RADIOLOGICAL ASSESSMENT SURVEY OF THE VANCE ROAD FACILITY SOURCE VAULT BUILDING MATERIALS OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION OAK RIDGE, TENNESSEE

J.R. MORTON

Prepared for the
Facilities and Transportation Department
Oak Ridge Institute for Science and Education

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
Environmental Survey and Site Assessment

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ABBREVIATIONS AND ACRONYMS

ϵ_i	instrument efficiency
ϵ_s	source efficiency
b_i	background counts in observation interval
BKG	background
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
DOE	U.S. Department of Energy
dpm	disintegrations per minute
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EML	Environmental Measurements Laboratory
ESSAP	Environmental Survey and Site Assessment Program
FTD	Facilities and Transportation Department
ITP	Intercomparison Testing Program
LSC	liquid scintillation counter
m	meter
m^2	square meter
mm	millimeter
MAPEP	Mixed Analyte Performance Evaluation Program
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
NRIP	NIST Radiochemistry Intercomparison Program
ORISE	Oak Ridge Institute for Science and Education
ORO	Oak Ridge Operations
RA	remedial action
s	seconds
SEPD	Safety and Environmental Protection Department
SVA	Source Vault Area
VRF	Vance Road Facility

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INTRODUCTION AND SITE HISTORY

The Oak Ridge Institute for Science and Education (ORISE) occupies and maintains, on behalf of the Department of Energy's Oak Ridge Operations Office (DOE-ORO), the Vance Road Facility (VRF). Several radiological research laboratories formerly operated on the second floor of the VRF. These laboratories were used since the early 1950's for medical research activities involving both sealed and unsealed sources of a variety of radionuclides. Radionuclides such as ^{3}H, ^{14}C, ^{90}Sr, ^{67}Ga, ^{68}Ga, ^{68}Ge, ^{60}Co, $^{44}Sc/^{44}Ti$, ^{137}Cs, and ^{226}Ra were used in these laboratories along with other rare radionuclides, such as some short-lived alpha and beta emitters that have most likely decayed away. The radionuclides used in these laboratories were stored in a source vault located on the first floor of the facility. Prior to this survey, the Source Vault Area (SVA) was converted into two laboratories which were identified as Rooms A107 and A107a. In 1997, the Facilities and Transportation Department (FTD) of ORISE remediated the second floor laboratories and converted them to office space. FTD has now requested that the Environmental Survey and Site Assessment Program (ESSAP) of ORISE perform a radiological assessment survey of the SVA and its associated miscellaneous building materials and laboratory equipment.

SITE DESCRIPTION

The VRF is located at 140 East Vance Road and is west of the Methodist Medical Center Hospital in Oak Ridge (Figure 1). The SVA is located in the far northwest end of the ground floor of the VRF A Building (Figure 2). The SVA consisted of two small rooms (Rooms A107 and A107a) with tile and vinyl floor coverings over a poured concrete base and walls constructed of wood framing with splash-proof wall panels (Figure 3). There was a false ceiling in place consisting of standard-sized panels and the corresponding metal hanging system that covered the duct systems. Equipment, including sinks, tables, shelves, and a refrigerator occupied approximately 25% of the available floor space. The SVA contained drain lines, three hoods,

and hood vent ductwork with the hood vent exhausts located on the roof. The three hoods were not removed during these surveys and will be addressed at a later date. The room also contained various sinks, countertops, and other miscellaneous equipment.

OBJECTIVE

The objective of this survey was to obtain sufficient data to evaluate the radiological condition of the removable materials and equipment within the SVA.

DOCUMENT REVIEW

As part of the remedial action activities, ESSAP reviewed available historical information regarding radionuclide usage within the facility.

PROCEDURES

During the period of March through July, 2000, ESSAP performed a remedial action release survey of the SVA. The radiological surveys involved the scanning of each individual piece of equipment/material prior to its removal from the SVA. Once the determination was made that the items had no residual activity, the materials were removed from the room and disposed of accordingly. Any materials found to possess elevated residual contamination were remediated or packaged properly prior to their removal from the SVA. Survey activities were conducted in accordance with a plan dated March 14, 2000 and the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 2000a, 1998, and 2000b). Deviations to the survey plan were made as the survey progressed and were recorded in the site logbook.

BACKGROUND MEASUREMENTS

Material-specific direct measurement backgrounds were performed on similar material types, but without a history of radioactive material use. These background measurements were used to correct gross surface activity measurements.

RADIOLOGICAL ASSESSMENT SURVEY PROCEDURES

Radiological assessment survey procedures applied to the temporary walls, floor coverings, false ceiling, hood ductwork, and equipment that were removed from the SVA.

Reference Locations

Measurement and sampling locations of the temporary walls removed from within the SVA were referenced to scaled drawings. Measurement location for other miscellaneous items (such as floor coverings, the false ceiling, sinks, benchtops, cabinets, etc.) removed from the SVA were only documented on the survey sheets by a description of the item and measurement location. Locations with residual contamination approaching or exceeding guidelines were also indicated on the scaled drawings.

Surface Scans

Surface scans for alpha plus beta activity were performed on 100% of all accessible surfaces of the building material/equipment using hand-held gas proportional detectors coupled to ratemeter-scalers with audible indicators. After the equipment had been removed from its original position, the previously inaccessible areas were also scanned at a rate of 100%. This process included the scans of the vinyl floor surface which covered up to two layers of floor tiles. Each tile was removed and scanned on both sides. Any pieces of vinyl flooring or tiles exhibiting surface activity greater than the release criteria via these scans were disposed of as radiological waste, while those exhibiting surface activity levels less than the criteria were removed from the SVA. Particular attention was given to locations where residual material may have accumulated. Locations of elevated direct radiation identified during the survey activities were marked for remedial action (Figure 4).

Surface Activity Measurements

Direct measurements for alpha and beta surface activity levels were obtained from 199 locations on the removed walls, flooring, building materials, equipment, etc. Figures 5 and 6 depict the

measurement locations performed on the removed walls. Direct measurements were not performed on a large portion of the building materials—the pieces were discarded in regular trash when no elevated activity was detected by scans or smear sampling or as radiological waste when contamination was identified. All measurements were performed using hand-held gas-proportional detectors coupled to ratemeter-scalers. Smears for determining removable gross alpha and gross beta contamination were collected at each direct measurement location exhibiting elevated activity. A separate set of smears was also collected at suspect or randomly selected locations to determine removable ^{3}H and ^{14}C contamination, as the sensitivity of the field instrumentation was not adequate to detect the low-energy beta emissions of these radionuclides.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and survey data were returned to the ESSAP Oak Ridge laboratory for analysis and interpretation. Sample analyses were performed in accordance with the ESSAP Laboratory Procedures Manual (ORISE 2000c). Smears were analyzed for gross alpha and gross beta activity using a low background gas proportional counter and for ^{3}H, ^{14}C, and ^{90}Sr using a liquid scintillation counter (LSC). The conversion of the LSC data for ^{90}Sr was not performed on all samples, just those with ratios indicating the presence of the radionuclide. Direct measurement and smear data were converted to units of disintegrations per minute per 100 square centimeters (dpm/100 cm^2). The data generated was compared with the DOE (as specified in DOE Order 5400.5) and U.S. Nuclear Regulatory Commission (NRC) guidelines.

