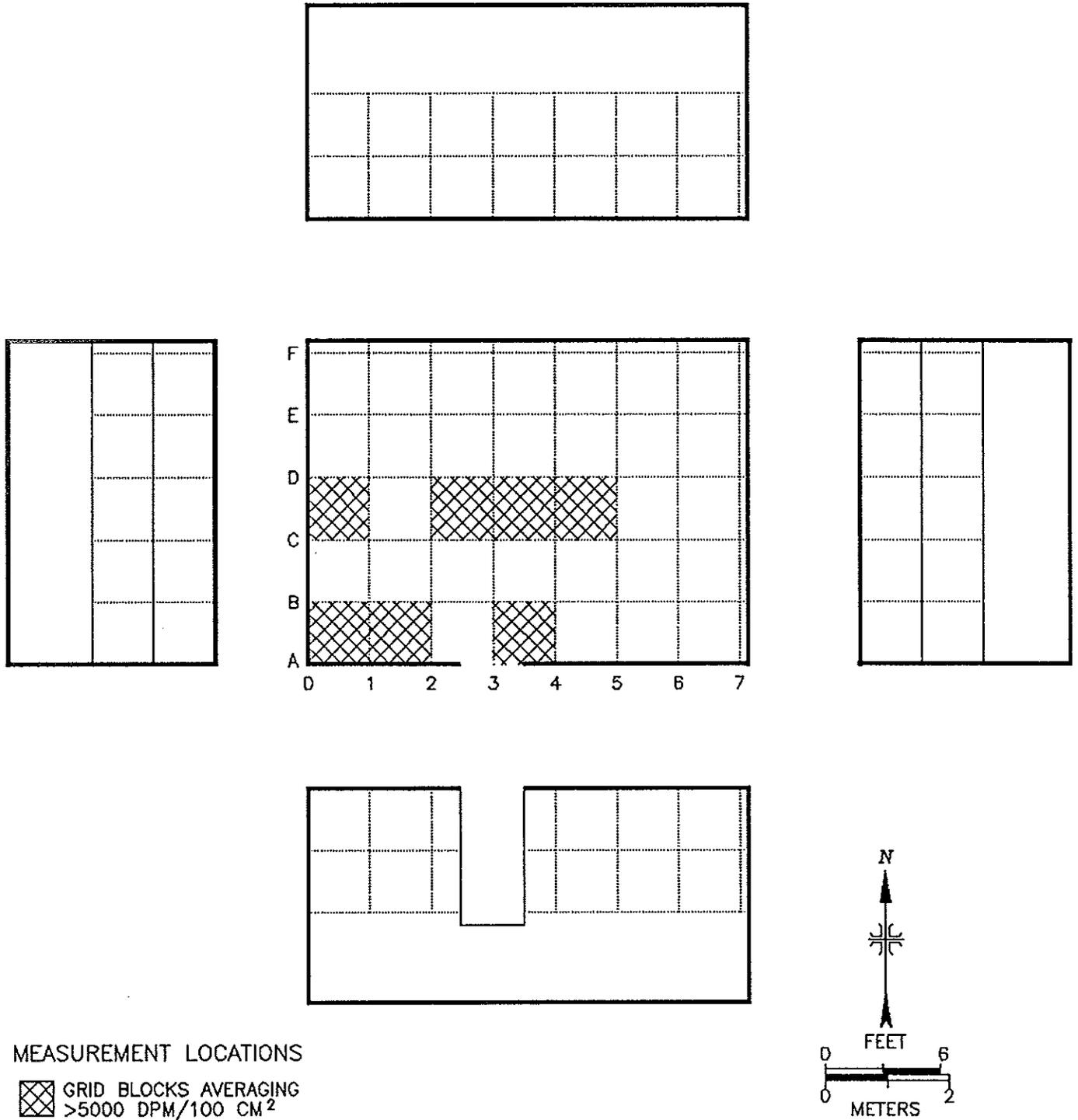


FIGURE 13: Vault, Room 4 – Grid Blocks Exceeding Guidelines

TABLE 1

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
 EXCEEDING GUIDELINES
 BUILDING 521-527 BASEMENT AND VAULT AREAS
 BAKER AND WILLIAMS WAREHOUSES
 NEW YORK, NEW YORK

