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**Radiological Survey Results
at the Former
Bridgeport Brass Company Facility
Seymour, Connecticut**

R. D. Foley
R. F. Carrier

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Environmental Restoration and Waste Management Non-Defense Programs
(Activity No. EX 20 20 01 0; ADS3170000)

**Radiological Survey Results at the Former Bridgeport Brass
Company Facility, Seymour, Connecticut**

R. D. Foley and R. F. Carrier

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Investigation Team

R. D. Foley — Measurement Applications and Development Manager

W. D. Cottrell — FUSRAP Project Director

R. D. Foley — Survey Team Leader

Survey Team Members

R. D. Foley

D. E. Rice

R. C. Gosslee

R. E. Rodriguez

R. A. Mathis

D. A. Rose

Work performed by the
MEASUREMENT APPLICATIONS AND DEVELOPMENT GROUP

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6285
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
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ABSTRACT

At the request of the U.S. Department of Energy (DOE), a team from Oak Ridge National Laboratory conducted a radiological survey of the former Bridgeport Brass Company facility, Seymour, Connecticut. The survey was performed in May 1992. The purpose of the survey was to determine if the facility had become contaminated with residuals containing radioactive materials during the work performed in the Ruffert building under government contract in the 1960s. The survey included a gamma scanning over a circumscribed area around the building, and gamma and beta-gamma scanning over all indoor surfaces as well as the collection of soil and other samples for radionuclide analyses.

Results of the survey demonstrated radionuclide concentrations in indoor and outdoor samples, and radiation measurements over floor and wall surfaces, in excess of the DOE Formerly Utilized Sites Remedial Action Program guidelines. Elevated uranium concentrations outdoors were limited to several small, isolated spots. Radiation measurements exceeded guidelines indoors over numerous spots and areas inside the building, mainly in Rooms 1-6 that had been used in the early government work.

Radiological Survey Results at the Former Bridgeport Brass Company Facility, Seymour, Connecticut*

INTRODUCTION

Between 1962 and 1964, Reactive Metals, Incorporated, conducted experiments related to the development of nuclear energy at a facility located at 15 Franklin Street, Seymour, Connecticut. Reactive Metals was one of several companies performing work associated with the development of nuclear energy for defense-related projects under contract to the U.S. Atomic Energy Commission (AEC) during that time period. Operations conducted under government contract at such sites included the procurement, storage, and processing of uranium oxides, salts, and metals, and the subsequent machining of these products. As a result of activities involving these materials, equipment, buildings, and land at some of the sites became radiologically contaminated with small amounts of the material resulting in low levels of contamination on the properties. At contract termination, release limits and decontamination operations were typically applied in conformance with standards currently deemed adequate for purposes of health and environmental protection. Subsequent to original assessments and the release of these facilities, new research and information have resulted in the development of more stringent guidelines for release of such facilities for unrestricted use. Furthermore, in some instances, documentation is limited or nonexistent, and conditions at a specific site may be unknown. It is the policy of the U.S. Department of Energy (DOE) to verify that radiological conditions at such facilities comply with existing guidelines.¹ The Formerly Utilized Sites Remedial Action Program (FUSRAP) was established by DOE in 1974 to assist in assessment and cleanup activities at these sites.

The radiological survey detailed in this report was performed under the FUSRAP program by members of the Oak Ridge National Laboratory (ORNL) at the request of DOE. The city of Seymour lies on the Nagatuack River approximately 10 miles northwest of New Haven (Fig. 1). The property, comprising ~60 acres located at 15 Franklin Street, was purchased by Bridgeport Brass Company in 1964, and was occupied at the time of this survey by the owner, Seymour Specialty Wire Company, and the Electric Cable Corporation. Of the numerous buildings presently used for manufacturing and offices, only one, the Ruffert building (Fig. 2) was used for the Mannesman Piercing Experiment that was conducted under government contract. The experimental activities included the machining, rolling, and extruding of uranium billets, and, according to former employees, consisted of a single effort involving only 2 or 3 weekends.

*The survey was performed by members of the Measurement Applications and Development Group of the Health and Safety Research Division of Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400.