FINDINGS AND RESULTS

DOCUMENT REVIEW

Historical data submitted for review by the Safety and Environmental Protection Department (SEPD) was limited to previous radiological laboratory survey data (maps and measurement locations) indicating the radionuclides that had been used during that time period.

SURFACE SCANS

Surface scans identified four locations of residual elevated activity on the shelves and cabinets, three locations on the sheetrock walls, four on the false ceiling tiles, and approximately a dozen on the vinyl flooring which had residual elevated activity in excess of the release guidelines. Additionally, 13 of the 14 surveyed pieces of hood ductwork and numerous pieces of floor tile and other miscellaneous parts of equipment (lead bricks, baseboard, etc.) were identified as having residual elevated surface activity.

SURFACE ACTIVITY LEVELS

Results of the total and removable surface activity levels for the radiological assessment survey are presented in Table 1. Total surface activity levels ranged from -8 to 48 dpm/100 cm^2 and -180 to 280,000 dpm/100 cm^2 for alpha and beta, respectively. Removable activity levels ranged from 0 to 13 dpm/100 cm^2 for gross alpha, -5 to 2,500 dpm/100 cm^2 for gross beta, -7 to 42,700 dpm/100 cm^2 for ^{3}H, -9 to 81,770 dpm/100 cm^2 for ^{14}C, and -12 to 72,400 dpm/100 cm^2 for ^{90}Sr.

COMPARISON OF RESULTS WITH GUIDELINES

The radionuclides of concern at VRF's Source Vault Area were ^{3}H, ^{14}C, ^{90}Sr, and ^{226}Ra. The DOE guidelines for residual radioactive materials and the current NRC guidelines for acceptable surface contamination levels for release of a facility for unrestricted use were considered, and in cases when these guidelines were not identical, the more conservative values were used to evaluate the survey results. The primary beta contaminants of concern were ^{90}Sr, ^{60}Co, and ^{14}C. The more restrictive beta contamination guideline for ^{90}Sr was used for comparing direct beta surface activity levels (DOE 1990).

^{3}H Removable Activity

10,000 dpm/100 cm^2

Total Alpha Activity

100 dpm/100 cm^2 (Average over 1 m^2)
300 dpm/100 cm^2 (Maximum in 100 cm^2)
20 dpm/100 cm^2 (Removable in 100 cm^2)

Beta-Gamma Activity

1,000 dpm/100 cm^2 (Average over 1 m^2)
3,000 dpm/100 cm^2 (Maximum in 100 cm^2)
200 dpm/100 cm^2 (Removable in 100 cm^2)

The surface activity guidelines in DOE Order 5400.5 do not specifically address tritium. Because tritium typically penetrates the materials in which in comes into contact, the beta-gamma emitter surface activity guidelines are not applicable. Therefore, DOE assessed the potential doses associated with the release of property containing residual tritium and recommended an interim value of 10,000 dpm/100 cm^2 for removable tritium (DOE 1995).

During the remedial action surveys, several of the removed pieces of equipment and building materials possessed residual activity in excess of the guidelines—these areas were remediated to allow for the removal of the pieces as the survey progressed.

SUMMARY

During the period of March through July 2000, the Environmental Survey and Site Assessment Program performed a remedial action survey of the Source Vault Area of the Oak Ridge Institute for Science and Education's Vance Road Facility.

The radiological assessment survey activities included surface scans, surface activity measurements, and smear sampling of the building materials and equipment which was being removed from the area to allow access to the structural surfaces. Many of the materials had areas of residual radioactive material that exceeded the release criteria for either surface or removable activity and were therefore, remediated accordingly. Once remedial activities were completed, the non-suspect pieces and the remediated portions of the pieces with activity levels exceeding criteria were removed from the SVA.

