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ORNL/RAP-18

HEALTH AND SAFETY RESEARCH DIVISION

Nuclear and Chemical Waste Programs
(Activity No. KG 02 00 00 0)

WASTE SCOPING SURVEY OF BUILDING 9419-1, A DECONTAMINATION FACILITY

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ABSTRACT

An interior waste scoping survey of Building 9419-1, an Oak Ridge National Laboratory (ORNL) decontamination facility located at the Y-12 Plant, was conducted on January 9, 1987. The objectives of the survey were: (1) to locate and identify the nature of any radiological contaminants; (2) to investigate the possibility of surface beryllium contamination; and (3) to determine if the levels of contaminants dictate corrective actions for personnel exposure and/or surface contamination control.

The results of the survey showed that the surfaces of stored/abandoned equipment and objects were contaminated with directly measured alpha and beta-gamma emitters in excess of applicable guidelines. Measurements were as high as 16,000 dpm/100 cm^2 and 8 mrad/h, respectively. The building was structurally uncontaminated with the exception of one, small, isolated area of floor that had a direct alpha level of 400 dpm/100 cm^2. Measurements of 1600 dpm/100 cm^2 on the alpha scintillation meter made over two floor drains could not be duplicated in subsequent sampling. It is suggested that occasional incidents of out-gassing vented from other sources in the Y-12 Plant area were responsible. Measurement of airborne radon progeny concentrations near the drains demonstrated that there was no radiological inhalation hazard. Smear sampling demonstrated the absence of contaminating levels of transferable alpha and beta-gamma emitters. Furthermore, there was no significant contamination of surfaces by transferable beryllium or beryllium compounds. The presence of asbestos insulation on pipelines inside the building was analytically confirmed. Peripheral physical hazards that may impact the conduct of remedial actions are identified along with recommendations of a corrective nature.

WASTE SCOPING SURVEY OF BUILDING 9419-1, A DECONTAMINATION FACILITY

INTRODUCTION

Building 9419-1, an Oak Ridge National Laboratory (ORNL) decontamination facility, is located in the southeast portion of Y-12 in Bear Creek Valley. It was operated to support technology development for the Molten Salt Reactor Experiment (MSRE) during the period 1958-1969. Steam-cleaning procedures were conducted on a variety of types of operating equipment in the 6.6 x 9.1 m (20 x 30 ft) building until cessation of reactor activities. According to a recent report, the decontamination activities resulted in the deposition of radioactive contamination, principally thorium, on interior surfaces.[1] Furthermore, according to ORNL sources, the decontamination activities carried out in Building 9419-1 may have resulted in beryllium contamination on equipment and surfaces as well. Subsequent to reactor shutdown, the building was used for storage. Because of a lack of maintenance and housekeeping procedures, the building became cluttered and unclean.[2]

A waste scoping survey of the interior of Building 9419-1 was conducted on January 9, 1987, by the Environmental Assessments group of the Health and Safety Research Division (HASRD) of ORNL at the request of the Maintenance, Surveillance and Corrective Actions (MS&CA) Program of ORNL. Sampling for the presence of beryllium and asbestos was performed by the Industrial Hygiene Division of the Y-12 Plant.

The purpose of the scoping survey of this decontamination facility was to investigate the presence of possible contamination by radioactive sources or by beryllium and to determine if their concentrations dictate corrective actions to prevent personnel exposure and/or redistribution of surface contamination. Specifically, the objectives of the survey were: (1) to locate and define the nature and extent of radiological contamination; (2) to identify the potential degree of hazard from radiological contaminants by measuring the radon decay products in air; and (3) to determine the presence of, and extent of, additional contamination by metallic beryllium and its compounds. Pipeline insulation in the building was also sampled for the presence of asbestos, and any peripheral potential hazards were noted.

This report describes the results of the survey of the building interior. An exterior view of Building 9419-1 is shown in Fig. 1. Figures 2 through 5 show various contaminated objects and equipment present in the building at the time of the survey. The results of this assessment survey will be used to determine whether the site is in compliance with applicable ORNL Health Physics/Y-12 Plant Industrial Hygiene environmental and/or health criteria and limits.

SURVEY METHODS

The waste scoping survey at this site included: (1) gamma exposure rates at the surface throughout the building; (2) a gamma scan on contact with the outside surface of the exterior walls; (3) direct and transferable alpha and beta-gamma activity measurements on interior surfaces; (4) measurements of indoor beryllium levels on surfaces; and (5) determination of indoor radon progeny concentrations.

A comprehensive description of the radiological survey methods and instrumentation is presented in *Procedures Manual for the Radiological Survey Activities (RASA) Program,* Oak Ridge National Laboratory, ORNL/TM-8600 (April 1987).[3]

SURVEY RESULTS

BACKGROUND AND GUIDELINE LIMITS

Typical background radiation and chemical waste levels at ORNL sites vary because of past and present research and development activities, particularly those activities directly involved with radioactive materials and/or chemicals. Background gamma exposure rates found for uncontaminated outdoor areas on the Oak Ridge Reservation are listed in Table 1 (locations shown in Fig. 6) for purposes of comparison with the results presented in this report. Guidelines and limits from several sources are referenced in support of establishing contamination levels at this site (Table 2). Indoor gamma levels and alpha and beta-gamma activity levels measured on interior and equipment surfaces are subject to ORNL Health Physics guidelines for establishing radiation control zones and for clearance of such materials to be released for reissue. The Department of Energy (DOE) guideline for internal radiation dose via exposure to airborne radon progeny (as adopted from the U. S. Environmental Protection Agency, 40 CFR 192) and the Nuclear Regulatory Commission (NRC) limits (10 CFR 20.106) are used herein as reference points. Furthermore, because this facility is located at the Y-12 Plant, limits used by the Y-12 Industrial Hygiene Department for the presence of beryllium on surfaces in the workplace serve as the basis for discussion of beryllium contamination.

All measurements presented in this report are gross readings; background radiation levels have not been subtracted. It should be noted that the results of this survey pertain strictly to the specific condition of the site and to the equipment and structures as they were at the time of the assessment.

