RADIOLOGICAL SURVEYS
SEATTLE VETERANS AFFAIRS MEDICAL CENTER
SEATTLE, WASHINGTON

W. C. ADAMS AND S. E. POTTER

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

ORISE

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

Environmental Survey and Site Assessment Program
Energy/Environment Systems Division

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ABBREVIATIONS

cm	centimeter
cm^2	square centimeter
cpm	counts per minute
dpm/100 cm^2	disintegrations per minute/100 square centimeters
ft	foot
GM	Geiger-Mueller
h	hour
H-3	tritium
I-125	iodine-125
K-40	potassium-40
kg	kilogram
m	meter
m^2	square meter
NaI(Tl)	sodium iodide (thallium activated)
P-32	phosphorous-32
S-35	sulfur-35
μrem/h	microrem per hour
pCi/g	picocurie per gram

ACRONYMS

ASME	American Society of Mechanical Engineers
ESSAP	Environmental Survey and Site Assessment Program
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
SVA	Seattle Veterans Affairs Medical Center

RADIOLOGICAL SURVEYS
SEATTLE VETERANS AFFAIRS MEDICAL CENTER
SEATTLE, WASHINGTON

INTRODUCTION AND SITE HISTORY

The Seattle Veterans Affairs Medical Center (SVA) at 1660 South Columbian Way, Seattle, Washington, is licensed (License No. 46-00990-01; Docket No. 030-03367) by the Nuclear Regulatory Commission (NRC) to conduct nuclear medicine research involving radiochemical procedures. Under this license, molecular biology research, using compounds labeled with small quantities of H-3 (10μCi), P-32 (25-50μCi), S-35 (25-50 μCi), and I-125 (10 μCi), was performed in Building 1, Rooms 151, 153, 161, and 187, and in Building 19, Room 102. Records indicate the following radioactive material use history:

Building 1	Room 151	H-3, P-32, S-35, I-125
	Room 153	H-3, P-32, S-35
	Room 161	H-3, P-32, S-35, I-125
	Room 187	H-3, I-125
Building 19	Room 102	P-32, S-35, I-125

Other areas, possibly affected by radioactive material use, include portions of the roof and room exhaust vents from Building 1, Rooms 153 and 161 and Building 19, Room 102, and the drain systems from the various laboratories.

In November 1992, radiochemical procedures were discontinued in these areas with intentions of renovating the rooms for non-radiological uses. Due to delays in initiating the renovation activities, additional uses of S-35 and/or P-32 occurred in Room 102 of Building 19 and Rooms 151, 153, and 161 of Building 1; some radioactivity use in these areas occurred as recently as January 1993. Licensed activities continue in other areas of the VA Medical Center facilities.

The Radiation Safety Office has conducted monthly contamination surveys of the floor, countertops and fume hood surfaces in each authorized radionuclide laboratory. A historical review by SVA staff indicated only two instance of radioactive contamination involving P-32 and S-35, and in both cases, residual contamination was reduced to background by routine decontamination.

Remediation activities by SVA and its contractor included the gridding of floors and countertops in each surveyed room and the collection of wipe samples from each grid block. All laboratory equipment was surveyed by direct measurement prior to being moved to other radioactive materials use laboratories. SVA also stated that all areas were deemed free of fixed and removable contamination except the radioactive materials sink plastic plumbing fixtures in Building 1, Room 151. These fixtures were isolated and placed in a storage area.

A final-status survey was conducted and the licensee's report was submitted to the NRC on January 26, 1993. The final-status survey consisted primarily of smears for removable activity; surveys for beta surface activity; gamma scans for I-125; samples of selected surfaces for total activity determinations; and, sampling of residues from sink drains were also performed.

At the request of the NRC Region V Office, the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) conducted confirmatory activities and additional radiological surveys at the Seattle Veterans Affairs Medical Center. This report describes the procedures and results of those activities.

SITE DESCRIPTION

The Seattle VA Medical Center is located at 1660 South Columbian Way in Seattle, Washington. The site is approximately 14 km (10 miles) north of the Seattle-Tacoma International Airport and approximately 5.6 km (4 miles) south of downtown Seattle (Figure 1). The site is located in a mixed industrial/residential area on a 13.6 hectare (34 acre) parcel of land north of South Snoqualane Street and between Beason Avenue and South Columbian Way (Figure 2).

The facility includes a 580 bed hospital, with auxiliary buildings for administration, special support activities, and research laboratories. The total medical center operational space is approximately 160,000 m^2 (1,700,000 ft^2). Areas devoted to general medical research represent 4650 m^2 (49,700 ft^2) of which 1580 m^2 (16,876 ft^2) has been authorized for radioactive materials use by the Radiation Safety Committee.

The rooms that are to be surveyed are Rooms 151, 153, 161, and 187 of Building 1 and Room 102 of Building 19. The locations of these rooms are indicated in Figures 2-4.

OBJECTIVES

The objectives of the confirmatory process were to provide document reviews and develop independent radiological data, for use by the NRC in evaluating the adequacy and accuracy of data presented in the licensee's final-status report.

In addition, limited additional radiological measurements and sampling were performed. Data from these activities supplement the licensee's data and will assist the NRC in the overall evaluation of the radiological status of the facilities.

DOCUMENT REVIEW

ESSAP reviewed the licensee's documentation associated with the decommissioning survey.[1-9] Analytical procedures and methods utilized by the licensee and its contractor were reviewed for adequacy and appropriateness. The final-status survey results and supporting data were reviewed for accuracy, completeness, and compliance with guidelines.

PROCEDURES

During the period of February 1-2, 1993, ESSAP performed confirmatory and radiological surveys of selected rooms at Seattle Veterans Affairs Medical Center. The survey was in accordance with a plan, submitted to and approved by NRC Region V.[10]

CONFIRMATORY SURVEY

Interior Survey

Reference Grid

ESSAP re-established a 2 ft (about 0.6 m) grid system on the floor of each room for referencing measurements and sampling locations. Measurements and sampling locations on walls were referenced to floor grid coordinates.

Surface Scans

Surface scans for gamma and beta activity were performed on accessible floors and lower walls (up to 2 m), cabinets, shelves, other equipment and furnishings, and drains using thin-crystal (FIDLER) and standard NaI(Tl) scintillation detectors and gas proportional detectors. All detectors were coupled to instruments with audible indicators.

Removable Surface Activity Measurement

Measurements to determine removable beta activity were performed on randomly selected grid blocks; a minimum of 10% of the floor grid blocks, and 5% of the lower wall grid blocks were selected using a random number generator. A total of 137 locations were sampled; sampling locations are identified on Figures 5 through 9.

Miscellaneous Samples

Drain swabs and residues were collected from 10 systematic locations. Sampling locations are illustrated on Figures 5 through 9.

RADIOLOGICAL SURVEY PROCEDURES

Exterior Survey

Reference Grid

A reference grid was not established for the exterior areas surveyed; sampling locations were referenced to prominent building features.

Surface Scans

Exhaust ventilation equipment for Rooms 151, 153, 161, and 187 and portions of the roof in the immediate vicinity (1 m radius) of the exhaust vents were scanned using a thin-window GM detector, coupled to a ratemeter-scaler with an audible indicator.

Removable Activity Measurements

Smear samples for removable contamination were obtained from 5 measurement locations on exhaust vents. Sampling locations are indicated on Figure 10.

Interior Survey

Surface Scans

Surface scans were performed on floors in adjacent rooms and hallways. Scans were performed with gamma scintillation and gas proportional detectors. All detectors were coupled to instruments with audible indicators.