Location Area/Grid Block	Figure	Beta Activity (dpm/100 cm ²)		Removable Activity (dpm/100 cm ²)		Surface Area of Elevated Activity
		Maximum	Grid Block Average	Alpha	Beta	
EAST BAY BASEMENT						
E,11	11	67,000	19,000	<6	<13	*
L,21	11	24,000	10,000	<6	<13	*
N,20	11	16,000	N/A ^b	<6	<13	100 cm ²
F,6 (Ledge)	11	34,000	N/A	15	<13	400 cm ²
VAULT ROOM 3						
D,1	12	N/A	5,000	<6	<13	*
B,1	12	N/A	6,800	<6	<13	*
E,2	12	N/A	5,200	<6	<13	*
E,1	12	N/A	5,200	11	<13	*
VAULT ROOM 4						
A,0	13	31,000	13,000	11	<13	*
A,1	13	23,000	10,000	<6	<13	*

TABLE 1 (Cont'd)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
 EXCEEDING GUIDELINES
 BUILDING 521-527 BASEMENT AND VAULT AREAS
 BAKER AND WILLIAMS WAREHOUSES
 NEW YORK, NEW YORK

Location Area/Grid Block	Figure	Beta Activity (dpm/100 cm ²)		Removable Activity (dpm/100 cm ²)		Surface Area of Elevated Activity
		Maximum	Grid Block Average	Alpha	Beta	
A,3	13	46,000	11,000	<6	<13	*
A,4	13	16,000	N/A	<6	<13	100 cm ²
C,0	13	N/A	5,100	<6	<13	*
C,22	13	16,000	7,600	7	<13	*
C,3	13	N/A	6,100	9	<13	*
C,4	13	N/A	6,700	<6	<13	*

^a*Entire 1 m² surface area of gridblock indicates elevated activity.

^bN/A = Not Applicable.

TABLE 2

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
 BUILDING 521-527 BASEMENT AND VAULT AREAS
 BAKER AND WILLIAMS WAREHOUSES
 NEW YORK, NEW YORK

Location	Figure	Number of Measurement		Highest Gridblock Average dpm/100 cm ²	Range of Total Activity dpm/100 cm ² Alpha plus Beta	Range of Removable Activity dpm/100 cm ²	
		Single Pt.	Locations Blocks			Alpha	Beta
<u>East Bay</u> Floor Lower Walls Ceiling Misc. ^b	6	N/A ^a	33	3,400	<320 - 12,000	<6 - 29	<13 - 33
	6	N/A	18	2,700	<320 - 9,500	<6	<13
	7	N/A	3	<320	<320	<6	<13
	7	58	N/A	N/A	<320 - 13,000	<6	<13
<u>West Bay</u> Floor Lower Walls Upper Walls Ceiling Misc. ^b	4	N/A	15	700	<330 - 1,200	<6	<13
	4	N/A	6	950	<330 - 3,200	<6	<13
	5	N/A	2	490	<330 - 850	<6	<13
	5	N/A	2	<330	<330	<6	<13
	5	8	N/A	N/A	<330 - 9,900	<6	<13
<u>Vault Rm 1/2</u> Floor Lower Walls Upper Walls Ceiling	8	N/A	4	360	<320 - 670	<6 - 7	<13
	8	N/A	2	<320	<320	<6	<13
	8	1	N/A	N/A	<340	<6	<13
	8	2	N/A	N/A	<340	<6	<13

TABLE 2 (Cont'd)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
 BUILDING 521-527 BASEMENT AND VAULT AREAS
 BAKER AND WILLIAMS WAREHOUSES
 NEW YORK, NEW YORK

Location	Figure	Number of Blocks/ Single Pt. Blocks		Highest Gridblock Average dpm/100 cm ²	Range of Total Activity dpm/100 cm ² Alpha plus Beta	Range of Removable Activity dpm/100 cm ²	
		Single Pt.	Blocks			Alpha	Beta
<u>Vault Room 3</u>							
Floor	9	N/A	14	4,900	<320 - 13,000	<6	<13
Lower Walls	9	N/A	4	<340	<320 - 720	<6	<13
<u>Vault Room 4</u>							
Floor	10	15	28	4,300	<320 - 12,000	<6 - 35	<13 - 39
Lower Walls	10	N/A	2	1,200	<340 - 3,900	<6	<13

^a N/A = Not Applicable.

^b Measurements were collected on overhead piping. Elevated activity levels are not applicable to average or maximum surface contamination guidelines.