In October, 1964, AEC contract manager for the Bridgeport Brass reported that final cleanup and removal of contamination was accomplished in all areas of the site that were formerly used for the AEC activities.² Subsequently, preliminary radiological surveys by members of the Health and Safety Research Division of ORNL demonstrated beta-gamma dose rates in some areas in excess of more recently developed guidelines. Thus, in May 1992 at the request of DOE, the ORNL team performed a complete radiological characterization of the Ruffert building and the adjacent outdoor areas shown in Fig. 3. The objective of the survey was to locate and define the extent of contamination in order to facilitate remedial action.

A floor plan of the Ruffert building indicating the areas formerly used by Reactive Metals, Inc., is diagrammed in Fig. 4. All accessible indoor areas were scanned, and equipment and materials were moved aside wherever possible to allow access for surveying. In general, the remaining inaccessible areas consisted of heavy equipment situated on concrete flooring of recent construction. Therefore, those areas are not likely to show any elevated measurements. The center of the long, narrow building is a high-bay area supported by beams and columns. The south end of the building has a second-story addition. A natural outcrop of schist stone surrounds the entire north side of the building.

SURVEY METHODS

The radiological survey included: (1) a surface gamma scan over a defined outdoor area; (2) collection and radionuclide analyses of outdoor sediment and water samples; (3) collection and radionuclide analysis of systematic and biased soil samples; (4) measurement of direct radiation levels on all accessible surfaces inside the Ruffert building; (5) collection and analysis of samples from indoor bore holes, beams, and manholes; and (6) collection of smear samples from selected indoor locations to determine removable alpha and beta-gamma surface activity levels. A description of typical methods and instrumentation providing guidance for the conduct of this survey is given in *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600 (April 1987).³

SURFACE RADIATION MEASUREMENTS

Gamma radiation levels were determined using a portable Victoreen Thyac II with a NaI gamma scintillation detector. Because NaI gamma scintillators are energy dependent, measurements of gamma radiation levels in counts per minute (cpm) are normalized to pressurized ionization chamber (PIC) measurements to estimate gamma exposure rates in $\mu\text{R}/\text{h}$. Using a Bicon Analyst ratemeter with a Geiger-Mueller pancake detector, beta-gamma radiation levels in cpm were measured over paved and other hard surfaces and then converted to mrad/h . Alpha measurements were made using a Bicon Analyst ratemeter

connected to an ORNL ZnS scintillation probe. Those results were subsequently converted to disintegrations per minute over 100 cm² (dpm/100 cm²). Removable (smear) alpha and beta-gamma activity levels were assessed by using a Ludlum 2000 alpha ratemeter and a Ludlum 2000 beta-gamma ratemeter. Gamma spectrometry analysis was used to determine radionuclide content of soil, dust, debris and dry sediment.

Large, open floor areas were scanned using a Ludlum 2221 meter with a Ludlum 23-1F floor monitor. Elevated areas were then measured using the above portable instrumentation. The same portable instrumentation was used on space-restricted areas.

SAMPLING AND ANALYSES

Surface and subsurface samples were collected over the property in locations and numbers sufficient to identify and quantify the radionuclides in soil and other materials including structures, dust, debris, and sediments. All samples were analyzed to determine ²³⁸U, ²³²Th, and ²²⁶Ra concentrations. Analysis was also performed on selected samples to identify the possible presence of contaminating levels of lead (²¹⁰Pb). Radionuclide concentrations (pCi/g) in dust that is easily removable from overhead horizontal surfaces, can be compared to removable surface contamination guidelines (dpm/100 cm²) when the sample weight and area from which the samples were taken are known.

SURVEY RESULTS

Current DOE guidelines for sites included within the FUSRAP are summarized in Table 1. Typical background radiation levels for the Seymour, Connecticut, area are presented in Table 2. These data are provided for comparison with the survey results presented in this section. Gamma radiation levels are reported in gross μ R/h. Background concentrations have not been subtracted from radionuclide concentrations in soil, debris, and other samples.