Surface Activity Measurements

Direct measurements for total beta activity levels were performed at 28 locations on the floor and lower wall surfaces with gas proportional detectors. All detectors were coupled to ratemeter-scalers with audible indicators. A smear sample was collected at each direct measurement location. Measurement and sampling locations are illustrated on Figures 4 through 7 and on Figure 10.

Dose Equivalent Rate Measurements

Dose equivalent rate measurements were performed at one meter (3.3 ft) above the surface within each surveyed area with a microrem meter. A general area background dose equivalent range was determined in Room 185 and the adjacent hallway of Building 1.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and survey data were returned to the ESSAP laboratory in Oak Ridge, Tennessee, for analyses and interpretation. Three analyses were performed on the smears collected. Smears were analyzed using a low-background alpha/beta counter to determine gross alpha and gross beta activity, solid state gamma spectrometry to determine I-125 activity, and a liquid scintillation counter for H-3, P-32, and S-35 activity. Direct measurements and smears were reported in units of dpm/100 cm^2. Miscellaneous samples were analyzed by liquid scintillation and/or gamma spectrometry and results are reported in units of dpm/sample. Radionuclides of primary interest are H-3, P-32, S-35, and I-125; however, spectra was reviewed for other identifiable photopeaks. Additional information concerning major instrumentation, sampling equipment, and analytical procedures is provided in Appendices A and B. With the exception of the miscellaneous samples, results were compared to the NRC guidelines which are provided in Appendix C.

FINDINGS AND RESULTS

DOCUMENT REVIEW

The final-status survey report and other supporting documentation, provided by Seattle Veterans Affairs Medical Center, were reviewed.[1-9] The documentation included information on surveys performed, instrumentation used, survey and analytical procedures, remediation activities, and post remediation surveys.

Additional information regarding SVA survey procedures and results was requested.[6-9] In response to these comments, SVA provided additional information and clarification, regarding site conditions, procedures, and data.[1-4]

SVA decisions regarding residual surface contamination relied primarily on smears; direct measurements were requested by ESSAP and the measurements in units of dpm/100 cm^2 were provided. No residual activity above guidelines is indicated by the final data.

CONFIRMATORY SURVEY

Interior Survey

Surface Scans

Surface scans did not identify any areas of elevated direct radiation.

Surface Activity Levels

Results of removable activity are summarized in Table 1. Removable alpha activity was < 13 dpm/100 cm^2; removable beta activity ranged from < 15 to 25 dpm/100 cm^2.

Smears were analyzed for H-3, P-32, and S-35. The range for all smears was from <20 to 31 dpm/100 cm^2 for H-3; <11 dpm/100 cm^2 for P-32; and, <13 dpm/100 cm^2 for S-35.

To obtain low detection levels for I-125, smears were composited in five batches, consisting of from 14 to 49 smears and analyzed by gamma spectrometry. The average levels on each smear were: <4 dpm/100 cm^2 for Room 151; <1 dpm/100 cm^2 for Room 153; <1 dpm/100 cm^2 for Room 161; <1 dpm/100 cm^2 for Room 187; and <2 dpm/100 cm^2 for Room 102.

Dose Equivalent Rates

Ambient dose equivalent rate measurements for the selected rooms at Seattle Veterans Affairs Medical Center were not distinguishable from background dose equivalent rates which ranged from 4 to 6 μrem/h.

Miscellaneous Samples

Radioactivity in miscellaneous samples are presented in Table 2. The activity levels for miscellaneous samples ranged from <59 to 540 dpm/sample for H-3, from <27 to 230 dpm/sample for P-32, from <58 to 820 dpm/sample for S-35, and <230 dpm/sample for I-125.

Only one sample contained activity levels greater than the detection sensitivity of the counting equipment. The sample was a residue from a water purifier which incorporates a potassium compound in the purification process. This potassium compound contains radioactive K-40, which is a naturally occurring isotope of potassium.

RADIOLOGICAL SURVEY

Exterior Survey

Surface Scans

Surface scans of the areas of the roof immediately surrounding the air handling vents for the subject rooms in Building 1 did not identify any areas of elevated direct radiation.

Surface Activity Levels

Smears obtained from the ventilation equipment, contained < 13 dpm/100 cm^2 for alpha, < 15 dpm/100 cm^2 for beta, < 20 dpm/100 cm^2 for H-3, < 13 dpm/100 cm^2 for P-32, and < 11 dpm/100 cm^2 for S-35.

To obtain low detection sensitivities for I-125, the smears were composited and analyzed by gamma spectrometry. The average activity levels on each smear were < 10 dpm/100 cm^2.

Interior Survey

Surface Scans

Surface scans did not identify any areas of elevated direct radiation in adjacent rooms and hallways.

Surface Activity Levels

Results of total and removable activity are summarized in Table 3. Total beta activity levels in all the surveyed rooms were < 630 dpm/100 cm^2. Removable activity levels were < 13 cpm/100 cm^2 and < 15 dpm/100 cm^2 for gross alpha and gross beta activity, respectively.

COMPARISON OF RESULTS WITH GUIDELINES

Guidelines for acceptable surface contamination levels, used by the NRC to determine whether a licensed facility may be released to unrestricted use, are summarized in Appendix C. The principal contaminants at the Seattle Veterans Affairs Medical Center were H-3, P-32, S-35, and I-125.

The applicable guidelines for these radionuclides are:

H-3, P-32, S-35

Total Activity

5,000 dpm/100 cm^2 (average over 1 m^2)

15,000 dpm/100 cm^2 (maximum in 100 cm^2)

Removable Activity

1,000 dpm/100 cm^2

I-125

Total Activity

100 dpm/100 cm^2 (average over 1 cm^2)

300 dpm/100 cm^2 (maximum in 100 cm^2)

Removable Activity

20 dpm/100 cm^2

Surface activity measurements conducted by ESSAP during the confirmatory and radiological surveys, are within these guidelines. It should be noted that currently available instrumentation and standard survey procedures are not capable of in situ measurement of H-3 and I-125 total surface activities at their respective guideline values; removable activity measurements were therefore used for comparison of residual levels of these radionuclides with their guidelines.

Because of detection sensitivity constraints, the removable activity levels reported by ESSAP for I-125 represent average levels on multiple smears. Individual samples may or may not contain activity in excess of the I-125 guideline.

The dose equivalent rates in the subject rooms were not distinguishable from background levels.

SUMMARY

On February 1 and 2, 1993, ESSAP performed confirmatory activities and radiological surveys at the Seattle Veterans Affairs Medical Center in Seattle, Washington. Activities included document reviews, surface scans, surface activity measurements, and miscellaneous sampling.

Some aspects of documentation developed by the licensee to describe the final radiological status of the facilities, were considered by ESSAP to be lacking details regarding procedures for conducting surveys and evaluating results. Per the request of the NRC and ESSAP, the licensee provided additional documentation to clarify the radiological status of the site.

The conclusion by the licensee, based on their survey results, is supported by the results of the ESSAP confirmatory measurements. The limited additional surface scans, direct measurements, and sampling by ESSAP, did not identify any areas of elevated activity.