GAMMA EXPOSURE RATE MEASUREMENTS

Accessible areas, equipment, and structures were scanned with a portable gamma scintillation meter, and the range of gamma radiation levels was recorded. The scintillation

meter provides the exposure levels in counts per minute (cpm). These measurements are converted to microroentgens* per hour (μR/h) using the formula:

$$y = x/\mathrm{CF}$$

where

y = the exposure rate in μR/h,

x = the scintillometer measurements in counts per minute (cpm),

CF = the conversion factor determined in the field through a direct correlation between a selected number of Pressurized Ionization Chamber (PIC) measurements and scintillometer measurements.

For this site, CF = 313 cpm/(μR·h).

Results of gamma exposure rate measurements taken inside Building 9419-1 are presented in Fig. 7 along with the 3 x 3 m (10 x 10 ft) grid system established to aid in pinpointing location of measurements and samples. The building was divided into grid blocks which are identified by the intersection of two mutually perpendicular lines, the first of which states distance from point 0 [e.g., 0+20(ft)]. The second coordinate is derived from distance to the right [e.g., 20(ft)R] of the baseline (BL).

Generally, the scan of the surface revealed gamma levels ranging from 6 to 32 μR/h. For comparison, typical ORNL background ranges from 10 to 17 μR/h. An exposure rate of 350 μR/h was found at grid location 0+35, BL on "equipment" located on a pallet under the steps leading to the change room (Fig. 2). Another pallet containing contaminated "equipment" (as indicated by surface measurements, see discussion following) inside the building at grid point 0+12, BL was responsible for an elevated gamma exposure rate of 48 μR/h found immediately outside the building at that location. The contaminated objects are shown in Figs. 3 and 4.

ALPHA AND BETA-GAMMA MEASUREMENTS

Measurements of fixed and removable alpha and beta-gamma activity levels were taken throughout the building as well as on equipment and structures to provide an estimate of the extent and location of radiological surface contamination. Directly measured alpha and beta-gamma activity levels which were found to exceed the ORNL Health Physics guideline values for the reissue of tools and equipment (300 dpm/100 cm^2 and 0.05 mrad/h,†respectively) are indicated on Fig. 7. The locations of transferable measurements are identified on Fig. 8, and the results listed in Table 3.

---

*The roentgen (R) is a unit that was defined for radiation protection purposes for people exposed to penetrating x rays or gamma radiation. A microroentgen (μR) is one millionth of a roentgen. A milliroentgen (mR) is one thousandth of a roentgen or one thousand microroentgens.

†The rad is the unit of absorbed dose and is defined as the amount of radiation required to cause absorption of 100 ergs per gram of medium. (The erg is a unit of energy. One erg in the form of heat will raise the temperature of 1 gram of water about 2.4 x 10^{-8} °C.) A millirad (mrad) is one thousandth of a rad.

Direct alpha activities indicating the presence of surface contamination were measured in seven separate regions and ranged from 400 to 16,000 dpm/100 cm^2. The maximum reading was found on contact with the miscellaneous objects on a pallet near the southwest corner of the building at grid point 0+12, BL. A direct alpha measurement of 400 dpm/100 cm^2 was detected in an area which measured ~0.84 m^2 on the floor of the building near the east wall at grid location 0+32, 17R. In a laboratory sink located along the west wall, two regions of elevated alpha levels (600 and 1600 dpm/100 cm^2) were noted. They measured <0.5 and ~1.2 m^2 in size, respectively. In addition, an alpha activity of 1600 dpm/100 cm^2 was determined directly over each of two floor drains located at 0+25, 09R and 0+09, 09R. The fact that subsequent measurements failed to duplicate these results suggests the possibility that vented out-gas was responsible for these anomalies.

Beta-gamma dose rates were 5 to 8 mrad/h at the objects on pallets along the west wall. The measurements were taken at 1 cm from the surface of the equipment using a portable side-window Geiger-Mueller (G-M) survey meter.

Maximum transferable alpha and beta-gamma levels at the 34 locations sampled were 99 dpm/100 cm^2 and 139 dpm/100 cm^2, respectively.

It should be noted that the contaminated objects located under the steps and near the southwest corner of the building, and the sink along the west wall, are not permanent fixtures on the site. The contaminated section of floor and the drains are integral components of the structure.

RADON PROGENY MEASUREMENTS

Airborne radon progeny concentrations were measured above the two drains in the floor of the building. Measurements were obtained by pumping air through a filter at 10-minute intervals at approximately 24 L/min. The filters, on which particulate radon decay products attached to airborne dust had collected, were counted in an alpha spectrometer. The concentrations of ^{218}Po, ^{214}Pb, and ^{214}Bi (the progeny of ^{222}Rn, itself a decay product of ^{226}Ra), and of ^{212}Pb and ^{212}Bi (the progeny of ^{220}Rn originating from ^{232}Th) were calculated from the results. The data for ^{222}Rn decay products were then converted to number of working levels (WL)* as listed in Table 4; ^{220}Rn progeny are reported in pCi/L.

The results for ^{222}Rn decay products were 0.0008 and 0.0007 WL for drains 1 and 2, respectively. A range of 0.0008 to 0.077 pCi/L was found for the progeny of ^{220}Rn. It should be noted that measurements made over a brief period of time often do not reflect average annual conditions. Furthermore, these measurements undergo drastic fluctuations because of changes in the building's ventilation rate and disturbances from mechanical or human activities.

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*The working level (WL) is a unit which was defined for radiation protection purposes for uranium miners. A 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 x 10^5 MeV of potential alpha particle energy. This is equal to the concentration of the short-lived decay products in equilibrium with 100 pCi/L of ^{222}Rn.

BERYLLIUM MEASUREMENTS

Smears were obtained at the locations indicated on Fig. 9 to determine the presence of possible transferable beryllium contamination inside the building. The results of analysis, shown in Table 5, establish a range of <0.01 to 0.81 $\mu g/100\ cm^2$ on these surfaces.

ASBESTOS SAMPLING

Sampling of pipelines entering at the southwest and northeast corners of the building was positive for asbestos insulation.

SIGNIFICANCE OF FINDINGS

The waste scoping survey of the decontamination facility, Building 9419-1, revealed a collection of miscellaneous, radiologically contaminated objects and "equipment" either abandoned or in storage there. The interior of the structure itself was found to be relatively uncontaminated with the exception of a small area of the floor and the possibility of contaminated out-gas occasionally vented through two floor drains.