OUTDOOR SURVEY RESULTS

Outdoor Radiation Measurements

Results of the ground surface gamma scan are shown on Fig. 5. Surface gamma exposure rates generally ranged from 6 to 13 μ R/h, which is comparable to the typical average background radiation level in the Seymour, Connecticut, area (8 μ R/h, Table 2). The maximum ground surface exposure rate, 26 μ R/h, was found in a 6 × 12 ft area 1 ft north of the north end concrete pad. Elevated gamma levels of 31 to 44 μ R/h, apparently due to the red brick and concrete block construction materials, were measured inside Manhole 2 (Fig. 6). Radiation levels in the other three manholes ranged from 15 to 20 μ R/h. Beta-gamma dose rates (and activity levels) in all four manholes ranged from 0.03 to 0.08 mrad/h (1,800 to 4,800 dpm/100 cm²), values well below guidelines

(Table 1). Slightly elevated levels of 16 to 21 $\mu\text{R/h}$ were measured near the south end of the Ruffert building and on contact with the stone outcrop located north of the building. Higher background values are frequently observed in association with natural materials such as certain kinds of stone, which inherently contain slightly elevated concentrations of naturally occurring radionuclides.

Outdoor Sample Results

Locations of biased and systematic soil samples are shown in Figs. 5 and 7, respectively. Locations of sediment samples taken from four manholes south of the Ruffert building are shown in Fig. 6. A photograph of the downstream outfall area where systematic samples S1 and S2 were collected is shown in Fig. 7. Systematic sample S3 was collected from the east river bank, approximately 1/4 mile downstream of the 007 outfall.* Results of outdoor sample analyses are listed in Table 3.

Maximum concentrations of ^{226}Ra and ^{232}Th in systematic (S) samples are 0.7 and 0.8 pCi/g, respectively. These results are comparable to typical background levels in the Seymour area (0.9 pCi/g, Table 2) and below DOE guidelines (Table 1). Uranium-238 concentrations in systematic soil samples range from 1.0 to 2.4 pCi/g, values also comparable to typical background levels and well below the DOE guidelines listed in Table 1.

Figure 8 is a photograph of the scale room at the north end of the building. Sample B1 was collected from beneath the north end of the room as indicated. Concentrations in biased soil samples and dust/debris samples are 0.3 to 0.8 pCi/g for ^{226}Ra and 0.3 to 1.7 pCi/g for ^{232}Th , values comparable to those typical of the area (Table 2). Concentrations of ^{238}U exceed guidelines in all biased samples [with the exception of the chunk of rusted metal (M31) from north of the concrete pad] ranging from 55 to 140 pCi/g in soil from two locations and with a maximum of 700 pCi/g in the sample of concrete chips (B1AB).

Concentrations of ^{226}Ra and ^{232}Th in outdoor manhole sediments range from 0.8 to 1.5 pCi/g and 0.8 to 1.8 pCi/g, respectively. These values are comparable to those found in soil in the general Seymour area. Concentrations of ^{238}U were 3.0 to 5.3 pCi/g and, although slightly above those typical for the area, are well below previously applied guidelines of 35 to 50 pCi/g used at other FUSRAP sites (Table 1). These outdoor manholes were not constructed as sumps and therefore had very little sediment in them.

INDOOR SURVEY RESULTS

In general, indoor measurement and sampling locations are identified by structure and/or room number. To facilitate mapping of data for the high-bay area, a grid was established

*Numbers are assigned to outfalls according to the state discharge permit.

using intersections of beams designated A–D and columns designated 1–5. An individual block is identified by the beam/column I.D. in the lower righthand (NE) corner of the block (e.g., B2). Areas exceeding DOE guidelines (Table 1) on floor and wall surfaces were outlined with yellow spray paint that is visible in many of the following photographs.

Directly Measured Radiation Levels

Directly measured radiation levels on surfaces inside the Ruffert building are detailed in Table 4 and illustrated on Figs. 9 and 10. As shown by the hatching used on Fig. 9 to indicate locations of measurements exceeding guidelines (Table 1), the areal extent of contamination was greatest in the north end of the building. Elevated measurements diminished in extent toward the south end of the building. As may be expected, the contaminated areas generally coincide with the areas formerly used by Reactive Metals, Inc. A room-by-room description of the findings follows. Elevated readings and measurements are those exceeding the guidelines as given in Table 1.