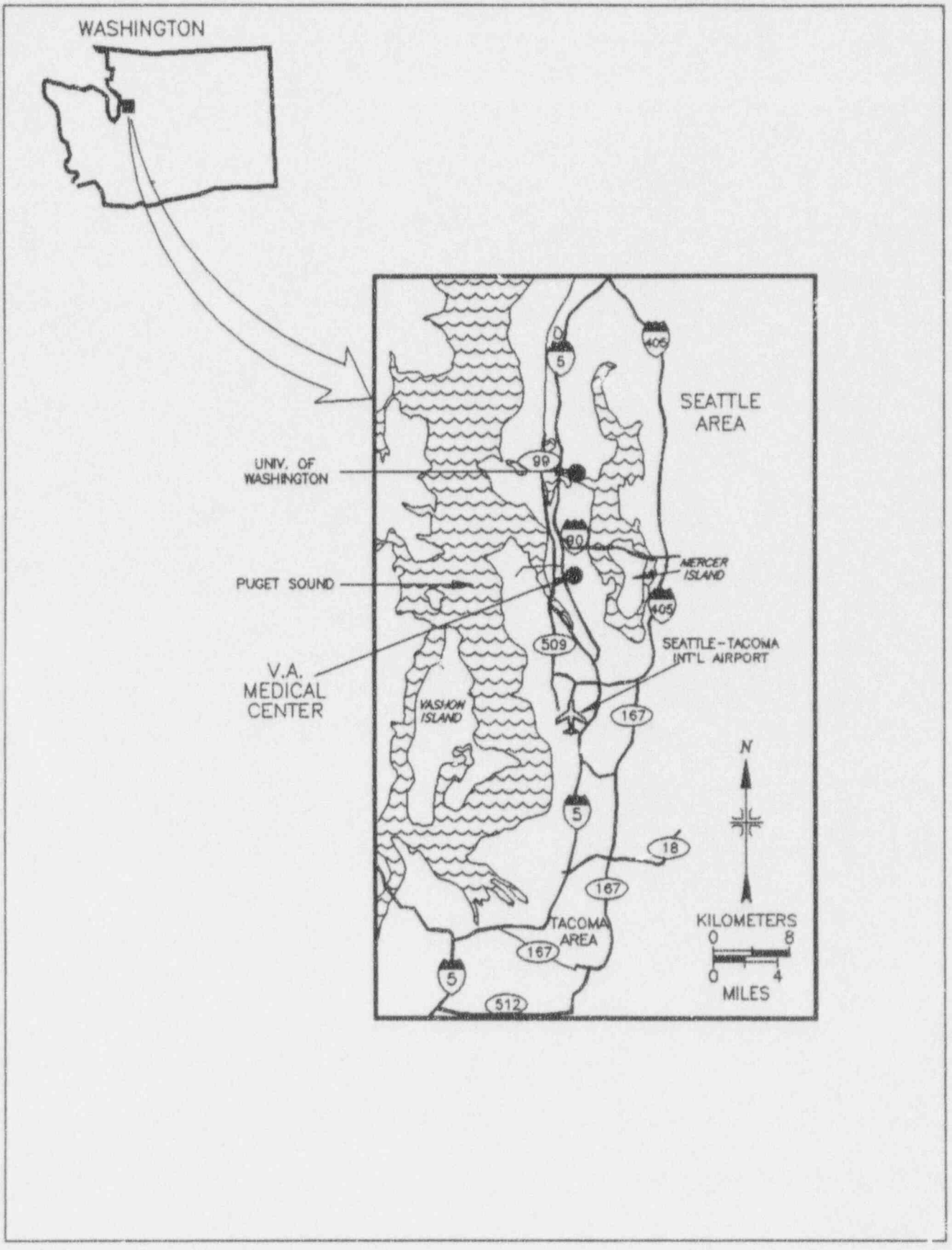


FIGURE 1: Location of the Seattle VA Medical Center in the Tacoma and Seattle, Washington Area