REFERENCES

1. Bechtel National, Inc.; Formerly Utilized Sites Remedial Action Program, "Implementation Plan For Radiological Surveys Protocols," July 1988.
2. Oak Ridge Associated Universities, Radiological Survey of the Baker and Williams Warehouses, New York, New York, June 1990.

APPENDIX A

MAJOR SAMPLING AND ANALYTICAL EQUIPMENT

APPENDIX A

MAJOR SAMPLING AND ANALYTICAL EQUIPMENT

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

A. Direct Radiation Measurements

Eberline "RASCAL"
Portable Ratemeter-Scaler
Model PRS-1
(Eberline, Santa Fe, NM)

Eberline PRM-6
Portable Ratemeter
(Eberline, Santa Fe, NM)

Eberline Alpha Scintillation Detector
Model AC-3-7
(Eberline, Santa Fe, NM)

Eberline "Pancake" Detector
Model HP-260
(Eberline, Santa Fe, NM)

Ludlum Scaler-Ratemeter
Model 2220
(Ludlum Measurements, Sweetwater, TX)

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

Ludlum Gas Proportional Floor Monitor
Model 239-1
(Ludlum Measurements, Sweetwater, TX)

Victoreen NaI Scintillation Detector
Model 489-55
(Victoreen, Cleveland, OH)

B. Laboratory Analyses

Low Background Gas Proportional Counter
Model BL-5110
(Tennelec, Oak Ridge, TN)

High-Purity Germanium Detector
Model GMX-23195-S, 23% efficiency
(EG&G ORTEC, Oak Ridge, TN)

Used in conjunction with:
Lead Shield, G-16
(Gamma Products, Palos Hills, IL)

Multichannel Analyzer
ND-66/MicroVax II
(Digital Equipment Corp., Maynard, MA)

APPENDIX B
MEASUREMENT AND ANALYTICAL PROCEDURES

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Surface Scans

Surface scans were performed by passing the probes slowly over the surface; the distance between the probe and the surface was maintained nominally about 1 cm. Identification of elevated levels was based on increases in the audible signal from the recording or indicating instrument. Scans of large surface areas on the floor of the facility were accomplished by use of a gas-proportional floor monitor. The detector was slowly moved in a systematic pattern to cover 100% of the accessible floor area. Other surfaces were scanned using smaller, hand-held detectors. Combinations of detectors and instruments used for the scans were:

- | | | |
|-----------------|---|--|
| Alpha Plus Beta | - | Gas Proportional Detector (100 cm ²), with Scaler/Ratemeter. |
| | - | Gas Proportional Detector (550 cm ²) Floor Monitor with Scaler/Ratemeter. |
| Beta-Gamma | - | Pancake GM Detector (15 cm ² , 1.4 mg/cm ² window), with Scaler/Ratemeter. |
| Gamma | - | NaI Scintillation Detector (3.2 cm x 3.8 cm crystal), with Ratemeter. |

Surface Activity Measurements

Measurements of total alpha plus beta surface activity were performed using portable scaler/ratemeters with thin-window gas-proportional detectors. Count rates (cpm) were converted to disintegration rates (dpm/100 cm²) by dividing the net rate by the 4 π efficiency and correcting of the active area of the detector. Effective window area is 100 cm² and the average background count rate is approximately 400 cpm. The efficiency factor for the gas-proportional detector is 21 percent.

Removable Measurements

Smears for determination of removable activity were performed using numbered dry filter paper disks, 47 mm in diameter; smears were sealed in labeled envelopes with the locations and other pertinent information recorded. The smears were returned to laboratories in Oak Ridge and counted on a low-background gas-proportional counter for gross alpha and gross beta activity.

Gamma Spectrometry

The samples were placed in an appropriate container chosen to reproduce the calibrated counting geometry. The net weights were determined and the samples counted using a high-purity germanium detector coupled to a Nuclear Data Model ND-66/Micro VaxII 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-238	0.093 MeV from Th-234*
U-235	0.143 MeV

Spectra were reviewed for other identifiable photopeaks.

*Secular equilibrium assumed.

Uncertainties and Detection Limits

The analytical data presented in this report represent the 95% confidence levels for that data. These uncertainties were calculated, based on both the gross sample count levels and the associated background count levels. When the net sample count was less than the 95% statistical deviation of the background count, the sample concentration was reported as less than the detection limit of the measurement procedure. Because of variations in background levels, sample volumes or weights, measurement efficiencies, and Compton contributions from naturally occurring radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument. Additional uncertainties of ± 6 to 10%, associated with laboratory procedures, have not been propagated into the data presented in this report.