Room 1

Although gamma exposure rates generally ranged from 9–15 $\mu\text{R}/\text{h}$ in this L-shaped room, approximately 60 to 70% of the floor around the perimeter had elevated beta–gamma and/or alpha activity levels on contact. One slightly higher gamma level (22 $\mu\text{R}/\text{h}$) was measured on contact with an anchor bolt in the floor (Fig. 9). All floor joints in the south end of the room were contaminated. A beta–gamma dose rate (and activity level) of 1.0 mrad/h (60,000 dpm/100 cm^2) was measured on contact with the surface of a floor tile located in the extreme northwest corner of the room (Figs. 9 and 11). The dose rate (and activity level) was 0.04 mrad/h (2,400 dpm/100 cm^2) beneath it after it was removed, and 1.8 mrad/h (110,000 dpm/100 cm^2) on the dust in the tile joint. Thus, the contamination is located on top of the tiles and in the tile joints rather than beneath them. Beta–gamma dose rates (and activity levels) were 0.05 to 7.5 mrad/h (3,000 to 450,000 dpm/100 cm^2) throughout the remainder of the floor in Room 1, $\sim 2/3$ of which was bare concrete.

Room 2

Gamma exposure rates ranged from 10 to 14 $\mu\text{R}/\text{h}$ in Room 2. However, alpha activity levels were $<\text{MDA}$ to 750 dpm/100 cm^2 * and beta–gamma dose rates (and activity levels) were 0.05 to 0.6 mrad/h (3,000 to 36,000 dpm/100 cm^2), respectively, in and around a grill-covered floor drain, a pipe with a brass plug, the west wall at the outside exit door at the junction of wall and floor, the floor between Rooms 1 and 2, and the areas around several structures along the north wall (see Fig. 12) including a water pipe outlet, a drain

*The instrument-specific minimum detectable activities (MDAs) for directly measured and removable alpha radiation levels are 25 and 10 dpm/100 cm^2 , respectively. For directly measured and removable beta–gamma radiation levels the MDAs are 0.01 mrad/h and 200 dpm/100 cm^2 , respectively.

and an electric receptacle. The higher beta-gamma dose rates and total activity levels exceed the guidelines shown in Table 1.

Room 3

Gamma radiation levels in Room 3 were 9 to 15 $\mu\text{R}/\text{h}$ while alpha activity levels ranged from <MDA to 80 dpm/100 cm^2 , and beta-gamma dose rates (and activity levels) were 0.05 to 0.25 mrad/h (3,000 to 15,000 dpm/100 cm^2), respectively. Beta-gamma measurements exceeded guidelines at one floor drain and at 6 small additional areas showing elevated readings (Table 4, Fig. 9). Four of these were near the west wall, and two were located at the steps that led to the second floor.

Room 4

This small office showed gamma exposure rates of 11 to 15 $\mu\text{R}/\text{h}$ over the gray tile floor surface (Table 4, Fig. 9). The only location in the room where elevated radiation levels were found was under the stairs at the south end of the room (Fig. 13). Beta-gamma levels at the junction of the floor and walls on each side of the ascending steps were 1.0 mrad/h (60,000 dpm/100 cm^2), and alpha activity levels were 10 to 350 dpm/100 cm^2 .

Room 5

Room 5 is the largest room in the building and was being used by the Electric Cable Company as the main processing area at the time of the survey. All floor areas were scanned except where equipment or machinery was either anchored to the floor or too massive to move aside. Gamma exposure rates overall were only 5 to 15 $\mu\text{R}/\text{h}$. However, the north end of the room is extensively contaminated as evidenced by beta-gamma dose rates (and activity levels) of 0.05 to 1.5 mrad/h (3,000 to 90,000 dpm/100 cm^2) and alpha activity levels of 7 to 140 dpm/100 cm^2 in block A1. Beta-gamma dose rates were as high as ~3.0 mrad/h (180,000 dpm/100 cm^2) in blocks A2, B1, and B2. Floor joints and cracks were contaminated and there were numerous other spots and areas on the floor, diminishing in number and size toward the south end of the room (Table 4, Fig. 9). Figures 14 and 15 are photographs of the B1/C1 and B2/C2 blocks showing contaminated areas and floor cracks, and the ramp leading to Room 1 at the north end door. The contaminated door crank is shown on Fig. 16.