Measurement of airborne radon progeny concentrations demonstrated that there was no radiological inhalation hazard associated with the drains. No evidence for the presence of transferable beryllium or beryllium compounds in excess of guideline limits was discovered on interior surfaces.

Measurements of gamma levels taken in Building 9419-1 determined that exposure rates at the surface were generally elevated above typical background values (10 to 17 $\mu R/h$), ranging from 6 to 32 $\mu R/h$. However, elevated measurements were the result of emanation from the contaminated objects found in several locations. An exposure rate of 350 $\mu R/h$ was found on contact with "equipment" on a pallet under the steps leading to the change room. Additionally, a gamma level of 48 $\mu R/h$ was measured at one isolated location outside the building as a result of emanation from contaminated objects indoors. For comparison, background gamma exposure rates (determined from 18 measurements in uncontaminated areas on the Oak Ridge Reservation) at the ground surface averaged 13 $\mu R/h$ and ranged from 10 to 17 $\mu R/h$. All exposure rates measured at this site were well below the minimum values of 0.003 to 0.006 rem/h required at ORNL for the establishment of radiation control zones.

Surface contamination was evidenced by elevated levels of directly measured alpha activity in seven separate areas, ranging from 400 to 16,000 $dpm/100\ cm^2$. The maximum measurement was found on stored "equipment" on a pallet along the west wall of the building. The area of floor registering a direct alpha level of 400 $dpm/100\ cm^2$ and the two floor drains, each reading 1600 $dpm/100\ cm^2$ when the alpha meter was held directly over them, are permanent fixtures on the site as compared to the contaminated equipment. The ORNL Health Physics guideline for directly measured alpha activity levels for all surfaces, including the surfaces of tools and equipment to be cleared for reissue, is 300 $dpm/100\ cm^2$.

At the "equipment" stored in two separate areas on pallets along the west wall, measurements of fixed beta-gamma activity levels were 5 to 8 mrad/h. These levels are factors ~100 and ~160 above the ORNL limit of 0.05 mrad/h for the clearance of equipment for reissue.

No measurements of transferable alpha activity levels on structural surfaces exceeded the ORNL Health Physics guideline for establishing contamination zones (30 dpm/100 cm^2). Two of the measurements for removable alpha contamination taken on miscellaneous objects in the building (again, on the pallets along the west wall) were higher than the clearance limit for items for reissue (20 dpm/100 cm^2). All removable beta-gamma contamination levels were below the ORNL Health Physics limit for the establishment of contamination zones (1000 dpm/100 cm^2) and the limit for items to be reissued (200 dpm/100 cm^2).

Measurements of airborne ^{222}Rn decay product concentrations were 0.0007 and 0.0008 WL over the drains where elevated direct alpha activity levels had been measured. By way of comparison, these values are well below the DOE guideline for indoor structures designated for restricted use (0.03 WL). A range of 0.0008 to 0.077 pCi/L was found for the progeny of ^{220}Rn. These concentrations are considerably less than the NRC limits which are given in Table 2 (10 CFR 20.106).

The results of smear sampling analysis for the presence of beryllium inside Building 9419-1 established a range of <0.01 to 0.81 $\mu g/100\ cm^2$ on interior surfaces. These values may be compared to the control limit established by the Y-12 Industrial Hygiene Division to prevent significant exposure to beryllium by workers (5 $\mu g/100\ cm^2$ for items or equipment for off-plant transfers). Although no guideline limit has been established by the Environmental Protection Agency under the Resource Conservation and Recovery Act (RCRA) for concentrations of beryllium and its compounds in wastes, it is listed as a hazardous constituent (40 CFR 261, Appendix VIII).

RECOMMENDATIONS

Analyses of radiological assessment data from this scoping survey indicate that miscellaneous objects and equipment stored inside the building, including a metal laboratory sink, is significantly contaminated with alpha emitters. Additionally, one small area of floor in the building, measuring ~0.8 m^2 in size, exceeded the ORNL guideline value for directly measured alpha activity (300 dpm/100 cm^2) by a factor of approximately one-third. Because the elevated alpha activity measured over the drains was not duplicated in subsequent sampling, the event could be occasional in nature, possibly attributed to the venting of out-gas from sources elsewhere in the Y-12 Plant area. Radon progeny concentrations determined over the drains did not indicate any airborne radiological hazard.

We recommend that the elevated radiological measurements be reduced to an acceptable level by removing the contaminated equipment and by plugging the floor drains. Prior to plugging the drains, the Y-12 Engineering Technology Division should be contacted to

circumvent possible impact from resulting spills or overflow of contaminated drainage or discharge water into the building and surrounding environs. The chemical data indicated that no corrective actions are required with regard to the presence of transferable beryllium or beryllium compounds. However, the asbestos insulation on the pipelines running through the building would dictate appropriate precautions were they to be involved in any future remedial actions.

Several unexpected hazards were identified in the process of obtaining radiological and chemical data on this site. We recommend that these conditions be brought to the attention of the Department of Environmental Management, Environmental Compliance and Health Protection Division. One of six rusting, unlabeled 50-gal drums sitting outside the building was observed to bulge, apparently in response to internal or external chemical/physical reactions. Furthermore, a variety of miscellaneous bottles, cans, and jars, some with labels indicating caustic contents (e. g., ammonium oxalate, nitric acid) had apparently been abandoned inside a cabinet along the interior west wall of the structure. Opposite these were several 12-gal drums labeled "Ammonia." In the change room, a water leak directly over an electrical conduit requires attention in order to avoid a possible electrical hazard or fire.

Radiation protection standards for occupational exposure, as noted in Section 3.1 of the ORNL Health Physics Manualback and plant protection procedures for beryllium contamination (Y-12 Plant Industrial Hygiene Manual) are limited to only planned occupational exposures. Furthermore, the DOE and NRC guidelines for exposure to ^{220}Rn and ^{222}Rn progeny are intended for use in restricted areas. However, the guidelines used for comparison with these survey results (Table 2) should be considered for region-specific contamination in order to maintain radiation and chemical exposures at levels as low as is reasonably achievable (ALARA).