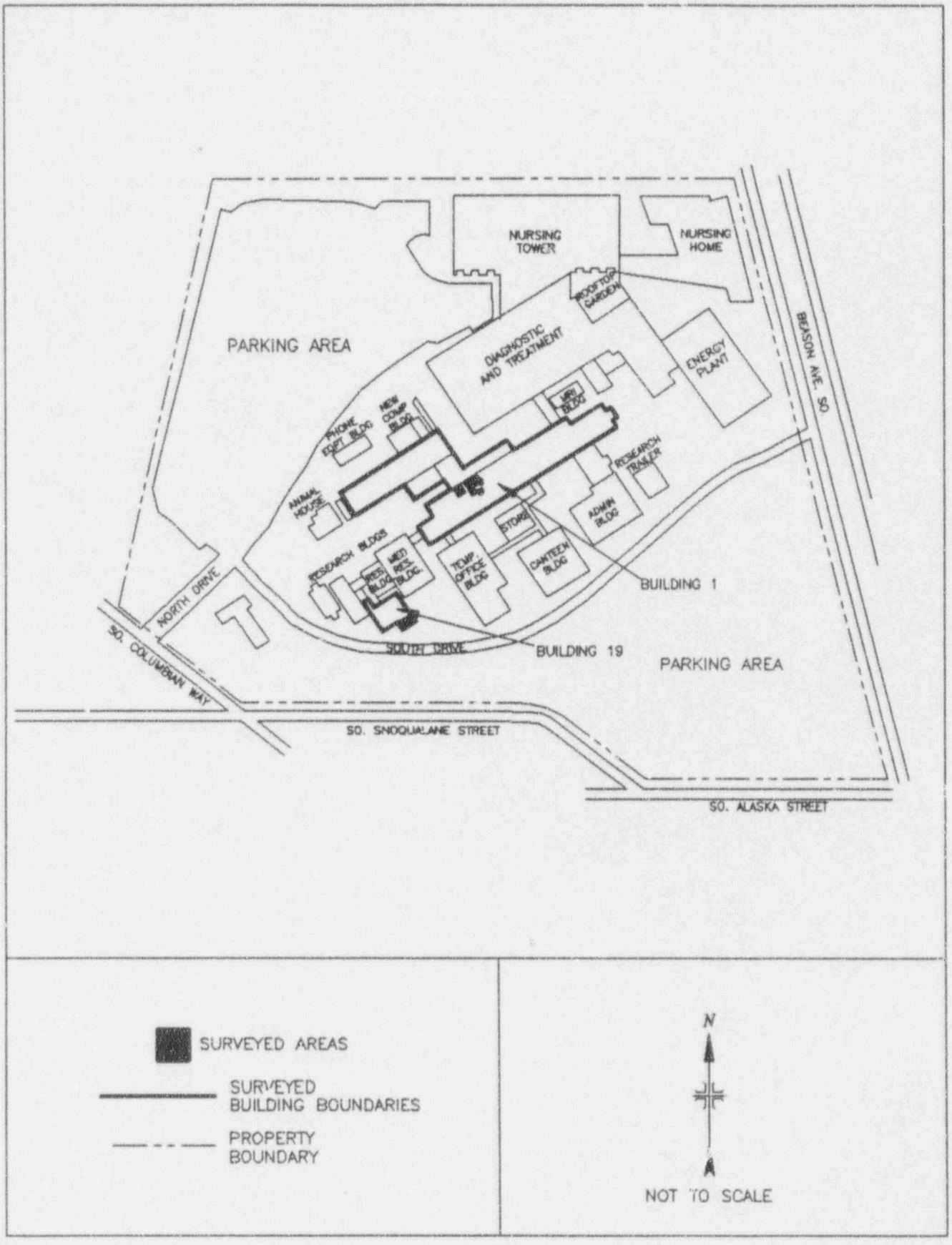


FIGURE 2: Plot Plan of the Seattle VA Medical Center, Seattle, Washington

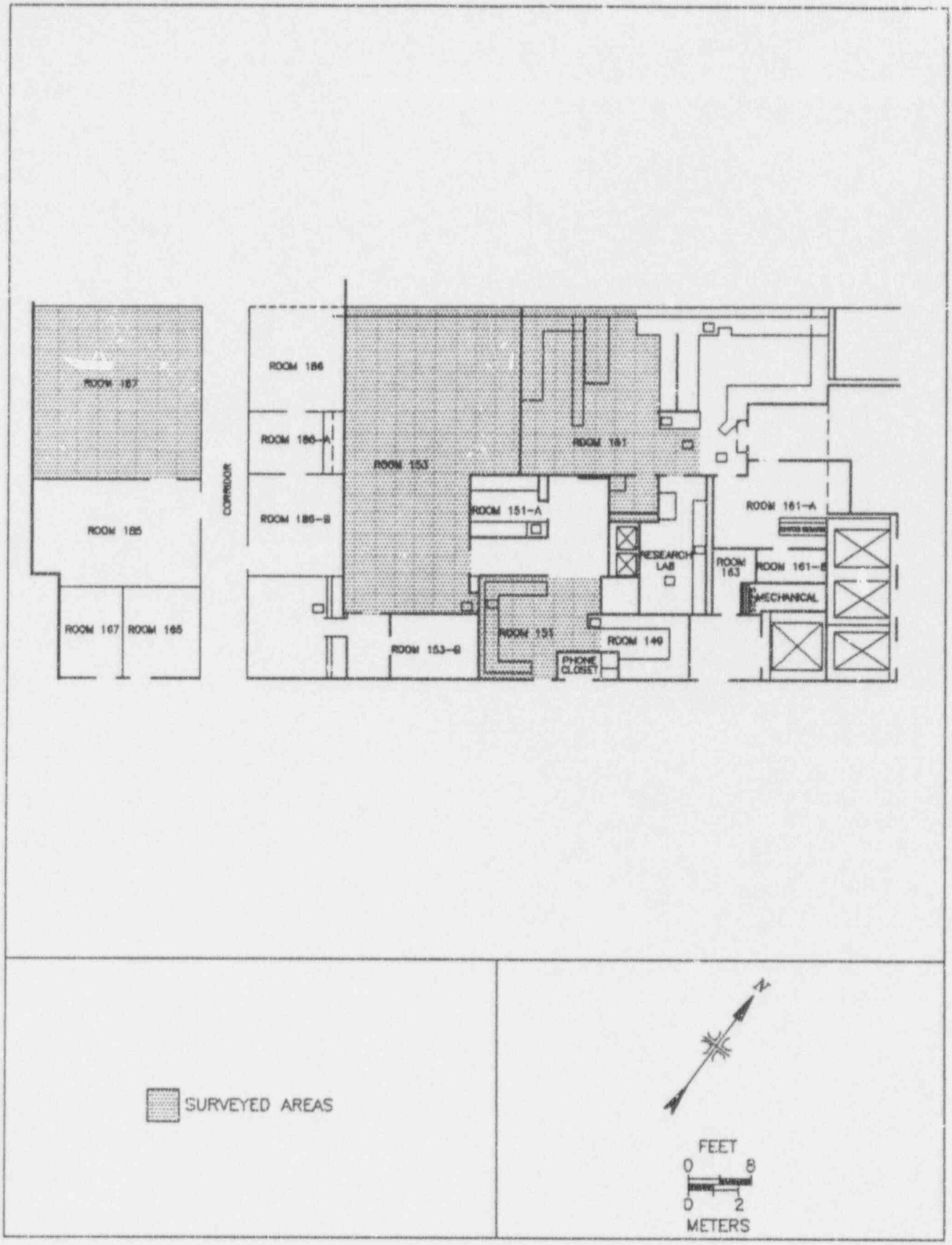


FIGURE 3: Portion of First Floor Plan – West Half of Building 1 of the Seattle VA Medical Center, Seattle, Washington

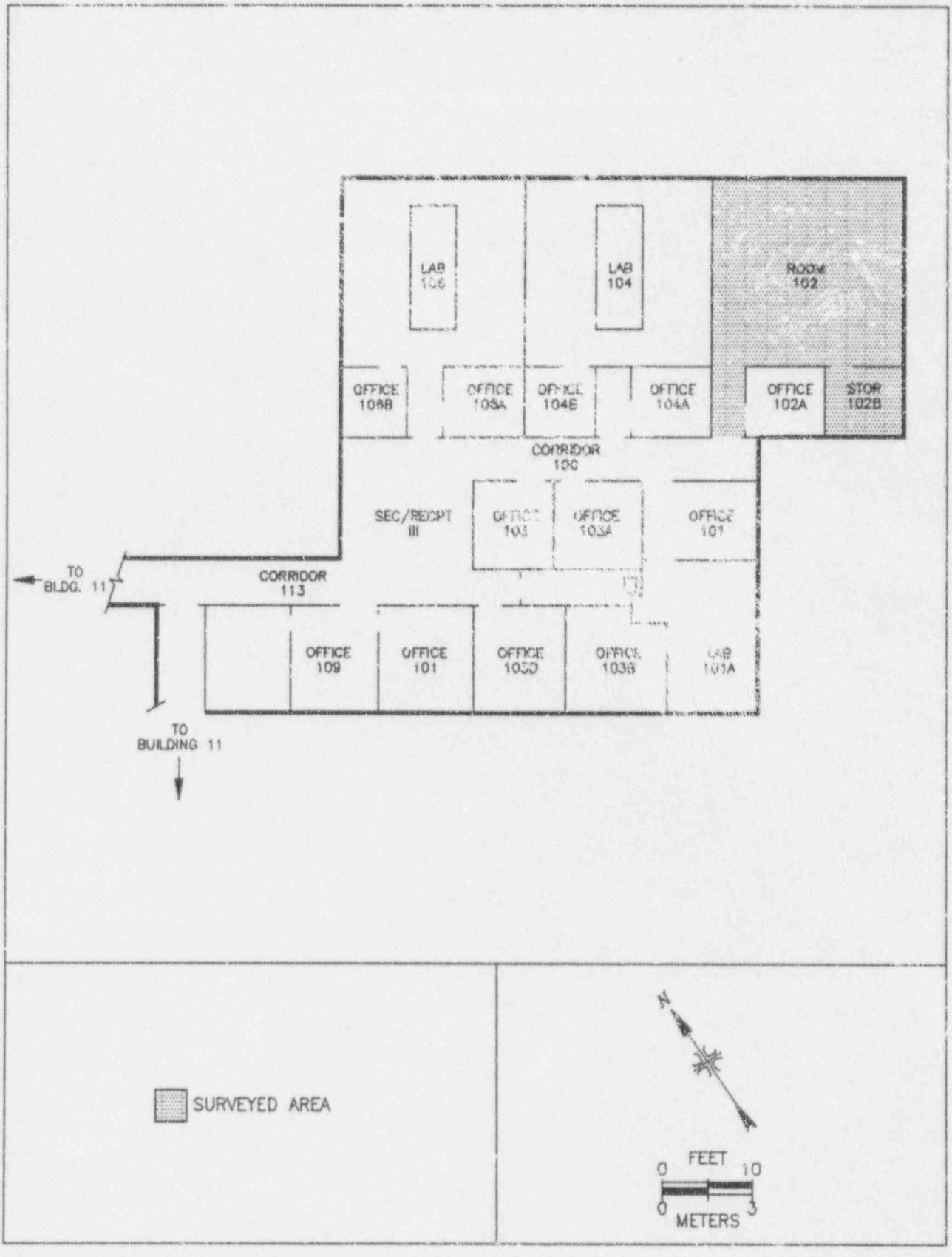


FIGURE 4: First Floor Plan of Building 19, Seattle VA Medical Center, Seattle, Washington