FIGURES

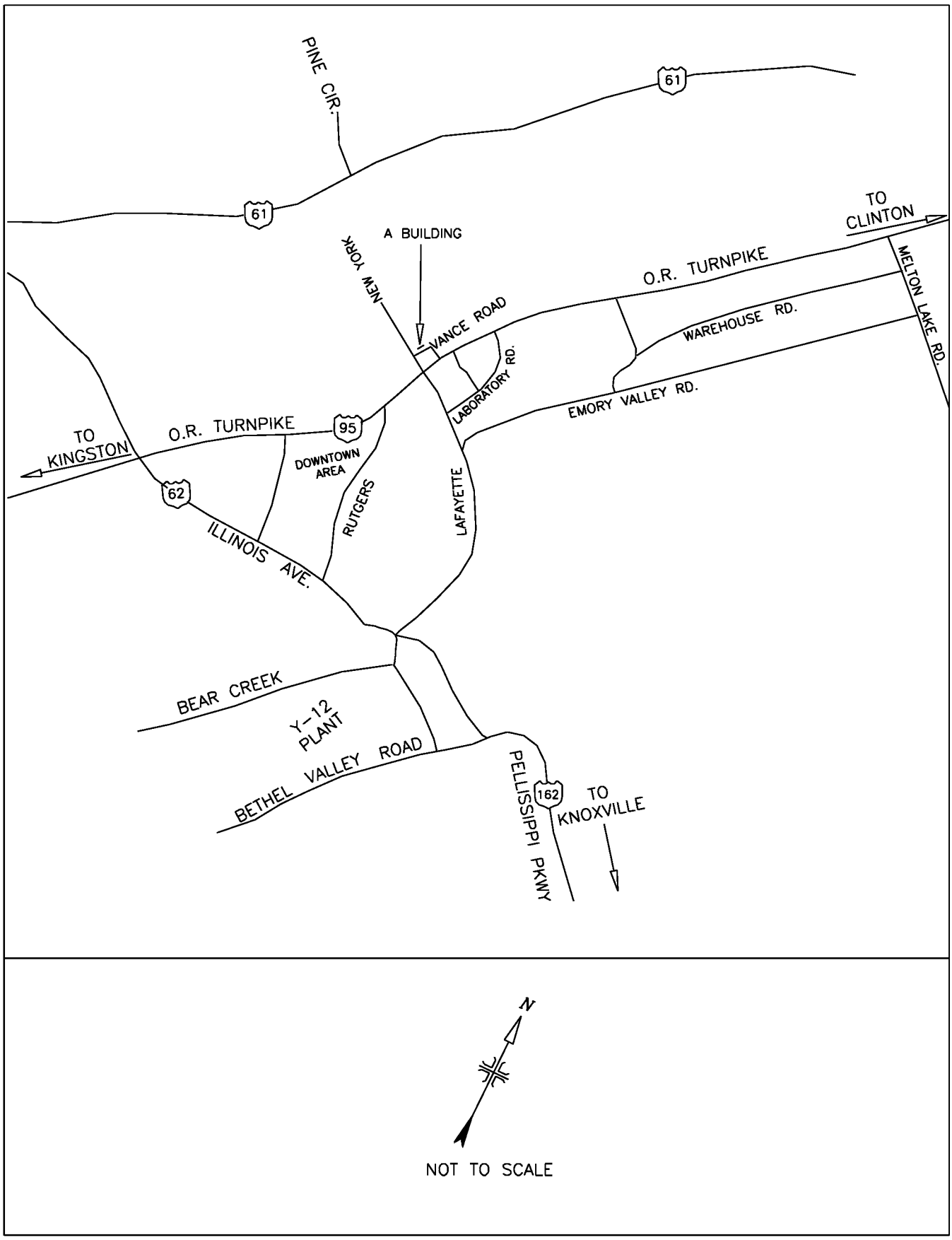


FIGURE 1: Location of Vance Road A Building

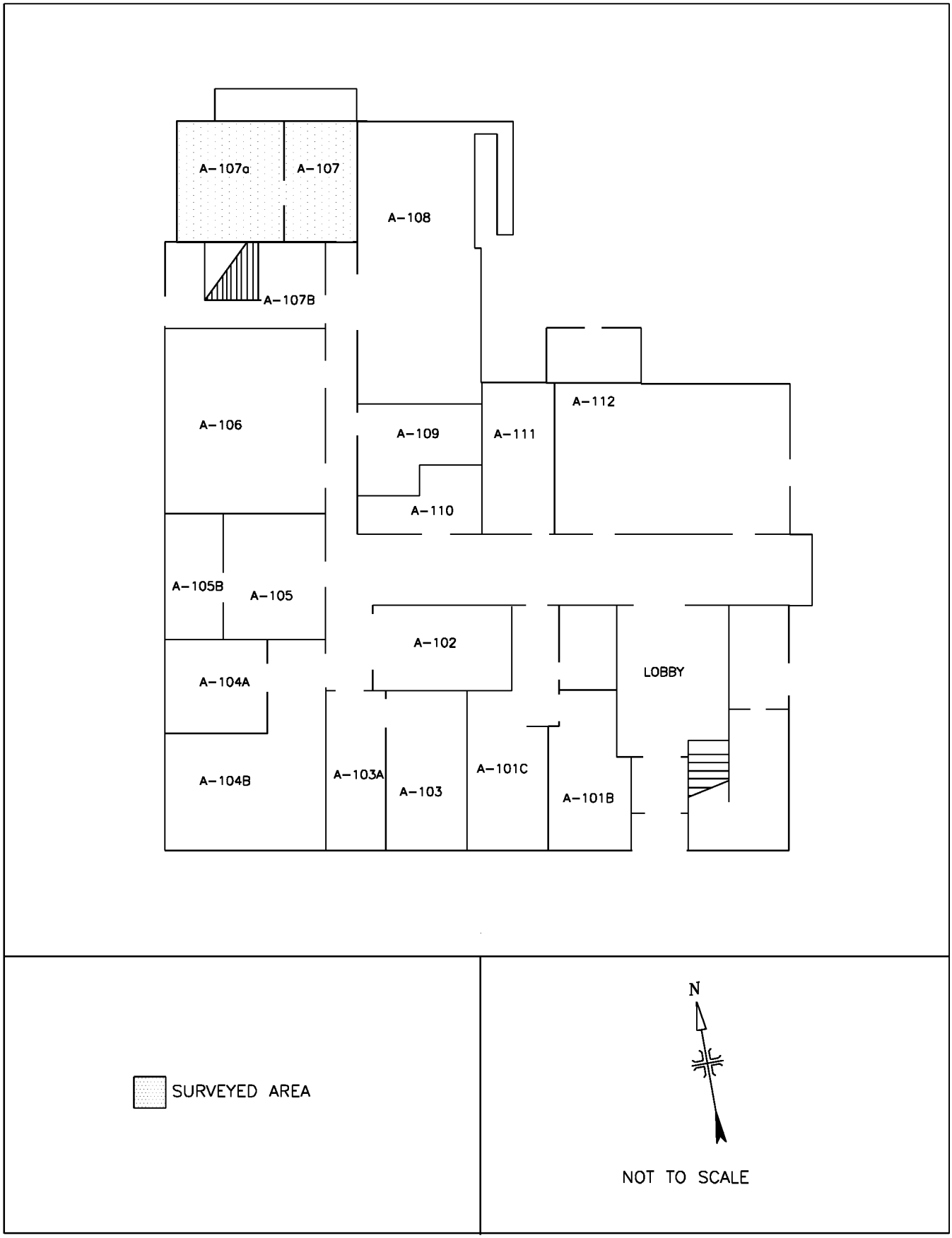
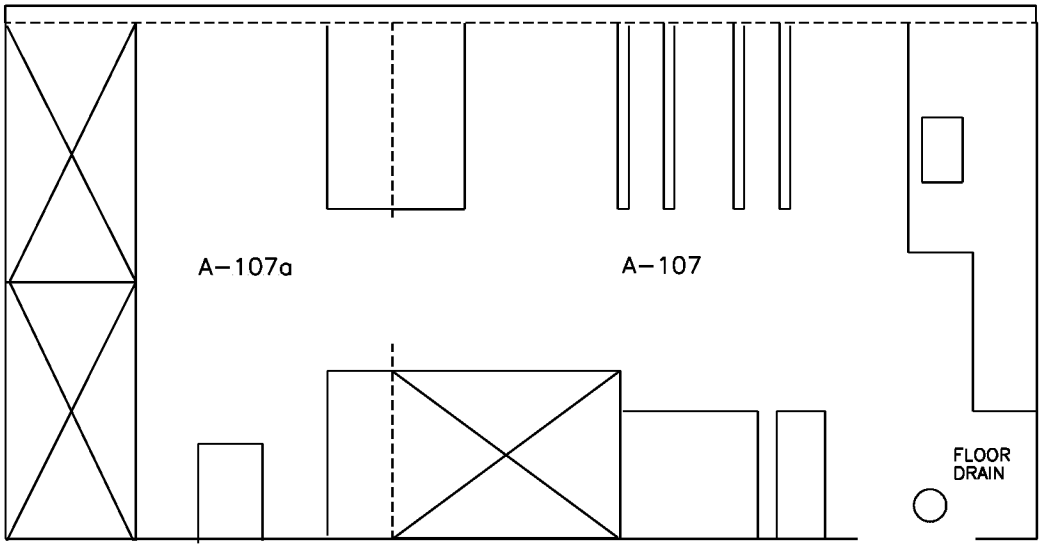


FIGURE 2: Vance Road A Building – Surveyed Areas



---------- Temporary Walls

FIGURE 3: Source Vault Area – Presurvey Floor Plan

531-008 (1)