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3. T. E. Myrick, B. A. Berven, W. D. Cottrell, W. A. Goldsmith, and F. F. Haywood, *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program,* Oak Ridge National Laboratory, ORNL/TM-8600 (April 1987).

ORNL PHOTO 4676-87

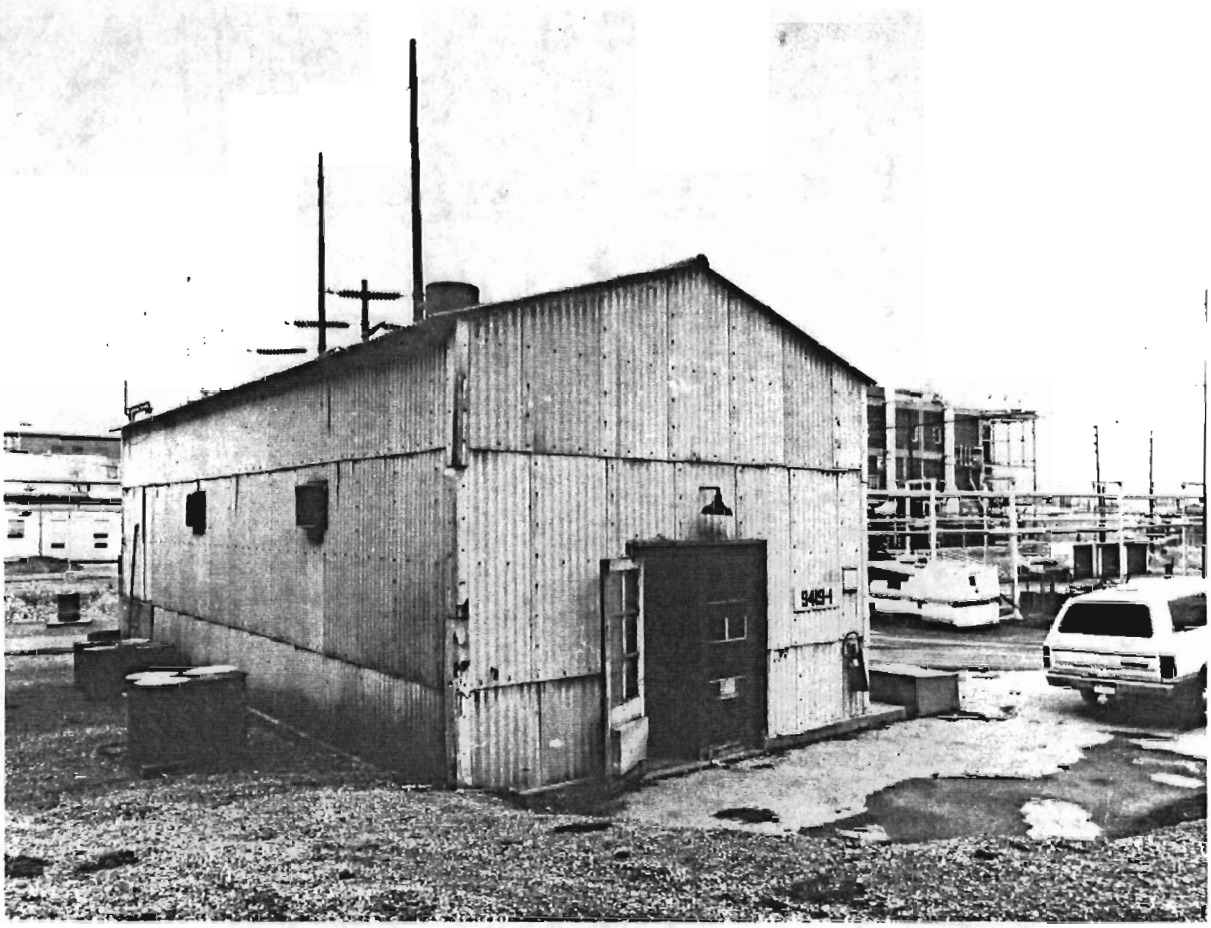

Fig. 1. Decontamination Facility, Building 9419-1, looking northeast.

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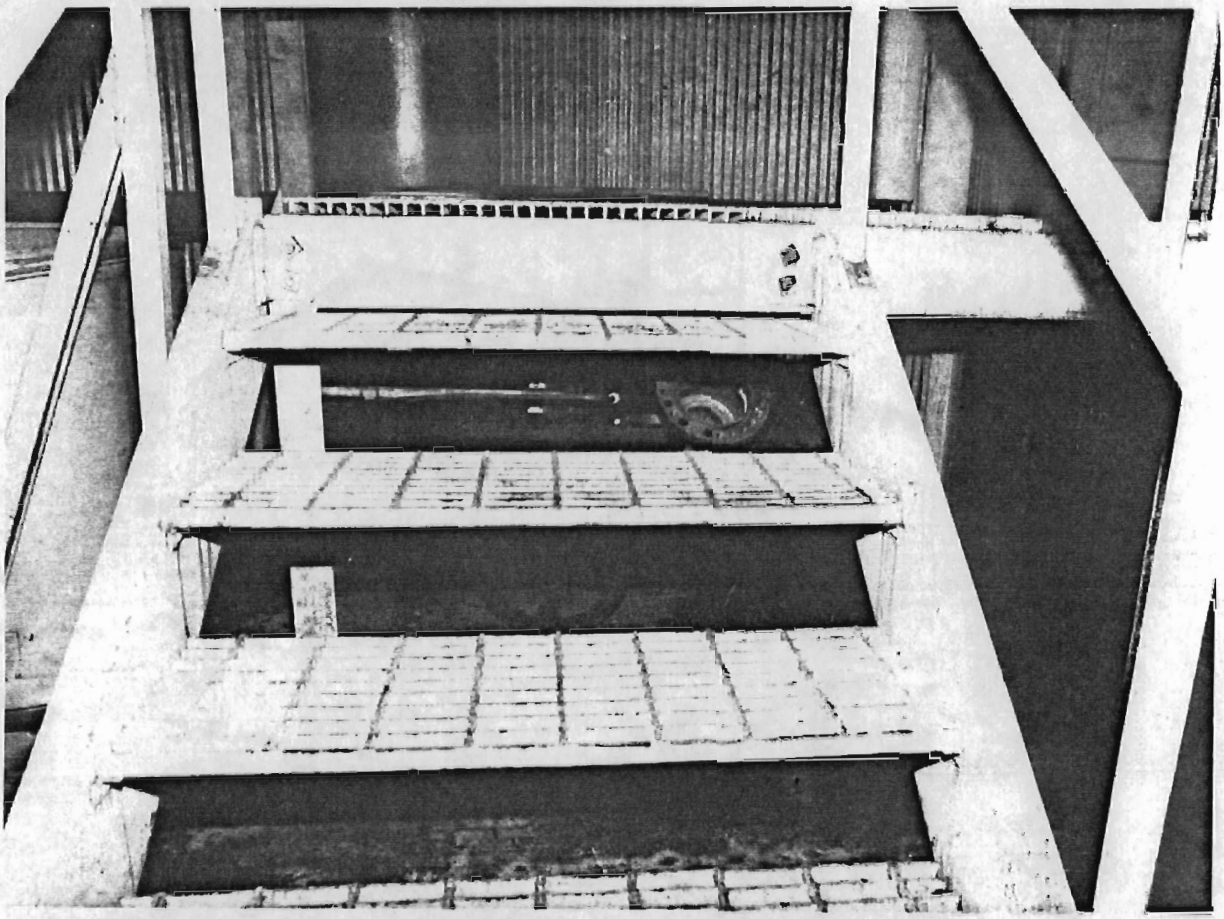