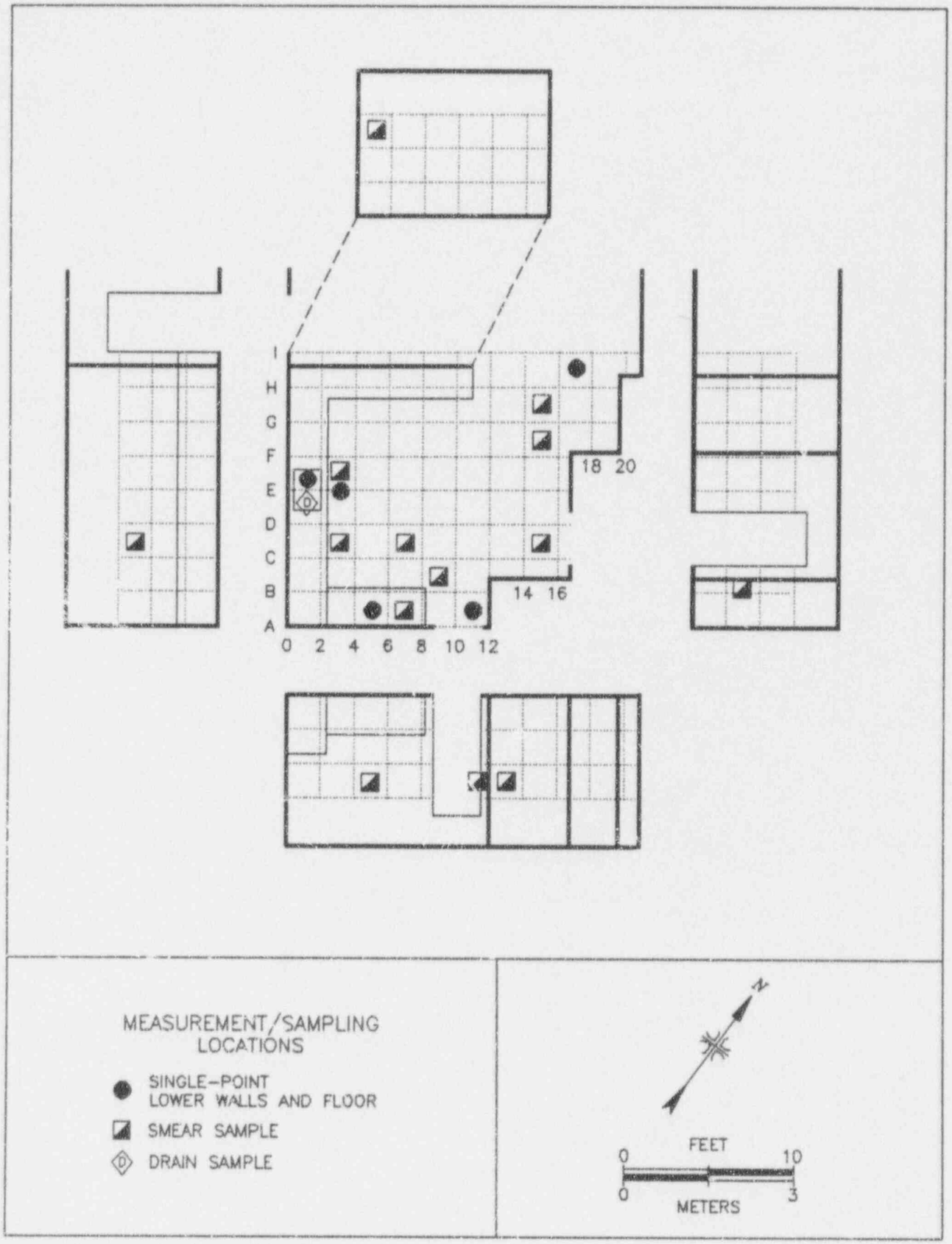


FIGURE 5: Building 1, Room 151 – Measurement and Sampling Locations

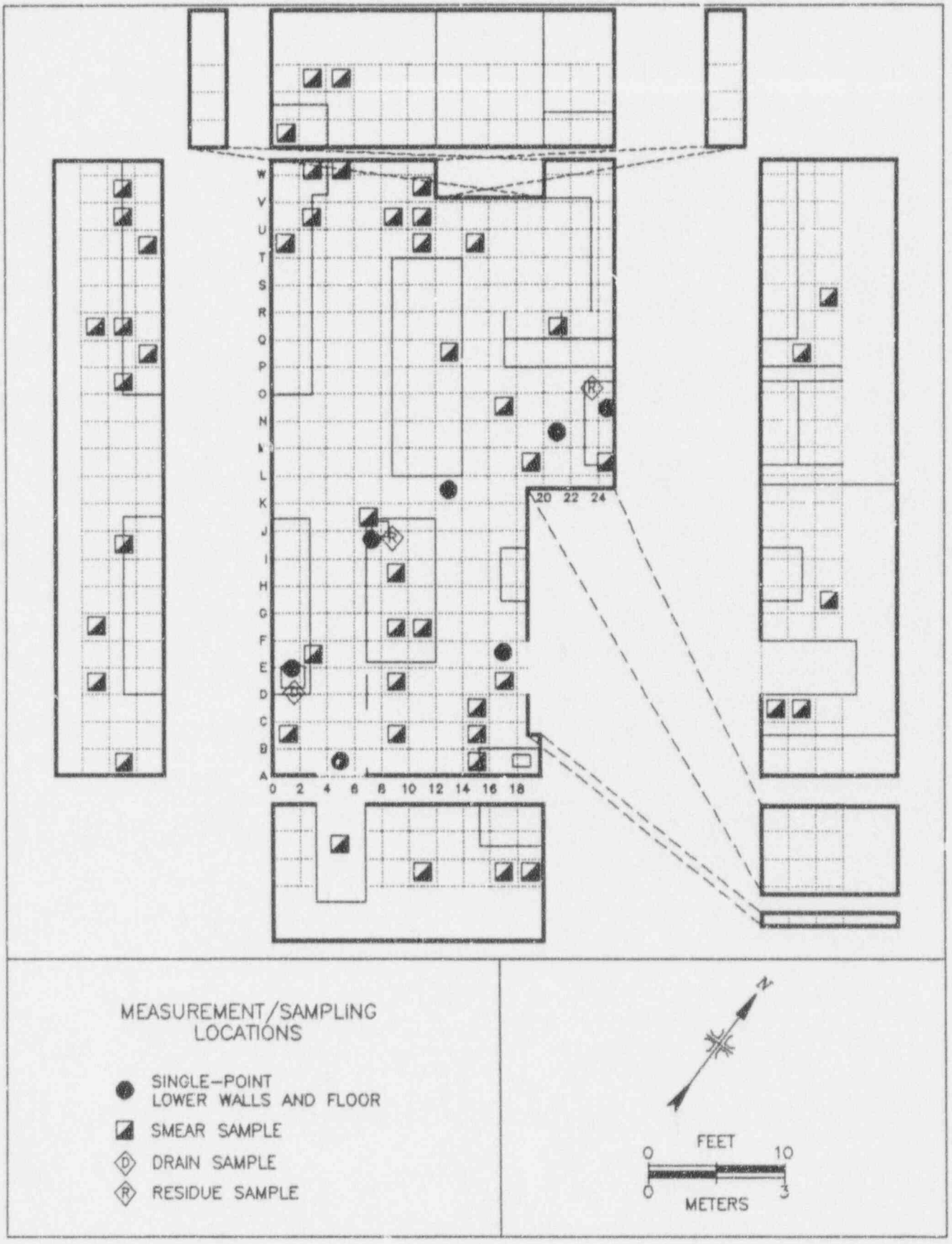


FIGURE 6: Building 1, Room 153 – Measurement and Sampling Locations