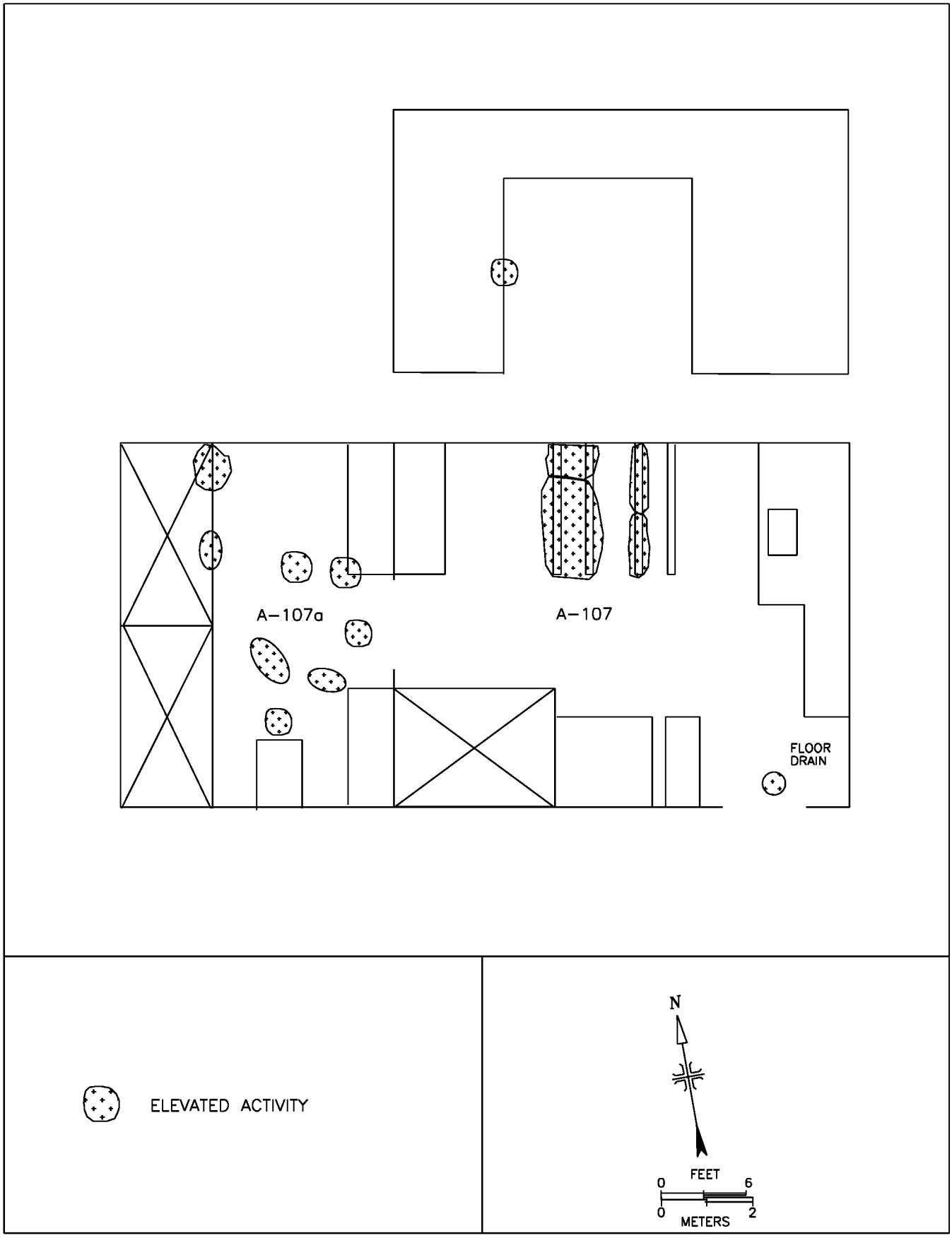


FIGURE 4: Source Vault Area – Elevated Activity Locations

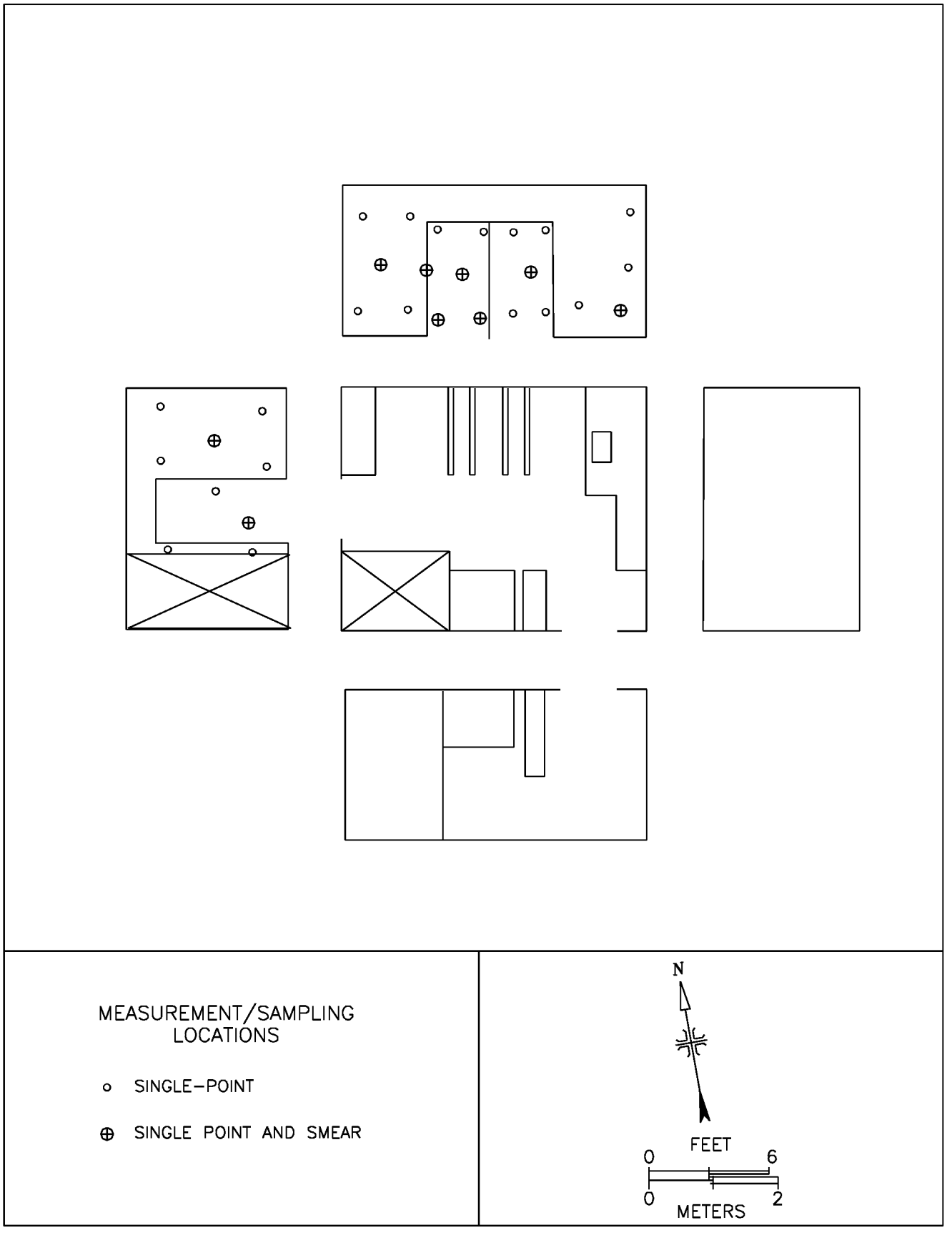
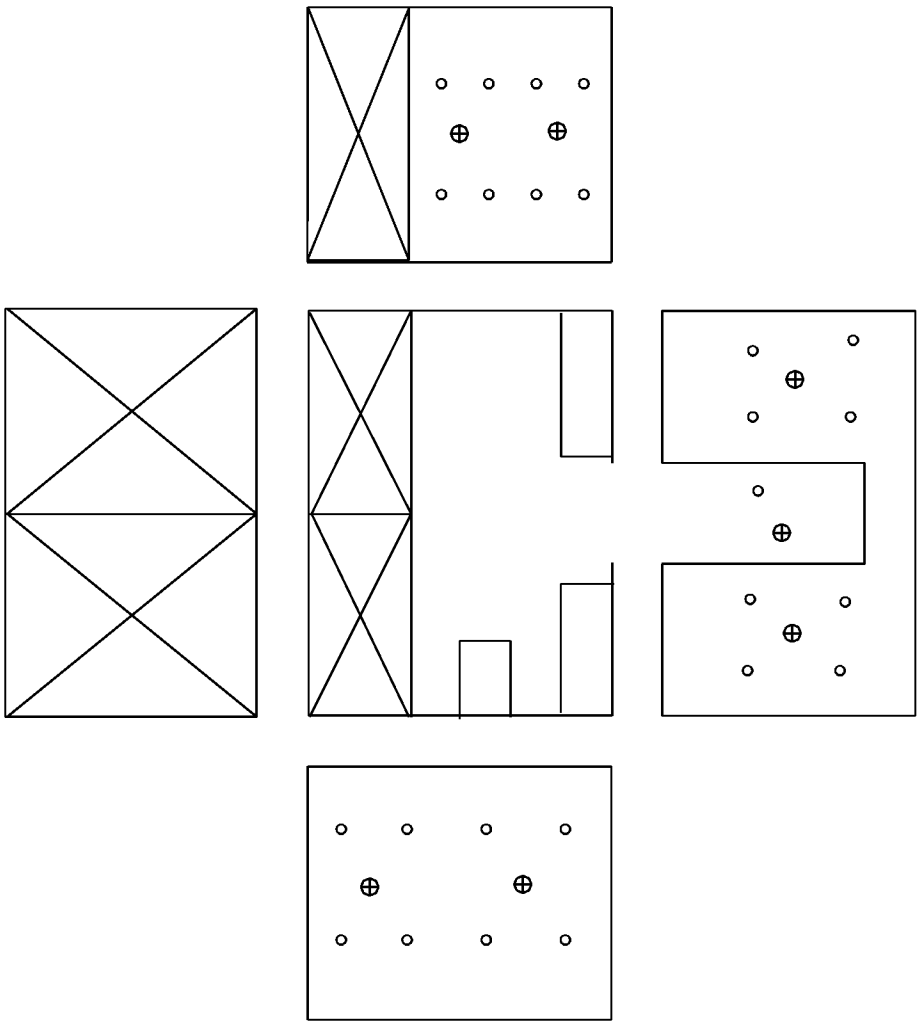