Calibration and Quality Assurance

The Environmental Survey and Site Assessment Program conducted the survey and analytical activities in accordance with field survey and laboratory procedures which are documented in manuals developed specifically for the Oak Ridge Associated Universities. The specific manuals and procedures applicable to this survey were the "Quality Assurance Manual," February 1990, Revision 3; "Survey Procedures Manual," February 1991, Revision 6; and the "Laboratory Procedures Manual," February 1990, Revision 5.

With the exception of the measurements conducted with portable gamma scintillation survey meters, instruments were calibrated with NIST-traceable standards.

Quality control procedures on all instruments included daily background and check-source measurements to confirm equipment operation within acceptable statistical fluctuations. The ORAU laboratory participates in the EPA and EML Quality Assurance Programs.

APPENDIX C

**U.S. DEPARTMENT OF ENERGY GUIDELINES
FOR RESIDUAL RADIOACTIVE MATERIAL AT
FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM
AND
REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM SITES**

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)

A. INTRODUCTION

This document presents U.S. Department of Energy (DOE) radiological protection guidelines for cleanup of residual radioactive material and management of the resulting wastes and residues. It is applicable to sites identified by the Formerly Utilized Sites Remedial Action Program (FUSRAP) and remote sites identified by the Surplus Facilities Management Program (SFMP).^{*} The topics covered are basic dose limits, guidelines and authorized limits for allowable levels of residual radioactive material, and requirements for control of the radioactive wastes and residues.

Protocols for identification, characterization, and designation of FUSRAP sites for remedial action; for implementation of the remedial action; and for certification of a FUSRAP site for release for unrestricted use are given in a separate document (U.S. Department of Energy 1986) and subsequent guidance. More detailed information on applications of the guidelines presented herein, including procedures for deriving site-specific guidelines for allowable levels of residual radioactive material from basic dose limits, is contained in "A Manual for Implementing Residual Radioactive Material Guidelines" (U.S. Department of Energy 1987), referred to herein as the "supplement".

"Residual radioactive material" is used in these guidelines to describe radioactive material derived from operations or sites over which DOE has authority. Guidelines or guidance to limit the levels of radioactive material and to protect the public and the environment are

^{*}A remote SFMP site is one that is excess to DOE programmatic needs and is located outside a major operating DOE research and development or production area.

provided for (1) residual concentrations of radionuclides in soil,* (2) concentrations of airborne radon decay products, (3) external gamma radiation levels, (4) surface contamination levels, and (5) radionuclide concentrations in air or water resulting from or associated with any of the above.

A "basic dose limit" is a prescribed standard from which limits for quantities that can be monitored and controlled are derived; it is specified in terms of the effective dose equivalent as defined by the International Commission on Radiological Protection (ICRP 1977, 1978). The basic dose limits are used for deriving guidelines for residual concentrations of radionuclides in soil. Guidelines for residual concentrations of thorium and radium in soil, concentrations of airborne radon decay products, allowable indoor external gamma radiation levels, and residual surface contamination concentrations are based on existing radiological protection standards (U.S. Environmental Protection Agency 1983; U.S. Nuclear Regulatory Commission 1982; and DOE Departmental Orders). Derived guidelines or limits based on the basic dose limits for those quantities are used only when the guidelines provided in the existing standards cited above are shown to be inappropriate.

A "guideline" for residual radioactive material is a level of radioactive or radioactive material that is acceptable if use of the site is to be unrestricted. Guidelines for residual radioactive material presented herein are of two kinds: (1) generic, site-independent guidelines taken from existing radiation protection standards and (2) site-specific guidelines derived from basic dose limits using site-specific models and data. Generic guideline values are presented in this document. Procedures and data for deriving site-specific guideline values are given in the supplement. The basis for the guidelines is generally a presumed worst-case plausible-use scenario for the site.