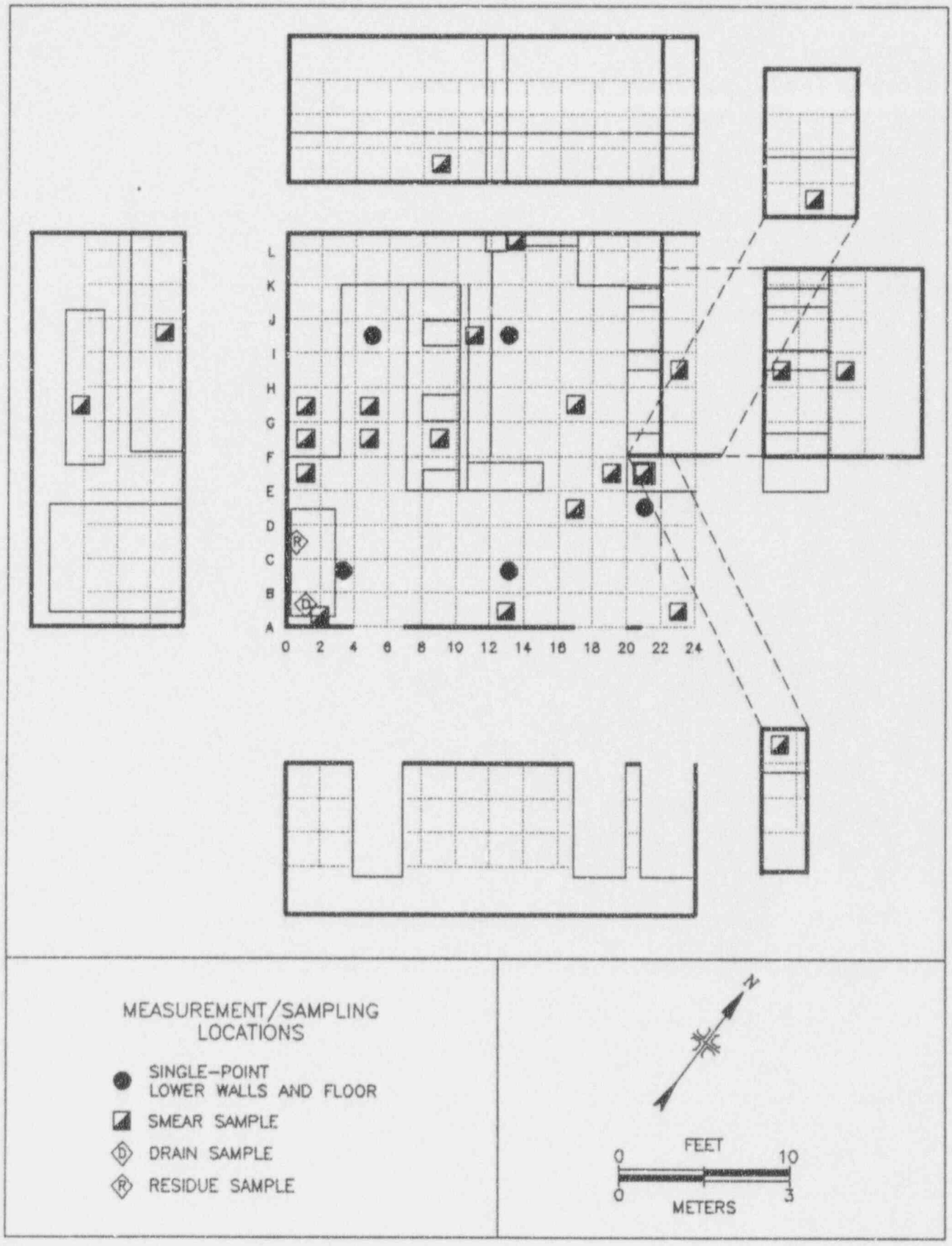


FIGURE 7: Building 1, Room 161 – Measurement and Sampling Locations

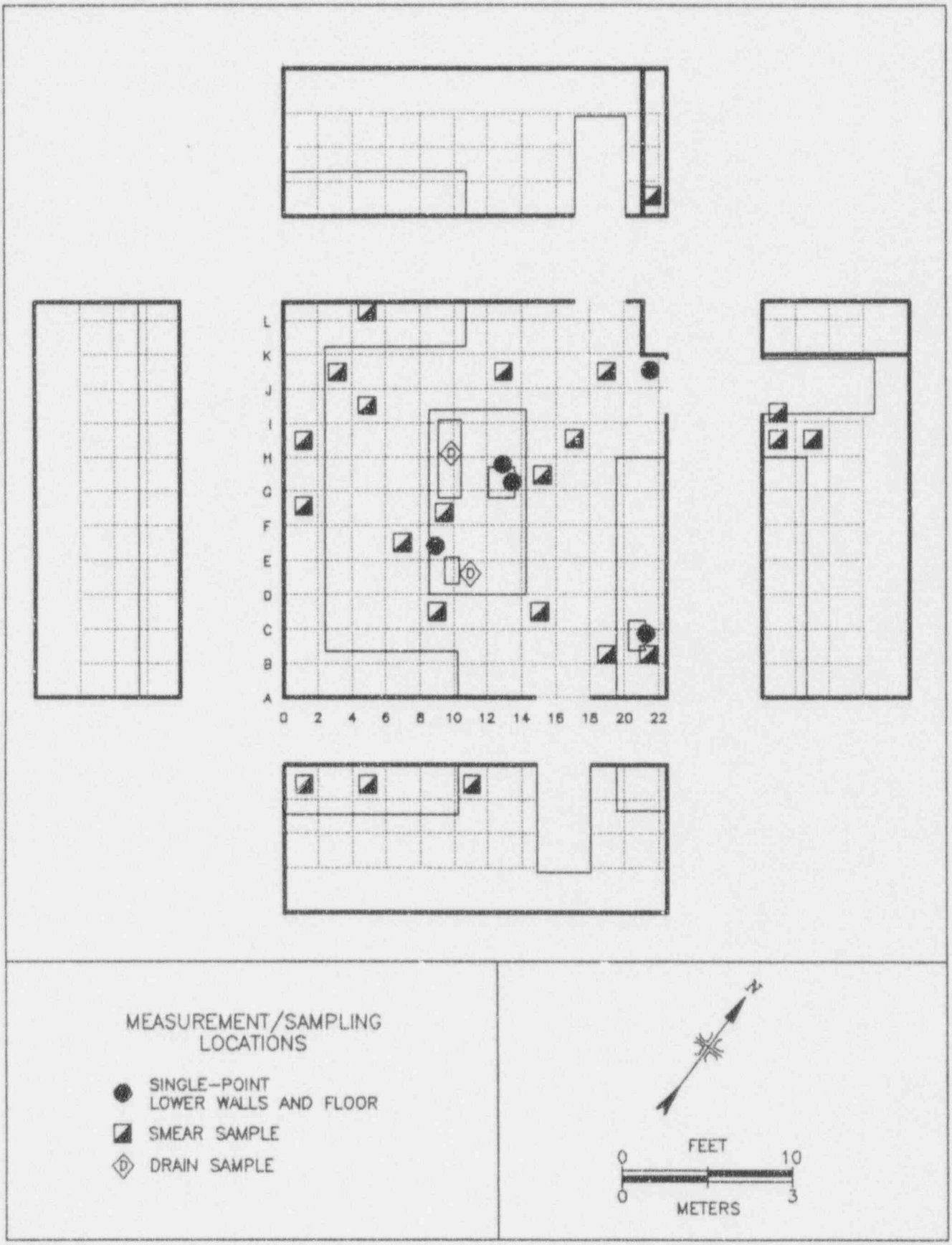
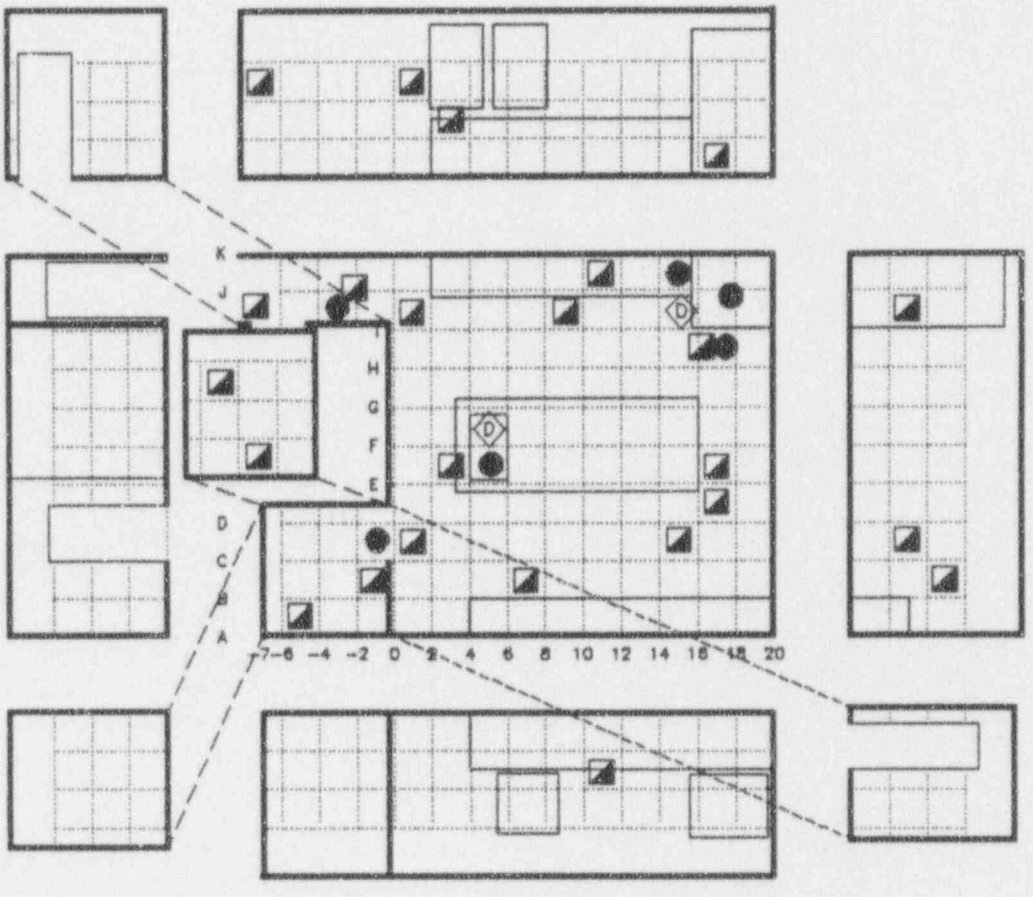