FIGURE 5: Source Vault Area, A107 – Lower Wall
Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- ○ SINGLE–POINT
- ⊕ SINGLE POINT AND SMEAR

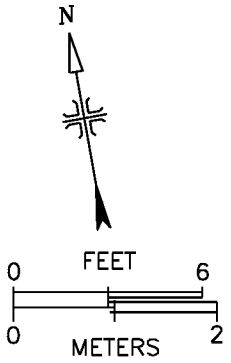


FIGURE 6: Source Vault Area, A107a – Lower Wall Measurement and Sampling Locations

TABLES

TABLE 1

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
OAK RIDGE, TENNESSEE

Location[a]	Total Surface Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Cabinet #1							
Top Shelf	0	83	0	-3	–[b]	--	--
Third Shelf	0	63	0	1	--	--	--
Second Shelf	0	120	0	3	27 ± 14[c]	-2.2 ± 5.0	
Bottom Shelf	0	170	0	-1	--	--	--
Underneath second shelf	0	210	0	-1	--	--	--
Underneath bottom shelf	8	1,300	0	96	45 ± 15	305 ± 12	
Cabinet Door	8	-89	0	-3	--	--	--
Right Side	0	-130	0	16	23 ± 13	-2.2 ± 5.0	--
Glass Door	8	130	0	4	20 ± 13	-4.6 ± 4.9	--
Cabinet # 2							
Bottom Shelf	8	130	2	-2	--	--	--
Middle Shelf	0	-7	0	8	12 ± 13	-2.5 ± 5.0	--
Top Shelf	0	150	2	-3	--	--	--
Underside	-8	60	0	1	20 ± 13	-6.0 ± 4.8	--
Door	16	-93	0	-2	32 ± 14	2.5 ± 5.2	--

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
OAK RIDGE, TENNESSEE

Location[a]	Total Surface Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Cabinet # 3							
Bottom Shelf	0	0	0	2	14 ± 13	9.7 ± 5.4	--
Middle Shelf	16	230	2	4	--	--	--
Door	16	-56	0	-4	--	--	--
Cabinet #4							
Bottom Shelf	0	170	0	-3	5.2 ± 12.5	0.5 ± 5.1	--
Second Shelf	0	110	0	-1	--	--	--
Door	16	-13	0	2	--	--	--
Cabinet # 5							
Third Shelf	0	-76	0	1	--	--	--
Second Shelf	8	23	0	-2	--	--	--
Underside	0	-33	0	1	23 ± 13	1.6 ± 5.1	--
Cabinet # 6							
Bottom Shelf	0	220	2	6	18 ± 13	6.9 ± 5.3	--
Top Shelf	24	83	2	-2	--	--	--
Door	8	-43	0	1	--	--	--

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
OAK RIDGE, TENNESSEE

Location[a]	Total Surface Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Counter # 1							
Top	0	530	0	3	38 ± 14	21.3 ± 5.5	--
Left Drawer #1	-8	-50	0	1	--	--	--
Left Drawer #2	-8	99	2	-2	--	--	--
Left Drawer #3	16	160	0	-2	--	--	--
Left Drawer #4	0	210	0	-2	--	--	--
Right Drawer #1	16	240	0	2	--	--	--
Right Drawer #2	24	220	2	2	--	--	--
Right Drawer #3	16	150	0	-3	--	--	--
Right Drawer #4	0	46	2	1	--	--	--
Top	40	150	0	5	--	--	--
Top	8	-10	0	6	--	--	--
Side	24	-83	0	2	28 ± 13	4.2 ± 4.9	--
Refrigerator							
Interior	8	780	3	34	161 ± 19	272 ± 11	
Exterior	16	30	0	-4	40 ± 14	6.2 ± 5.0	