An "authorized limit" is a level of residual radioactive material or radioactivity that must not be exceeded if the remedial action is to be considered completed and the site is to be released for unrestricted use. The authorized limits for a site will include (1) limits for each

*"Soil" is defined herein as unconsolidated earth material, including rubble and debris that may be present in earth material.

radionuclide or group of radionuclides, as appropriate, associated with residual radioactive material in soil or in surface contamination of structures and equipment, (2) limits for each radionuclide or group of radionuclides, as appropriate, in air or water, and, (3) where appropriate, a limit on external gamma radiation resulting from the residual material. Under normal circumstances, expected to occur at most sites, authorized limits for residual radioactive material or radioactivity are set equal to guideline values. Exceptional conditions for which authorized limits might differ from guideline values are specified in Sections D and F of this document. A site may be released for unrestricted use only if site conditions do not exceed the authorized limits or approved supplemental limits, as defined in Section F.1, at the time remedial action is completed. Restrictions and controls on use of the site must be established and enforced if site conditions exceed the approved limits, or if there is potential to exceed the basic dose limit if use of the site is not restricted (Section F.2). The applicable controls and restrictions are specified in Section E.

DOE policy requires that all exposures to radiation be limited to levels that are as low as reasonably achievable (ALARA). For sites to be released for unrestricted use, the intent is to reduce residual radioactive material to levels that are as far below authorized limits as reasonable considering technical, economic, and social factors. At sites where the residual material is not reduced to levels that permit release for unrestricted use, ALARA policy is implemented by establishing controls to reduce exposure to levels that are as low as reasonably achievable. Procedures for implementing ALARA policy are discussed in the supplement. ALARA policies, procedures, and actions shall be documented and filed as a permanent record upon completion of remedial action at a site.

B. BASIC DOSE LIMITS

The basic limit for the annual radiation dose received by an individual member of the general public is 100 mrem/yr. The internal committed effective dose equivalent, as defined in ICRP Publication 26 (ICRP 1977) and calculated by dosimetry models described in ICRP Publication 30 (ICRP 1978), plus the dose from penetrating radiation sources external to the

body, shall be used for determining the dose. This dose shall be described as the "effective dose equivalent." Every effort shall be made to ensure that actual doses to the public are as far below the basic dose limit as is reasonably achievable.

Under unusual circumstances, it will be permissible to allow potential doses to exceed 100 mrem/yr where such exposures are based upon scenarios that do not persist for long periods and where the annual lifetime exposure to an individual from the subject residual radioactive material would be expected to be less than 100 mrem/yr. Examples of such situations include conditions that might exist at a site scheduled for remediation in the near future or a possible, but improbably, one-time scenario that might occur following remedial action. These levels should represent doses that are as low as reasonably achievable for the site. Further, no annual exposure should exceed 500 mrem.

C. GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL

C.1 Residual Radionuclides in Soil

Residual concentrations of radionuclides in soil shall be specified as above-background concentrations averaged over an area of 100 m². Generic guidelines for thorium and radium are specified below. Guidelines for residual concentrations of other radionuclides shall be derived from the basic dose limits by means of an environmental pathway analysis using site-specific data where available. Procedures for these derivations are given in the supplement.

If the average concentration in any surface or below-surface area less than or equal to 25 m² exceeds the authorized limit or guideline by a factor of $(100/A)^{1/2}$, where A is the area of the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the supplement. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

Two types of guidelines are provided, generic and derived. The generic guidelines for residual concentrations of Ra-226, Ra-228, Th-230, and Th-232 are:

- 5 pCi/g, averaged over the first 15 cm of soil below the surface

- 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface

These guidelines take into account ingrowth of Ra-226 from Th-230 and of Ra-228 from Th-232, and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the appropriate guideline is applied as a limit to the radionuclide with the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit or 2) the sum of the ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity"). Explicit formulas for calculating residual concentration guidelines for mixtures are given in the supplement.

C.2 Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that are intended for unrestricted use; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR Part 192) is: In any occupied or habitable building, the objective of remedial action shall be, and a reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL.* In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions by DOE are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive material is not the cause.

C.3 External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site to be released for unrestricted use shall not exceed the background level by more than 20 $\mu\text{R/h}$ and shall comply with the basic dose limit when an appropriate-use scenario is considered. This requirement shall not necessarily apply to structures scheduled for demolition or to buried foundations. External gamma radiation levels on open lands shall also comply with the basic dose limit, considering an appropriate-use scenario for the area.