FIGURE 8: Building 1, Room 187 – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SINGLE–POINT LOWER WALLS AND FLOOR
- SMEAR SAMPLE
- DRAIN SAMPLE

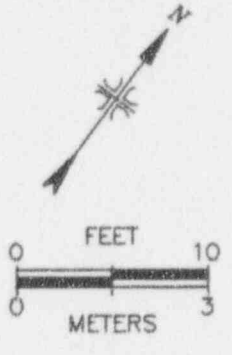
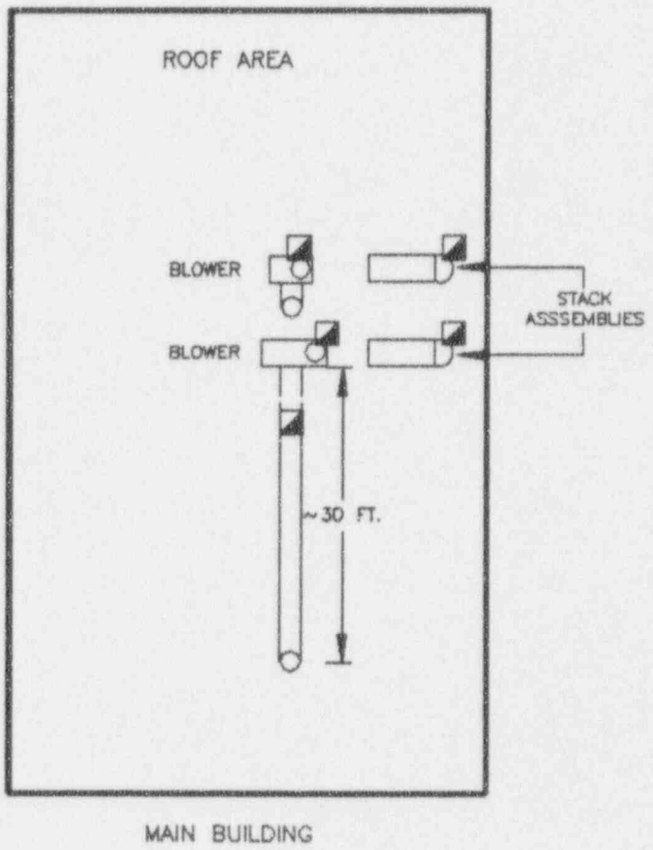


FIGURE 9: Building 19, Room 102 – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

SMEAR SAMPLE

NOT TO SCALE

FIGURE 10: Building 1, Roof Area – Measurement and Sampling Locations

TABLE 1

SUMMARY OF REMOVABLE ACTIVITY MEASUREMENTS
SEATTLE VA MEDICAL CENTER
SEATTLE, WASHINGTON

Location	Figure Number	Number of Smears	Range of Removable Activity (dpm/100 cm²)				
			Alpha	Beta	H-3	S-35	P-32
Building 1							
Room 151 Floor	4	8	<13	<15	<20	<13	<11
Room 151 Lower Walls	4	6	<13	<15	<20	<13	<11
Room 153 Floor	5	26	<13	<15-25	<20	<13	<11
Room 153 Lower Walls	5	23	<13	<15-15	<20	<13	<11
Room 161 Floor	6	16	<13	<15	<20	<13	<11
Room 161 Lower Walls	6	7	<13	<15	<20	<13	<11
Room 187 Floor	7	15	<13	<15	<20	<13	<11
Room 187 Lower Walls	7	7	<13	<15	<20	<13	<11
Roof Area	8	5	<13	<15	<20	<13	<11
Building 19							
Room 102 Floor	10	14	<13	<15-19	<20-31	<13	<11
Room 102 Lower Walls	10	10	<13	<15	<20	<13	<11

TABLE 2

RADIOACTIVITY IN MISCELLANEOUS SAMPLES
SEATTLE VA MEDICAL CENTER
SEATTLE, WASHINGTON

Location	Figure Number	Type	Total Activity (dpm/sample)			
			H-3	S-35	P-32	I-125
Building 1						
Room 151 D-0	4	Drain Swab	<110	<110	<52	<200
Room 153 D-0	5	Drain Swab	<92	<90	<42	<200
Room 153 I,8	5	Residue	540[a]	820[a]	230[a]	<230
Room 153 O,22	5	Residue	<130	<150	<140	<200
Room 161 A,0	6	Drain Swab	<84	<82	<39	<220
Room 161 C,0	6	Residue	<220	<240	<230	<210
Room 187 D,8	7	Drain Swab	<59	<58	<27	<210
Room 187 H,10	7	Drain Swab	<130	<130	<61	<190
Building 19						
Room 102 E,4	10	Drain Swab	<80	<79	<37	<210
Room 102 I,16	10	Drain Swab	<71	<70	<33	<220

[a] Activity due to potassium-40 interference in all three channels on liquid scintillation counting system. The sample was a residue that was collected underneath a sink near a water purifier which commonly incorporates a potassium compound in the purification process. The potassium compound contains K-40, a natural contaminant. Gamma spectrometry analysis of the sample confirmed that the contaminant was K-40.