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
OAK RIDGE, TENNESSEE

Location[a]	Total Surface Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Desk							
Top	16	76	0	5	33 ± 14	10.1 ± 5.1	--
Top	-8	50	0	-1	--	--	--
Top	16	160	2	2	--	--	--
Left Drawer	8	180	0	2	--	--	--
Right Drawer #1	8	93	0	-2	--	--	--
Right Drawer #2	24	40	3	-1	--	--	--
Right Drawer #3	0	110	0	3	--	--	--
Front	0	-73	0	1	31 ± 14	4.7 ± 4.9	--
Cabinet #2							
Bottom Right Cabinet	16	240	0	3	--	--	--
Center Right Cabinet	0	110	2	4	--	--	--
Center Left Cabinet	8	99	0	4	--	--	--
Bottom Left Cabinet	24	160	0	-3	--	--	--
Top	24	200	0	1	22 ± 13	5.3 ± 4.9	--
Top Ledge	-8	100	0	2	19 ± 13	9.0 ± 5.1	--

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
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OAK RIDGE, TENNESSEE

Location[a]	Total Surface Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Cabinet # 2 (continued)							
Sink	16	160	0	-4	13 ± 13	2.3 ± 4.8	--
Top Ledge	8	160	0	6	--	--	--
Top	8	110	2	1	--	--	--
Right Drawer	0	180	0	1	--	--	--
Left Drawer	24	330	0	1	--	--	--
Front Left	-8	-83	0	3	11 ± 12	3.6 ± 4.9	--
Front Right	32	-26	0	-4	--	--	--
File Cabinet							
Top Drawer	-8	110	3	1	--	--	--
Second Drawer	0	170	2	-5	--	--	--
Third Drawer	-8	110	0	-5	--	--	--
Bottom Drawer	16	50	2	3	--	--	--
Top	0	73	0	6	22 ± 13	5.6 ± 4.9	--

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
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Location[a]	Total Surface Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
File Cabinet (continued)							
Left Side	32	-50	0	-1	26 ± 13	-0.2 ± 4.7	--
Cabinet # 2 - Top	8	930	0	-2	--	--	153 ± 13
Valance Piece	-8	280	0	-1	--	--	3.3 ± 8.1
Refrigerator Top	8	3,600	0	69	--	--	258 ± 16
Cabinet Over Fridge - Top	-8	11,000	0	299	--	--	1,863 ± 38
Cabinet #1 Post Smear of Location	--	450	2	--	--	--	--
Counter # 1							
Top	0	73	0	3	34 ± 15	16.4 ± 5.7	--
Top	0	96	0	-2	--	--	--
Top Right Drawer Interior	8	63	2	-3	--	--	--
Top Middle Right Drawer Interior	0	140	0	-3	--	--	--

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
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Location[a]	Total Surface Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Counter # 1 (continued)							
Top Middle Left Drawer Interior	0	63	2	5	--	--	--
Top Left Drawer Interior	0	180	0	-3	--	--	--
Top Middle Left Drawer Interior	8	60	0	2	--	--	--
Top Middle Right Drawer Interior	0	23	0	-2	--	--	--
Middle Middle Right Drawer Right Drawer Interior	8	73	0	-4	--	--	--
Middle Middle Left Drawer Interior	8	69	0	5	--	--	--
Bottom Drawer Interior	-8	66	0	-3	20 ± 15	-2.3 ± 5.0	--
Front Exterior	8	-43	0	2	3.5 ± 13.6	1.9 ± 5.2	--
Left Side Exterior	24	-40	0	6	4.9 ± 13.7	-3.1 ± 5.0	--

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
OAK RIDGE, TENNESSEE

Location[a]	Total Surface Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Counter # 2							
Top	0	99	0	2	9.3 ± 14.0	-0.7 ± 5.1	--
Top Drawer Interior	0	160	0	24	--	--	--
Second Drawer Interior	0	130	0	0	--	--	--
Third Drawer Interior	-8	96	0	0	--	--	--
Fourth Drawer Interior	8	73	0	2	2.0 ± 13.6	-2.5 ±5.0	--
Bottom Drawer Interior	0	56	2	3	--	--	--
Front	16	-56	0	0	0.8 ± 13.5	0.0 ± 5.1	--
Left Side	0	-180	0	-3	--	--	--
Right Side	0	-86	2	2	--	--	--
Counter # 3							
Underneath Right	0	170	0	0	-6.5 ± 13.1	-3.8 ± 5.0	--
Underneath Left	0	110	0	-3	--	--	--
Top Right	0	93	2	5	16 ± 14	5.6 ± 5.3	--
Sink	0	96	0	2	17 ± 14	4.6 ± 5.3	--

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
OAK RIDGE, TENNESSEE

Location[a]	Total Surface Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Cabinet #3 (continued)							
Top Left	0	130	0	0	--	--	--
Front Left	0	-110	0	8	-1.9 ± 13.4	-3.9 ± 5.0	--
Front Right	8	-7	0	3	--	--	--
Right Side	0	-60	0	1	--	--	--
Cabinet							
Underside Front Edge	-8	1,300	0	5	8.8 ± 13.9	-6.3 ± 4.9	--
Bottom Shelf	8	-26	0	-3	7.4 ± 13.9	0.9 ± 5.2	--
Second Shelf	8	120	0	6	--	--	--
Third Shelf	8	89	0	4	–	--	--
Top Shelf	0	120	0	-4	--	--	--
Door	8	96	2	4	1.2 ± 13.5	-0.8 ± 5.1	--
Right Side	8	-76	0	-2	8.9 ± 14.0	-2.2 ± 5.0	--
Room 107A South Wall							
1	8	20	--	--	--	--	--
2	8	-43	--	--	--	--	--

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
OAK RIDGE, TENNESSEE

Location[a]	Total Surface Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Room 107A - South Wall (continued)							
3	-8	33	--	--	--	--	--
4	-8	-7	--	--	--	--	--
5	8	17	--	--	-1.0 ± 12.9	-5.5 ± 5.2	
6	0	33	–	--	--	--	--
7	0	7	--	--	--	--	--
8	0	-46	--				
9	-8	-30	--	--	--	--	--
10	-8	33	--	--	-2.8 ± 12.8	-4.2 ± 5.0	--
Room 107A - East Wall							
11	8	20	--	--	--	--	--
12	8	17	--	--	--	--	--
13	-8	-23	--	--	--	--	--
14	0	-36	--	--	--	--	--
15	-8	-110	--	--	17.2 ± 13.9	-5.3 ± 5.2	--
16	8	60	--	--	--	--	--

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
OAK RIDGE, TENNESSEE

Location[a]	Total Surface Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Room 107A - East Wall (continued)							
17	0	10	--	--	8.4 ± 13.5	-3.6 ± 5.2	--
18	0	-89	--	--	--	--	--
19	24	0	--	--	--	--	--
20	8	7	--	--	--	--	--
21	-8	-150	--	--	--	--	--
22	8	-96	--	--	3.4 ± 13.2	-6.0 ± 5.1	--
Room 107A - North Wall							
23	8	0	--	--	--	--	--
24	0	36	--	--	--	--	--
25	8	-73	--	--	--	--	--
26	24	-43	--	--	--	--	--
27	8	-150	--	--	-2.1 ± 12.9	6.0 ± 5.1	--
28	-8	-130	--	--	--	--	--
29	0	-20	--	--	--	--	--
30	8	-13	--	--	--	--	--