Each overhead beam was generally scanned at 4 locations. Dust samples were collected at two of the locations and smears were taken at the other two. A blower/motor platform and its associated duct system were similarly surveyed.

Room 6

In the former Dynapack area (Room 6), virtually all horizontal surfaces including beams had elevated beta-gamma activity levels. Gamma exposure rates ranged from 6 to 14 $\mu\text{R}/\text{h}$.

Approximately 90% of the floor was accessible to surveying after removal of various stored materials. The floor along the east and west walls as well as the entire floor in the south end of the room were contaminated; beta-gamma dose rates (and activity levels) ranged from 0.04 to 4.2 mrad/h (2,400 to 250,000 dpm/100 cm²), and alpha activity levels were 7 to 3,100 dpm/100 cm². Gamma exposure rates and beta-gamma dose rates were elevated in 2 floor drains in the south end of the room. The beta-gamma dose rate (and activity level) was 72 mrad/h (4,300,000 dpm/100 cm²) at a depth of 4 in. below the surface in Floor Drain 1; 1.5 mrad/h (90,000 dpm/100 cm²) at 6 in. depth; and 0.3 mrad/h (18,000 dpm/100 cm²) at 15 in. depth. The gamma exposure rate was 100 μ R/h at both 6- and 12-in. The beta-gamma dose rate (and activity level) was 1.1 mrad/h (66,000 dpm/100 cm²) in Floor Drain 2 at a depth of 12 in. The floor in this area was generally elevated. Elevated floor areas in two regions of the room are shown in Figs. 17 and 18.

Room 7

Room 7, used as a raw material mixing room during the time of the survey, was ~60% accessible and had 5 small spots of slightly elevated beta-gamma radiation levels at the large doorway in the southeast corner of the room. Gamma exposure rates were generally 10 to 16 μ R/h with one location measuring 35 μ R/h between two skids of raw material stored in the room. The 35 μ R/h was probably due to the clay constituent that was listed on the raw material tag.

Rooms 8—12

No elevated radiation levels were found in these rooms. Gamma exposure rates ranged from 10 to 16 μ R/h.

Room 13

Gamma exposure rates in Room 13 were 10 to 12 μ R/h and beta-gamma dose rates (and activity levels) were 0.05 to 0.1 mrad/h (3,000 to 6,000 dpm/100 cm²). The maximum readings were found on the ceramic tile walls.

Room 14

Because the 2 bays in the southwest corner of Room 14 had reportedly been used for uranium machining, all stored equipment and materials were cleared out and all areas surveyed. However, no elevated readings were found on the floor, walls, overhead fixtures, or heating and cooling apparatus. The interior of the latter was surveyed and found to be free of radiological contamination. Gamma radiation levels were 10 to 15 μ R/h and beta-gamma dose rates (and activity levels) ranged from 0.02 to 0.04 mrad/h (1,200 to 2,400 dpm/100 cm²).

Second floor, south end of building

Measurements taken on the second floor (Fig. 10) showed gamma exposure rates of 8 to 12 $\mu\text{R/h}$ and beta-gamma dose rates (and activity levels) of 0.02 mrad/h (1,200 dpm/100 cm^2) over floors and walls. All areas in the laboratory, rest rooms, and offices were free of elevated radiation levels attributable to AEC operations with the exception of 4 of 5 floor drains surveyed. Directly measured beta-gamma dose rates (and activity levels) prior to sampling these drains ranged from 0.02 mrad/h (1,200 dpm/100 cm^2) in Floor Drain 1 to 0.4 mrad/h (24,000 dpm/100 cm^2) in Floor Drain 2. Beta-gamma levels decreased in Drains 2 through 5 after the collection of samples M25–M30 (Table 5).

Indoor Sample Results

Results of radionuclide analyses of samples collected indoors in overhead areas, auger holes, manholes, and drains are given in Table 5. Sampling locations are diagrammed on Figs. 10 and 19.