Fig. 2. View of "equipment" beneath steps in the northwest area of Building 9419-1.

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Fig. 3. View of "equipment" in the southwest corner of Building 9419-1.

ORNL PHOTO 4679-87

Fig. 4. Close-up view of "equipment" in southwest corner of Building 9419-1.

ORNL PHOTO 4680-87

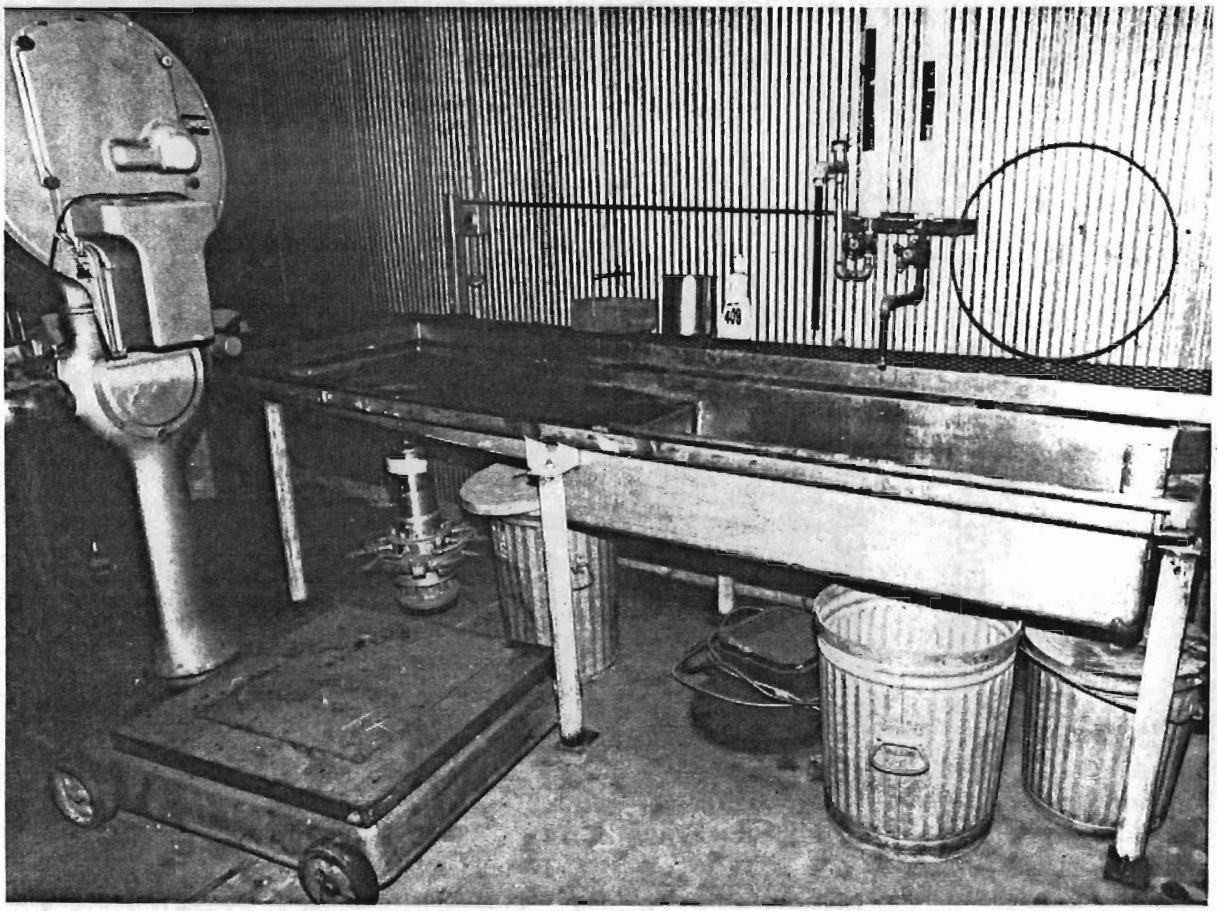

Fig. 5. View of the sink along the west wall in Building 9419-1.