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
OAK RIDGE, TENNESSEE

Location[a]	Total Surface Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Room 107A - North Wall (continued)							
31	24	-23	--	--	--	--	--
32	-8	-36	--	--	7.4 ± 13.3	-2.2 ± 5.3	--
Room A107 - West Wall							
1	24	-60	--	--	--	--	--
2	-8	-53	--	--	--	--	--
3 - Door	-8	370	--	--	6.6 ± 13.4	5.7 ± 5.6	--
4 - Door	-8	0	--	--	--	--	--
5	0	43	--	--	--	--	--
6	0	-93	--	--	--	--	--
7	8	-63	--	--	--	--	--
8	0	-13	--	--	--	--	--
9	24	-20	--	--	-1.0 ± 12.9	-2.4 ± 5.3	--
Room A107 - North Wall							
10	-8	-73	--	--	--	--	--
11	0	-76	--	--	--	--	--

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
OAK RIDGE, TENNESSEE

Location[a]	Total Surface Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Room A107 - North Wall (continued)							
12	8	420	--	--	--	--	--
13	-8	-46	--	--	--	--	--
14	0	-96			-1.8 ± 12.9	-7.1 ± 5.1	--
15	8	1,900	0	-2	12.0 ± 13.6	-3.1 ± 5.2	--
16	-8	-89	--	--	--	--	--
17	8	-130	--	--	--	--	--
18	0	790	0	6	--	--	--
19	-8	710	0	-3	--	--	--
20	-8	10	--	--	1.2 ± 13.1	-8.7 ± 5.0	--
21	16	-110	--	--	--	--	--
22	-8	-140	--	--	--	--	--
23	-8	330	--	--	--	--	--
24	0	820	--	--	--	--	--
25	0	-120	--	--	0.4 ± 13.0	-5.2 ± 5.2	--

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
OAK RIDGE, TENNESSEE

Location[a]	Total Surface Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Room A107 - North Wall (continued)							
26	0	-69	--	--	--	--	--
27	-8	33	--	--	--	--	--
28	-8	-36	--	--	-0.4 ± 13.0	-3.7 ± 5.2	--
29	0	7	--	--	--	--	--
Rooms A107 and A107A							
Baseboard	48	42,000	11	1,300	1,262 ± 43	2,505 ± 32	3,702 ± 16
Ceiling Tile (back)	8	82,000	5	16	166 ± 19	330 ± 12	361 ± 5.0
Ceiling Tile (back)	32	19,000	3	36	191 ± 20	364 ± 13	386 ± 6.0
Ceiling Tile (back)	-8	280,000	13	2,500	42,700 ± 240	81,770 ± 180	72,379 ± 68
Ceiling Tile (back)	0	3,400	0	6	75 ± 15	32.4 ± 6.1	30.2 ± 2.7
Misc. Ceiling Grid	-8	110	--	--	14 ± 12	-1.5 ± 4.9	--
Misc. Ceiling Grid	0	130	--	--	--	--	--
Ceiling Tile (back)	16	96	--	--	1.8 ± 11.3	4.4 ± 5.1	-3.0 ± 2.3
Ceiling Tile (front)	8	110	--	--	--	--	--
Light Screen	0	190	--	--	7.9 ± 11.6	2.5 ± 5.0	2.1 ± 2.4

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
OAK RIDGE, TENNESSEE

Location[a]	Total Surface Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Room A107							
Door Frame	-8	11,000	0	14	397 ± 26	669 ± 17	705.7 ± 7.1
Metal Rod	0	4,300	0	110	85 ± 16	112.0 ± 8.2	109.1 ± 3.5
Hood Ductwork							
Hood 2 Exit	0	1,500	1	3	143 ± 19	58 ± 7	-2 ± 2
Hood 1 Exit	0	7,000	0	38	419 ± 27	454 ± 14	13 ± 2
Hood 1 / Section 1	0	17,000	0	56	1,040 ± 40	1,059 ± 21	22 ± 3
Hood 1 / Section 2	16	10,000	0	45	493 ± 29	828 ± 19	48 ± 3
Hood 1 / Section 2	8	20,000	0	32	1,168 ± 42	1,451 ± 25	29 ± 3
Hood 1 - Stack	8	320	2	1	-2 ± 12	26 ± 6	2 ± 2
Hood 2 / Section 1	40	1,000	0	5	108 ± 17	55 ± 7	-1 ± 2
Hood 2 / Section 2	16	6,900	0	240	935 ± 38	750 ± 18	11 ± 2
Hood 2 / Section 2	16	26,000	3	530	2,418 ± 60	2,551 ± 32	64 ± 4
Hood 2 / Section 3	48	2,000	0	6	205 ± 21	109 ± 8	-3 ± 2
Hood 2 / Section 3	32	1,600	--	--	--	--	--
Hood 2 / Section 4	0	3,200	3	590	785 ± 35	544 ± 16	19 ± 3

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
VANCE ROAD FACILITY SOURCE VAULT
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
OAK RIDGE, TENNESSEE

Location[a]	Total Surface Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)				
	Alpha	Beta	Alpha	Beta	H-3	C-14	Sr-90
Hood Ductwork (continued)							
Hood 2 / Section 4	8	5,100	5	120	87 ± 16	20 ± 6	-12 ± 2
Hood 2 / Section 5	16	19,000	0	120	1,635 ± 50	1,709 ± 27	67 ± 4
Hood 2 / Section 5	16	7,000	3	40	836 ± 36	678 ± 17	11 ± 2
Hood 2 / Section 6	-8	3,800	3	200	515 ± 30	258 ± 11	-6 ± 2
Hood 2 / Section 6	24	25,000	3	380	3,476 ± 71	3,841 ± 39	70 ± 4

[a]Refer to Figures 5 and 6.
[b] Sample not collected.
[c]Uncertainties are total propagated uncertainties at the 95% confidence level.

REFERENCES

Oak Ridge Institute for Science and Education. Survey Procedures Manual for the Environmental Survey and Site Assessment Program, Revision 10. Oak Ridge, TN; January 7, 1998.

Oak Ridge Institute for Science and Education. Proposed Radiological Assessment Survey Plan for the Vance Road Facility Source Vault, Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee. Oak Ridge, TN; March 14, 2000a.

Oak Ridge Institute for Science and Education. Quality Assurance Manual for the Environmental Survey and Site Assessment Program, Revision 10. Oak Ridge, TN; March 10, 2000b.

Oak Ridge Institute for Science and Education. Laboratory Procedures Manual for the Environmental Survey and Site Assessment Program, Revision 15. Oak Ridge, TN; May 10, 2000c.

U. S. Department of Energy (DOE). "Radiation Protection of the Public and the Environment," DOE Order 5400.5, Washington, DC; February 8, 1990.

U. S. Department of Energy. DOE Memorandum from R. Pelletier to Distribution, "Application of DOE 5400.5 Requirements for Release and Control of Property Containing Residual Radioactive Material", November 17, 1995.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or his employer.