C.4 Surface Contamination

The generic surface contamination guidelines provided in Table 1 are applicable to existing structures and equipment. These guidelines are adapted from standards of the U.S. Nuclear Regulatory Commission (NRC 1982)* and will be applied to a manner that provides a level of protection consistent with the Commission's guidance. These limits apply to both interior and exterior surfaces. They are not directly intended for use on structures to be demolished or buried, but should be applied to equipment or building components that are potentially salvageable or recoverable scrap. If a building is demolished, the guidelines in Section C.1 are applicable to the resulting contamination in the ground.

C.5 Residual Radionuclides in Air and Water

Residual concentrations of radionuclides in air and water shall be controlled to levels required by DOE Environmental Protection Guidance and Orders, specifically DOE Order 5480.1A and subsequent guidance. Other Federal and/or state standards shall apply when they are determined to be appropriate.

*A working level (WL) is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.

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

^aAs 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 instruction.

^bWhere surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

^cMeasurements of average contamination should not be averaged over an area of more than 1 m². For objects of less surface area, the average should be derived for each such object.

^dThe average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

^eThe maximum contamination level applies to an area of not more than 100 cm².

^fThe amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area 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 cm² is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.

D. AUTHORIZED LIMITS FOR RESIDUAL RADIOACTIVE MATERIAL

Authorized limits shall be established to (1) ensure that, as a minimum, the basic dose limits specified in Section B will not be exceeded under the worst-case plausible-use scenario consistent with the procedures and guidance provided or (2) be consistent with applicable generic guidelines, where such guidelines are provided. The authorized limits for each site and its vicinity properties shall be set equal to the generic or derived guidelines except where it can be clearly established on the basis of site-specific data -- including health, safety, and socioeconomic considerations -- that the guidelines are not appropriate for use at the specific site. Consideration should also be given to ensure that the limits comply with or provide a level of protection equivalent to the appropriate limits and guidelines (i.e., state or other Federal). Documentation supporting such a decision should be similar to that required for supplemental limits and exceptions (Section F), but should be generally more detailed because the documentation covers the entire site.

Remedial action shall not be considered complete unless the residual radioactive material levels comply with the authorized limits. The only exception to this requirement will be for those special situations where the supplemental limits or exceptions are applicable and approved as specified in Section F. However, the use of supplemental limits and exceptions should be considered only if it is clearly demonstrated that it is not reasonable to decontaminate the area to the authorized limit or guideline value. The authorized limits are developed through the project offices in the field and are approved by the headquarters program office.

E. CONTROL OF RESIDUAL RADIOACTIVE MATERIAL AT FUSRAP AND REMOTE SFMP SITES

Residual radioactive material above the guidelines at FUSRAP and remote SFMP sites must be managed in accordance with applicable DOE Orders. The DOE Order 5480.1A and

*These guidelines are functionally equivalent to Section 4 -- Decontamination for Release for Unrestricted Use -- of NRC Regulatory Guide 1.86 (U.S. Atomic Energy Commission 1974), but they are applicable to non-reactor facilities.

subsequent guidance or superseding Orders require compliance with applicable Federal and state environmental protection standards.

The operational and control requirements specified in the following DOE Orders shall apply to interim storage, interim management, and long-term management.

- a. 5000.3, Unusual Occurrence Reporting System
- b. 5440.1C, Implementation of the National Environmental Policy Act
- c. 5480.1A, Environmental Protection, Safety, and Health Protection Program for DOE Operations, as revised by DOE 5480.1 change orders and the 5 August 1985 memorandum from Vaughan to Distribution
- d. 5480.2, Hazardous and Radioactive Mixed Waste Management
- e. 5480.4, Environmental Protection, Safety, and Health Protection Standards
- f. 5482.1A, Environmental, Safety, and Health Appraisal Program
- g. 5483.1A, Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities
- h. 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements
- i. 5820.2, Radioactive Waste Management

E.1 Interim Storage

- a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 50 years and, in any case, at least 25 years.
- b. Above-background Rn-222 concentrations in the atmosphere above facility surfaces or openings shall not exceed (1) 100 Pci/L at any given point, (2) an annual average concentration of 30 Pci/L over the facility site, and (3) an annual average concentration of 3 pCi/L at or above any location outside the facility site (DOE Order 5480.1A, Attachment XI-I).

- c. Concentrations of radionuclides in the groundwater or quantities of residual radioactive material shall not exceed existing Federal or state standards.
- d. Access to a site shall be controlled and misuse of on-site material contaminated by residual radioactive material shall be prevented through appropriate administrative controls and physical barriers -- active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These control features should be designed to ensure, to the extent reasonable, as effective life of at least 25 years. The Federal government shall have title to the property or shall have a long-term lease for exclusive use.