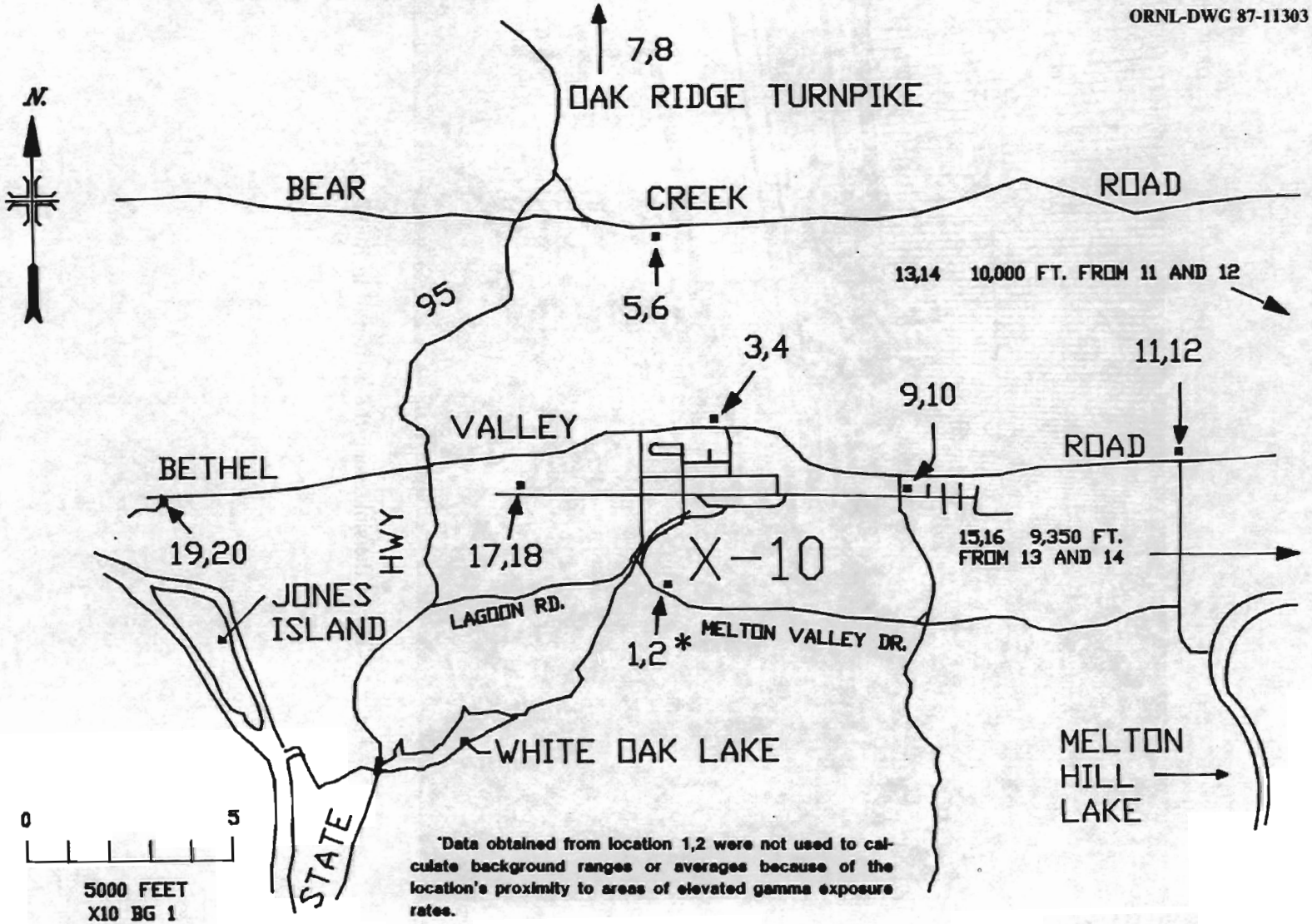

Fig. 6. Locations of gamma exposure rate measurements in uncontaminated areas on the Oak Ridge Reservation.

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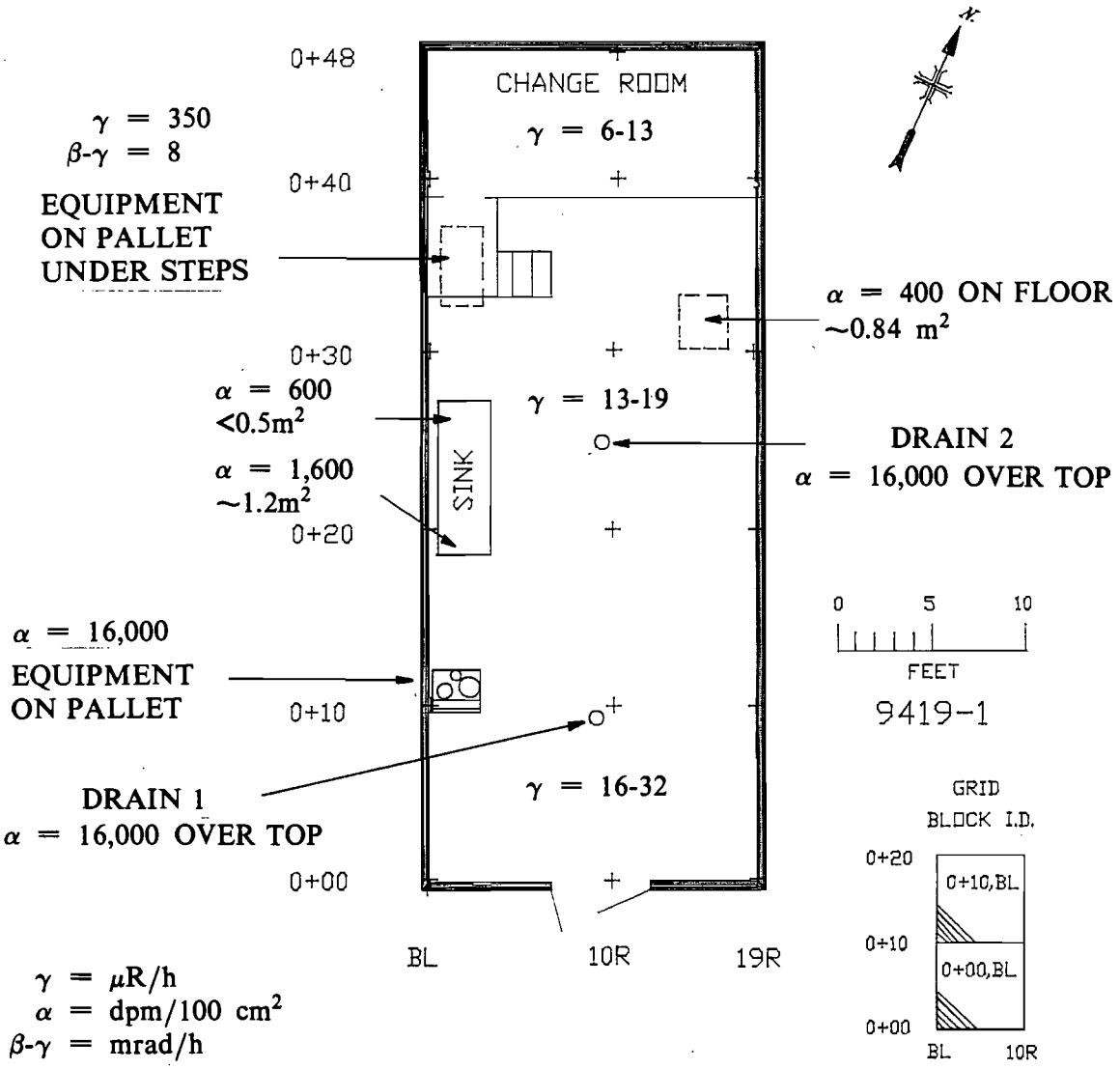