TABLE 3

SUMMARY OF ADDITIONAL SURFACE ACTIVITY MEASUREMENTS
SEATTLE VA MEDICAL CENTER
SEATTLE, WASHINGTON

Location	Figure Number	Number of Measurements	Range of Beta Activity (dpm/100 cm^2)	Range of Removable Activity (dpm/100 cm^2)	
				Alpha	Beta
Building 1					
Room 151	4	5	<630	<13	<15
Room 153	5	7	<630	<13	<15
Room 161	6	5	<630	<13	<15
Room 187	7	5	<630	<13	<15
Building 19					
Room 102	10	6	<630	<13	<15

REFERENCES

1. Letter from J. T. Krujeck (Director, Seattle VAMC) to Micheal Cillis (USNRC Region V) "RE: Seattle VA Medical Center Decommissioning Plan and Special Request NRC License Number 4600990-01," Seattle VA Medical Center, October 26, 1992.

2. Letter from J. T. Krujeck (Director, Seattle VAMC) to Mr. Montgomery (USNRC Region V) "RE: Seattle VAMC Phase IV Decommissioning Plan, License Number: 4600990-01," Seattle VA Medical Center, September 23, 1992.

3. Letter from M. S. Simmons (Radiation Safety Officer, Seattle VAMC) to Micheal Cillis (USNRC Region V), "RE: Seattle VA Medical Center Biomedical Research Laboratory Decommissioning Survey Report," Seattle VA Medical Center, January 25, 1993.

4. Letter from M. S. Simmons (Radiation Safety Officer, Seattle VAMC) to Micheal Cillis (USNRC Region V), "RE: Request for Supplemental Information to the Seattle VA Medical Center Biomedical Research Laboratory Decommissioning Survey Report," Seattle VA Medical Center, February 1, 1993.

5. Letter from James Reese (USNRC Region V) to J. T. Krujeck (Director, Seattle VAMC), "RE: NRC Special Inspection," USNRC Region V, October 22, 1992.

6. Letter from Micheal Cillis (USNRC Region V) to M. S. Simmons (Radiation Safety Officer, Seattle VAMC), "RE: Comments on Seattle VA Medical Center Decommissioning Survey Report, dated January 25, 1993," USNRC Region V, January 29, 1993.

7. Letter from M. R. Landis (Project Manager, ORISE/ESSAP) to Mike Cillis (USNRC Region V), "Comments on 'Seattle VA Medical Center, Description of Research Laboratory Decommissioning Process, October 1992'," ORISE/ESSAP, December 7, 1992.

8. Letter from M. R. Landis (Project Manager, ORISE/ESSAP) to Micheal Cillis (USNRC Region V), "Comments on the Department of Veterans Affairs' Response to ESSAP's Comments on 'Seattle VA Medical Center, Description of Research Laboratory Decommissioning Process, October 1992'," ORISE/ESSAP, January 14, 1993.

9. Letter from W. C. Adams (Project Leader, ORISE/ESSAP) to Micheal Cillis (USNRC Region V), "ORISE Survey of Seattle Veterans Affairs Medical Center," ORISE/ESSAP, January 25, 1993.

10. "Radiological Survey Plan for Selected Rooms at Seattle Veterans Affairs Medical Center of Seattle, Washington," ORISE/ESSAP, January 26, 1993.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

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

DIRECT RADIATION MEASUREMENT

Instruments

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

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

Bicron NaI Scintillation Detector
Model G5 "Fidler"
(Bicron, Corporation, Newburgh, OH)

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

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

Ludlum Gas Proportional Detector
Model 43-68
Effective Area, 100 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

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

LABORATORY ANALYTICAL INSTRUMENTATION

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)

Liquid Scintillation Counter
Model 1900 CA
(Packard Instruments, Downers Grove , IL)

Low Background Gas Proportional Counter
Model LB 5100-W
(Oxford, Oak Ridge, TN)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

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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 100 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 u d for the scans were:

Beta	-	gas proportional detector with ratemeter-scaler
	-	pancake GM detector with ratemeter-scaler
Gamma	-	NaI scintillation detector with ratemeter
Gamma	-	Fidler with ratemeter-scaler

Surface Activity Measurements

Measurements of total beta activity levels were performed using gas proportional dete.tor with portable ratemeter-scalers. Based on the low efficiency of the gas proportional detector for gamma radiation and no history of use of alpha emitting radionuclides in the facility, all recorded events were assumed to be due to beta particles.

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 4 π efficiency and correcting for the active area of the detector. The beta activity background count rates for the proportional detector averaged 202 cpm. The beta efficiency factor for the gas proportional detector was 0.11 cpm/dpm and the effective window was 100 cm^2.

Removable Activity Measurements

Removable activity levels were determined using numbered filter paper disks, 47 mm in diameter. Moderate pressure was applied to the smear with two or three fingers, and approximately 100 cm^2 of the surface was wiped. Smears were placed in labeled envelopes with the location and other pertinent information recorded.

Two smear samples for removable contamination (one smear for gross alpha/beta and gamma spectrometry analysis and one smear for H-3/S-35/P-32 analyses) were obtained from each measurement location.

Dose Equivalent Rate Measurements

Measurements of dose equivalent rates (μrem/h) were performed using a Bicron micro-rem meter.

Miscellaneous Samples

In order to determine if removable activity was present in drains, selected drains were sampled by inserting paper swabs into the drain pipes. Moderate pressure was applied to the swab on the interior of drain pipes and the swab sample was placed in a labeled plastic container with the location and other pertinent information recorded.

ANALYTICAL PROCEDURES

Removable Activity

Gross Alpha/Beta and Liquid Scintillation

Smears were counted on a low background gas proportional system for gross alpha and gross beta activity, and/or in a liquid scintillation counter for beta activity to determine H-3, S-35, and P-32 activity.

Gamma Spectrometry

Groups of smears were composited, by room or area, and analyzed by gamma spectrometry for I-125, and other gamma emitting radionuclides. Average activity levels for each smear were calculated.

Miscellaneous Samples

Gamma Spectrometry

Drain swabs and residues were placed in a container that 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:

I-125	35.5 keV
K-40	1460 keV

Spectra were also reviewed for other identifiable photopeaks.

H-3 and P-32, S-35

Drain swabs and solid residue sample analyses for H-3 and P-32, S-35 were performed by placing a representative portion of the samples into a scintillation cocktail and counting on a liquid scintillation counter. Samples were then spiked with a known amount of tritium, carbon-14, and strontium-90 standards and recounted on the liquid scintillation counter. Data from both counts were calculated using an in-house program to determine activity.

DETECTION LIMITS

The analytical data presented in the tables of this report represent the 95% confidence level for that data. These data were calculated based on both the gross sample count levels and the associated background count levels. When the net sample count was less than 2.71 + 4.66 times the statistical deviation of the background count [$2.71+(4.66\sqrt{BKG})$], the sample concentration was reported as less than the detection limit of the measurement procedures. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits may 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 documents:

- Survey Procedures Manual, Revision 7 (May 1992)
- Laboratory Procedures Manual, Revision 7 (April 1992)
- Quality Assurance Manual, Revision 5 (May 1992)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C and ASME NQA-1for Quality Assurance and contain measures to assess processes during their performance.

Calibration of 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.

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 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

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

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.