E.2 Interim Management

- a. A site may be release under interim management when the residual radioactive material exceeds guideline values if the residual radioactive material in inaccessible locations and would be unreasonably costly to remove, provided that administrative controls are established to ensure that no member of the public shall receive a radiation dose exceeding the basic dose limit.
- b. The administrative controls as approved by DOE, shall include but not be limited to periodic monitoring as appropriate, appropriate shielding, physical barriers to prevent access, and appropriate radiological safety measures during maintenance, renovation, demolition, or other activities that might disturb the residual radioactive material or cause it to migrate.
- c. The owner of the site or appropriate Federal, state, or local authorities shall be responsible for enforcing the administrative controls.

E.3 Long-Term Management

Uranium, Thorium, and Their Decay Products

- a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 1,000 years and, in any case, at least 200 years.
- b. Control and stabilization features shall be designed to ensure that Rn-222 emanation to the atmosphere from the wastes shall not (1) exceed an annual average release rate of 20 pCi/m²/s and (2) increase the annual average Rn-222 concentration at or above any location outside the boundary of the contaminated area by more than 0.5 pCi/L. Field verification of emanation rates is not required.
- c. Prior to placement of any potentially biodegradable contaminated wastes in a long-term management facility, such wastes shall be properly conditioned to ensure that (1) the generation and escape of biogenic gases will not cause the requirement in paragraph b. of this section (E.3) to be exceeded and (2) biodegradation within the facility will not result in premature structural failure in violation of the requirements in paragraph a. of this section (E.3).
- d. Groundwater shall be protected in accordance with appropriate Departmental Orders and Federal and state standards, as applicable to FUSRAP and remote SFMP sites.
- e. Access to a site should be controlled and misuse of on-site material contaminated by residual radioactivity should be prevented through appropriate administrative controls and physical barriers -- active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These controls should be designed to be effective to the extent reasonable for at least 200 years. The Federal government shall have title to the property.

Other Radionuclides

- f. Long-term management of other radionuclides shall be in accordance with Chapters 2, 3, and 5 of DOE Order 5820.2, as applicable.

F. SUPPLEMENTAL LIMITS AND EXCEPTIONS

If special site-specific circumstances indicate that the guidelines or authorized limits established for a given site are not appropriate for a portion of that site or for a vicinity property, then the field office may request that supplemental limits or an exception be applied. In either case, the field office must justify that the subject guidelines or authorized limits are not appropriate and that the alternative action will provide adequate protection, giving due consideration to health and safety, the environment, and costs. The field office shall obtain approval for specific supplemental limits or exceptions from headquarters as specified in Section D of these guidelines and shall provide to headquarters those materials required for the justification as specified in this section (F) and in the FUSRAP and SFMP protocols and subsequent guidance documents. The field office shall also be responsible for coordination with the state or local government of the limits or exceptions and associated restrictions as appropriate. In the case of exceptions, the field office shall also work with the state and/or local governments to ensure that restrictions or conditions of release are adequate and mechanisms are in place for their enforcement.

F.1 Supplemental Limits

The supplemental limits must achieve the basic dose limits set forth in this guideline document for both current and potential unrestricted uses of a site and/or vicinity property. Supplemental limits may be applied to a vicinity property or a portion of a site if, in the basis of a site-specific analysis, it is determined that (1) certain aspects of the vicinity property or portion of the site were not considered in the development of the established authorized limits and associated guidelines for that vicinity property or site and, (2) as a result of these unique characteristics, the established limits or guidelines either do not provide adequate protection or are unnecessarily restrictive and costly.

F.2 Exceptions

Exceptions to the authorized limits defined for unrestricted use of a site or vicinity property may be applied to a vicinity property or a portion of a site when it is established that the authorized limits cannot be achieved and restrictions on use of the vicinity property or portion of the site are necessary to provide adequate protection of the public and the environment. The field office must clearly demonstrate that the exception is necessary and that the restrictions will provide the necessary degree of protection and will comply with the requirements for control of residual radioactive material as set forth in Section E of these guidelines.