Fig. 7. Direct gamma, alpha, and beta-gamma measurements in Building 9419-1.

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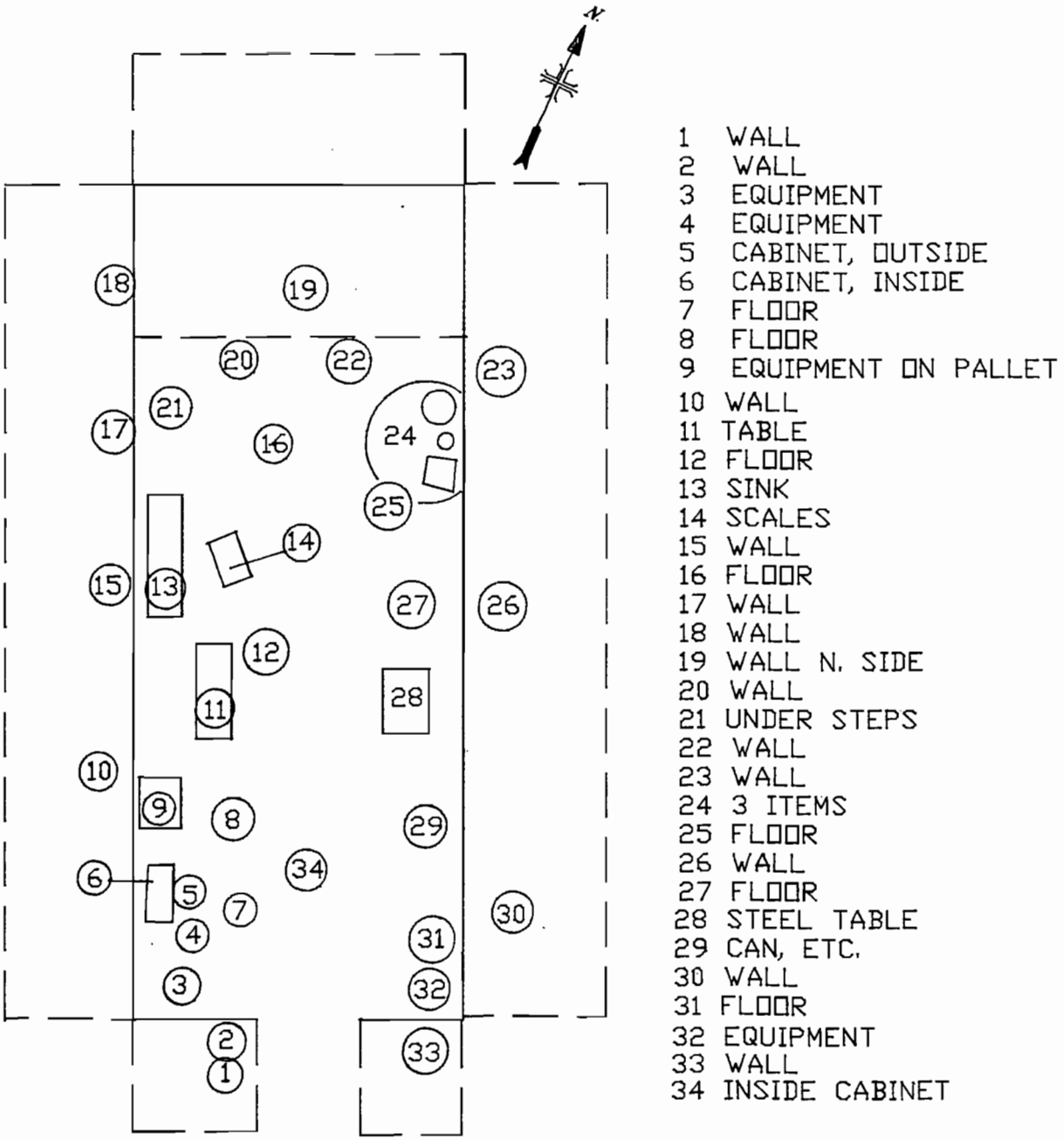

Fig. 8. Location of transferable alpha and beta-gamma measurements in Building 9419-1 (see Table 3).