DIRECT RADIATION MEASUREMENT

Instruments

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

Detectors

Ludlum Gas Proportional Detector
Model 43-68
Physical Probe Area, 126 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

LABORATORY ANALYTICAL INSTRUMENTATION

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

Tri-Carb Liquid Scintillation Analyzer
Model 1900CA
(Packard Instrument Co., Meriden, CT)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B
SURVEY AND ANALYTICAL PROCEDURES

PROJECT HEALTH AND SAFETY

All survey and laboratory activities were conducted in accordance with ORISE health and safety and radiation protection programs.

CALIBRATION AND QUALITY ASSURANCE

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry-recognized organization were used.

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual (January 1998)
- Laboratory Procedures Manual (May 2000)
- Quality Assurance Manual (March 2000)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 414.1A and ASME NQA-1 for Quality Assurance and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in MAPEP, NRIP, ITP, and EML Laboratory Quality Assurance Programs.

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

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent the total propagated uncertainty at the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels.

Detection limits, referred to as minimum detectable concentration (MDC), were based on 3 plus 4.65 times the standard deviation of the background count [$3 + (4.65\sqrt{BKG})$]. When the activity was determined to be less than the MDC of the measurement procedure, the result was reported as the actual (positive or negative) value. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in the vicinity of the measurement area, the detection limits may differ from measurement to measurement and instrument to instrument.

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the detectors slowly over the surface; the distance between the detectors and the surface was maintained at a minimum—nominally about 1 cm. Surfaces were scanned using small area (126 cm^2) gas proportional hand-held detectors. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument. Combinations of detectors and instruments used for the scans were:

Alpha - gas proportional detector with ratemeter-scaler

Alpha + Beta - gas proportional detector with ratemeter-scaler

Scan minimum detectable concentrations (MDCs) were estimated using the calculational approach described in NUREG-1507.[1] The scan MDC is a function of many variables, including the background level. Typical beta background levels on floors and walls ranged from 250 to 450 cpm for the hand-held gas proportional detectors. Additional parameters selected for the calculation of scan MDCs include a four-second observation interval, a specified level of performance at the first scanning stage of 95% true positive rate and 25% false positive rate, which yields a d' value of 2.32 (NUREG-1507, Table 6.1), and a surveyor efficiency of 0.5. The instrument efficiencies for the hand-held gas proportional detectors calibrated to Th-230, Sr-90, and C-14 were 0.10, 0.24, and 0.08, respectively. To illustrate an example for the hand-held gas proportional detector, the minimum detectable count rate (MDCR) and scan MDC for beta activity can be calculated as follows:

b_i = (250 cpm)(4 s)(1 min/60 s) = 16.7 counts,

MDCR = (2.32)(16.7 counts)^{½} [(60 s/min)/(4 s)] = 142 cpm,

$MDCR_{surveyor}$ = 142 (0.5)^{½} = 201 cpm

The scan MDC is calculated assuming a source efficiency of 0.50 (for Sr-90):

$$Scan\ MDC = \frac{MDCR_{surveyor}}{(\epsilon_s)\ (\epsilon_i)\ (\frac{probe\ area}{100\ cm^2})} = dpm/100\ cm^2$$

For the given background range, the estimated scan MDC range for the hand-held gas proportional detector was 1,330 dpm/100 cm^2 to 1,790 dpm/100 cm^2 for Sr-90 and 7,980 dpm/100 cm^2 to 10,720 dpm/100 cm^2 for C-14.

Surface Activity Measurements

Measurements of total alpha and total beta surface activity levels were performed using gas proportional and GM detectors with portable ratemeter-scalers. Based on the low efficiency of the gas proportional detectors for gamma radiation and since alpha activity was not detected at

[1]NUREG-1507. Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions. US Nuclear Regulatory Commission. Washington, DC; June 1998.

the elevated beta activity measurement locations, all recorded beta events were assumed to be due to beta particles, only. Surface activity measurements were performed on floors, lower walls, upper walls, some equipment, and at locations of elevated direct radiation, using gas proportional detectors coupled to ratemeter-scalers.

Count rates (cpm), which were integrated over one minute with the detector held in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net rate by the total efficiency ($\epsilon_i \times \epsilon_s$) and correcting for the active area of the detector. The 2π instrument efficiency factors (ϵ_i) were as follows: alpha efficiency factor was 0.39 for the gas proportional detectors calibrated to Th-230; beta efficiency factors were 0.31 and 0.47 for the gas proportional detectors calibrated to C-14 and Sr-90, respectively. The source efficiency factor (ϵ_s) was 0.25 for alpha and C-14 and 0.5 for Sr-90. The total alpha, C-14 beta, and Sr-90 beta efficiency factors for the gas proportional detectors were 0.10, 0.08, and 0.24, respectively. For the modified GM detector, the total beta efficiency factor was 0.19.

Because different building materials (poured concrete, brick, wood, steel, etc.) may have different background levels, average background count rates were determined for each material encountered in the surveyed area at a location of similar construction and having no known radiological history.

The alpha activity background count rates for the gas proportional detector averaged 1 cpm for all surfaces. The beta activity background count rates for the gas proportional detector averaged 381 cpm. The physical probe area for the gas proportional detector was 126 cm^2. Using efficiencies derived from a Sr-90 calibration source and comparing to the Sr-90 guideline proved to be the most conservative approach for evaluating surface activity.

Removable Activity Measurements

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

For tritium, C-14, and Sr-90 determination, a second smear was moistened with deionized water and an adjacent 100 cm^2 was wiped. The smear was then sealed in a labeled liquid scintillation vial with the location and pertinent information recorded.

ANALYTICAL PROCEDURES

Gross Alpha/Beta

Smears were counted on a low-background gas proportional system for gross alpha and gross beta activity. The MDCs of the procedure were 9 dpm/100 cm^2 for gross alpha and 15 dpm/100 cm^2 for gross beta.

Liquid Scintillation

Smears were counted in a liquid scintillation counter for low-energy beta activity to determine H-3, C-14, and Sr-90 activity—typical MDCs for the procedures are 22, 8, and 44 dpm/100 cm^2, respectively.

APPENDIX C

SUMMARY OF DEPARTMENT OF ENERGY RESIDUAL RADIOACTIVE MATERIAL GUIDELINES

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5 (DOE 1990)

BASIC DOSE LIMITS

The basic dose limit for the annual radiation (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as low as reasonably achievable principles to set site-specific guidelines.

EXTERNAL GAMMA RADIATION

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restriction on its use shall not exceed the background level by more than 20 μR/h and will comply with the basic dose limits when an appropriate-use scenario is considered.

SURFACE CONTAMINATION GUIDELINES

Allowable Total Residual Surface Contamination
(dpm/100 cm^2)[a]

Radionuclides[b]	Average[c,d]	Maximum[d,e]	Removable[d,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	5,000α	15,000α	1,000α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000β-γ	15,000β-γ	1,000β-γ

[a] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[b] Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[c] Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[d] The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at a depth of 1 cm.

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

[f] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.