F.3 Justification for Supplemental Limits and Exceptions

Supplemental limits and exceptions must be justified by the field office on a case-by-case basis using site-specific data. Every effort should be made to minimize use of the supplemental limits and exceptions. Examples of specific situations that warrant use of the supplemental standards and exceptions are:

- a. Where remedial action would pose a clear and present risk of injury to workers or members of the general public, notwithstanding reasonable measures to avoid or reduce risk.
- b. Where remedial action -- even after all reasonable mitigative measures have been taken -- would produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near affected sites, now or in the future. A clear excess of environmental harm is harm that is long-term, manifest, and grossly disproportionate to health benefits that may reasonably be anticipated.

- c. Where it is clear that the scenarios or assumptions used to establish the authorized limits do not, under plausible current or future conditions, apply to the property or portion of the site identified and where more appropriate scenarios or assumptions indicate that other limits are applicable or necessary for protection of the public and the environment.

- d. Where the cost of remedial action for contaminated soil is unreasonably high relative to long-term benefits and where the residual radioactive material does not pose a clear present or future risk after taking necessary control measures. The likelihood the buildings will be erected or that people will spend long periods of time at such a site should be considered in evaluating this risk. Remedial action will generally not be necessary where only minor quantities of residual radioactive material are involved or where residual radioactive material occurs in an inaccessible location at which site-specific factors limit their hazard and from which they are costly or difficult to remove. Examples include residual radioactive material under hard-surface public roads and sidewalks, around public sewer lines, or in fence-post foundations. A site-specific analysis must be provided to establish that it would not cause an individual to receive a radiation dose in excess of the basic dose limits stated in Section B, and a statement specifying the level of residual radioactive material must be included in the appropriate state and local records.

- e. Where there is no feasible remedial action.

G. SOURCES

<u>Limit or Guideline</u>	<u>Source</u>
<u>Basic Dose Limits</u>	
Dosimetry model and dose limits	International Commission on Radiological Protection (1977, 1978)
<u>Generic Guidelines for Residual Radioactivity</u>	
Residual concentrations of radium and thorium in soil	40 CFR Part 192
Airborne radon decay products	40 CFR Part 192
External gamma radiation	40 CFR Part 192
Surface contamination	Adapted from U.S. Nuclear Regulatory Commission (1982)
<u>Control of Radioactive Wastes and Residues</u>	
Interim storage	DOE Order 5480.1A and subsequent guidance
Long-term management	DOE Order 5480.1A and subsequent guidance; 40 CFR Part 192; DOE Order 5820.2

H. REFERENCES

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- U.S. Environmental Protection Agency, 1983. Standards for Remedial Actions at Inactive Uranium Processing Sites; Final Rule (40 CFR Part 192). Federal Register 48(3):590-604 (January 5, 1983).
- U.S. Nuclear Regulatory Commission, 1982. Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material. Division of Fuel Cycle and Material Safety, Washington, D.C. July 1982.

APPLICATION OF HOT SPOT GUIDELINE

1. The method for determining Hot Spot Limits, which is based on the 100 mrem/year Dose Limit, as described in the FUSRAP procedures manual, shall still be applicable for determining allowable concentrations of radionuclides under inhomogeneous soil contamination conditions. However, the following approach, more appropriate for field applications, may be used in place of the Dose Limit method and is recommended for general applications.
2. For the alternative approach, the basic Hot Spot Limits will be calculated for each specific site by (See attached figure):

$$Shg - Sg + (100 \text{ m}^2/A)^{1/2}$$

where, Shg = the Hot Spot Limit (pCi/gram)
 Sg = the Authorized Limit for a specific site (pCi/gram)
 A = the area of the hot spot in square meters
 $(100/A)^{1/2}$ is the hot spot multiplication factor.

3. The limits shall be applied in the field over ranges of area with the factors being constant over a given area. The ranges and factors to be used are:

<u>Range</u>	<u>Factor (Multiple of Authorized Limit)</u>
< 1 m ²	10*
1 - < 3 m ²	6
3 - < 10 m ²	3
10 - 25 m ²	2

*Areas less than one square meter are to be averaged over the one square meter and that average shall not exceed ten times the Authorized Limit.

4. The average Authorized Limit is considered adequate to protect the public for areas larger than 25 square meters; hence, no special Hot Spot Limits are required for areas larger than 25 square meters.
5. Averaging of hot spots less than or equal to 25 square meters shall be done only over the local hot spot area.
6. Every reasonable effort shall be made to identify and remove any source which has a concentration of a radionuclide exceeding 30 times the Authorized Limit irrespective of area.