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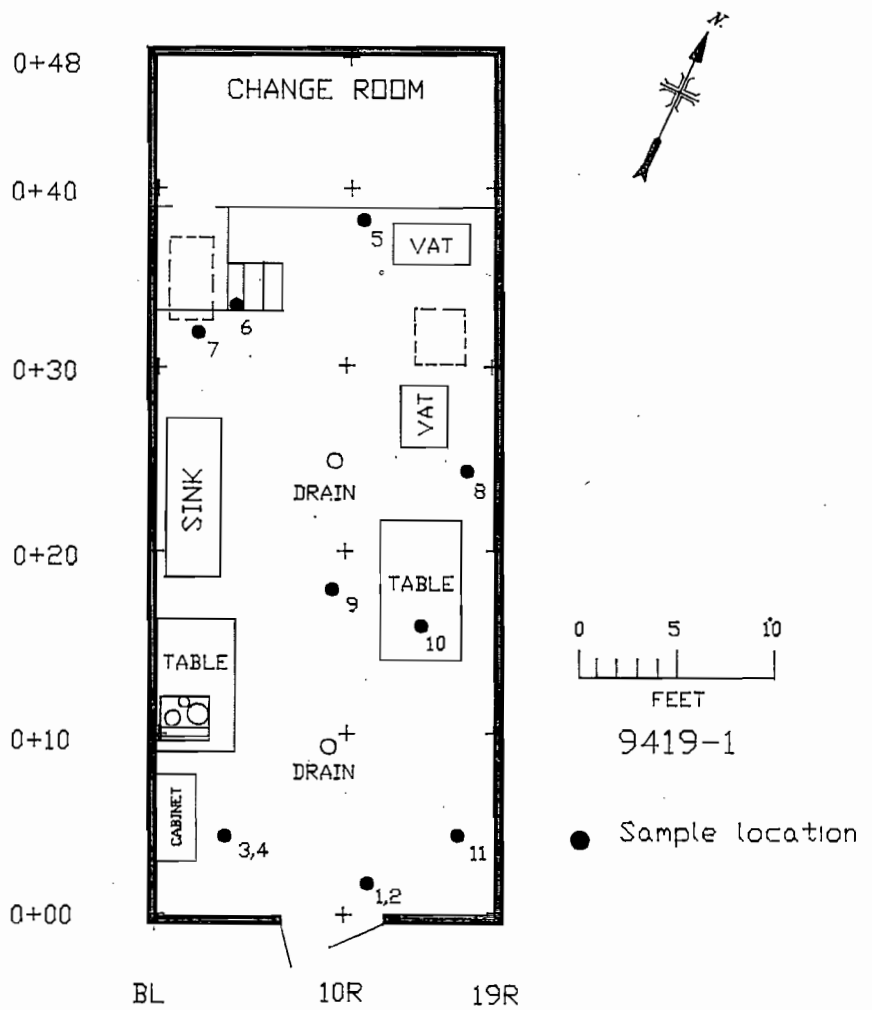

Fig. 9. Location of beryllium measurements taken on surfaces in Building 9419-1 (see Table 5).

Table 1. Radiation levels measured in uncontaminated areas on the Oak Ridge Reservation

Type of radiation[a]	Radiation level	
	Range	Average
Gamma exposure rate at 1 m above ground surface (μR/h)	8-13	10
Gamma exposure rate at ground surface (μR/h)	10-17	13

[a]Values were obtained from 18 measurements taken from 9 locations on the Oak Ridge Reservation. (See Fig. 6 for locations.)

Table 2. Guidelines for protection against radiation and beryllium exposure

Mode of exposure	Exposure conditions	Guideline value	Guideline source
Gamma radiation	Minimum exposure rate required for radiation control zone	3000-6000 μR/h	Oak Ridge National Laboratory, Health Physics Manual, Sects. 2.5 and 2.7
Surface alpha contamination	Contamination fixed on structural/item surfaces	300 dpm/100 cm^2	Ibid.
	Removable alpha		
	—for contamination zone	30 dpm/100 cm^2	Ibid.
	—for items for reissue	20 dpm/100 cm^2	Ibid.
Surface beta	Removable beta-gamma[a]		
	—for contamination zone	1000 dpm/100 cm^2	Ibid.
	—for items for reissue	200 dpm/100 cm^2	Ibid.
Beta-gamma dose rates	Surface dose rate averaged over not more than 1 m^2	0.25 mrad/h	Ibid.
	Clearance limit for items for reissue	0.05 mrad/h	Ibid.
Exposure to ^{222}Rn daughters	Average annual radon daughter concentration (including background)	0.03 WL	U. S. Department of Energy Guidelines for Residual Radioactivity at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites (July 1985)
Exposure to ^{220}Rn daughters	Maximum permissible concentration in air		10 CFR 20.106, Appendix B, Table 1
	^{212}Pb (soluble)	2×10^{-8} μCi/L	
	(insoluble)	2×10^{-8} μCi/L	
	^{212}Bi (soluble)	1×10^{-7} μCi/L	
	(insoluble)	2×10^{-7} μCi/L	
Exposure to metallic beryllium and its compounds	Control limit for items/equipment to leave the Y-12 Plant	5 μg/100 cm^2	Oak Ridge Y-12 Plant Procedures, Industrial Hygiene Manual, Sect. 70-210

[a]Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr, ^{228}Ra, ^{223}Ra, ^{227}Ac, ^{133}I, ^{131}I, ^{129}I, ^{126}I, and ^{125}I.

Table 3. Transferable alpha and beta-gamma measurements taken on surfaces in Building 9419-1

Smear number[a]	Alpha (dpm/100 cm^2)	Beta-gamma (dpm/100 cm^2)
1	b	b
2	3	25
3	3	b
4	6	b
5	3	b
6	b	b
7	b	b
8	6	20
9	99	139
10	b	b
11	18	b
12	3	19
13	6	25
14	b	b
15	3	6
16	3	b
17	3	32
18	b	6
19	b	19
20	3	31
21	27	38
22	b	b
23	3	19
24	b	19
25	6	25
26	3	b
27	b	b
28	b	18
29	3	b
30	b	6
31	b	18
32	b	31
33	b	25
34	b	18

[a]Location shown on Fig. 8.
[b]No activity detected.

Table 4. Results of radon daughter measurements over floor drains in Building 9419-1

Sample location[a]	Radon daughter concentration		
	^{220}Rn (pCi/L)		^{222}Rn (WL)
	^{212}Pb	^{212}Bi	
Drain 1	0.035	0.0077	0.0008
Drain 2	0.077	0.0008	0.0007

[a]Location shown on Fig. 7.

Table 5. Results of beryllium measurements on surfaces in Building 9419-1

Smear number[a]	Beryllium[b] (μg/100 cm^2)
1	0.06
2	0.81
3	0.71
4	<0.1
5	<0.1
6	<0.1
7	0.09
8	<0.1
9	<0.1
10	0.1
11	<0.1

[a]Location shown on Fig. 9.

[b]A value preceded by a "<" sign is the minimum detectable activity (MDA).

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