Overhead samples

Locations of overhead samples are shown on Fig. 19. Maximum concentrations of ^{226}Ra and ^{232}Th in dust from beams and selected overhead structures (a blower platform and light fixtures in Room 14) were 2.1 and 2.4 pCi/g, respectively. These values are comparable to typical background concentrations found in soil in the general area (0.9 pCi/g, Table 2). However, ^{238}U concentrations were above typical background in every sample, ranging from 6.2 to 1100 pCi/g with the highest concentration in sample M16 from a beam in Room 6, the former Dynapack area. Concentrations of uranium converted to dpm/100 cm^2 (Table 6) show a range of 23 to 520 dpm/100 cm^2 in Rooms 1, 5, and 14, and 270 to 3900 dpm/100 cm^2 in the former Dynapack room. Of these 22 samples, only M16 is in excess of the surface contamination guideline of 1000 dpm/100 cm^2 (Table 1). Lead-210 concentrations determined for 5 of the samples ranged from 2.2 to 6.0 pCi/g.

Auger hole and manhole samples

Concentrations of radionuclides in samples taken from various depths from auger holes drilled at 4 locations in the first floor of the Ruffert building (Fig. 19, Table 5) ranged from 0.6 to 1.7 pCi/g (^{226}Ra), 0.6 to 1.3 pCi/g (^{232}Th), and 0.7 to 25 pCi/g (^{238}U). Concentrations of uranium were elevated only in soil sample A2B (10 pCi/g) taken from a depth of 0–15 cm beneath the floor, and A4AB (25 pCi/g), a sample of concrete chipped from the floor in Room 6. The location of Auger hole 1 is indicated in Fig. 20. Other samples contained ^{238}U in concentrations comparable to typical background for the general area. The two highest are below the 35–40 pCi/g limit that has been applied at other FUSRAP sites. The two samples analyzed for ^{210}Pb contain 0.9 pCi/g and less than 2.4 pCi/g [the minimum detectable activity (MDA) for that sample].

Concentrations of ^{226}Ra , 0.9 and 0.5 pCi/g, and ^{232}Th , 2.3 and 1.7 pCi/g, in sediment samples from Manholes 1 and 2 (Fig. 19, Table 5) are comparable to background values and well below guidelines for both surface and subsurface soil shown in Table 1. However, each sample contained 700 pCi/g ^{238}U . Manholes 1 and 2 were constructed as sumps and therefore had collected $\sim 0.5\text{ m}^3$ of sediment from which the samples were taken.

Second floor drain samples

Drain sample locations are diagrammed on Fig. 10, and 3 of the drains are shown in Fig. 21. Concentrations of ^{226}Ra and ^{232}Th in the dust samples taken from floor drains on the second floor of the Ruffert building were comparable to the typical average value for the general area (0.9 pCi/g, Table 2) ranging from 0.6 to 1.4 pCi/g and 1.1 to 1.9 pCi/g, respectively. Uranium-238 concentrations were elevated, ranging from 50 to 250 pCi/g, exceeding previously applied guidelines for soil (Table 1).

Air samples

Eight 1- to 4-hour air samples were collected inside the Ruffert building in volumes ranging from 0.5–9.6 m^3 (18–336 ft^3). Radiological analysis to determine alpha- and beta-emitters revealed disintegration rates below the MDA*.

SIGNIFICANCE OF FINDINGS

The results of the radiological survey at the former Bridgeport Brass Company facility demonstrate uranium concentrations in excess of previously applied DOE limits in numerous locations inside the Ruffert building and in isolated spots outdoors. Concentrations of ^{238}U in samples of concrete, soil, and debris collected near the north end of the building, and beta-gamma activity levels over floor and wall surfaces inside the building exceeded guidelines.

Outdoors, uranium concentrations exceeding derived limits were confined to two small, isolated spots: one beneath the north end scale room and the second north of the concrete pad. Samples of rusted metal and samples of concrete and soil from those locations contained concentrations of ^{238}U ranging from 55 to 700 pCi/g. The maximum concentration is a factor of approximately 15 higher than previously applied guidelines (Table 1).

*The minimum detectable activity (MDA) corresponds to an air concentration of <4.5% of the ^{238}U guideline value in Order U.S. DOE 5400.5, February 8, 1990, via inhaled air, Y-Class.

Indoor radiation measurements showed beta-gamma activity levels above guidelines over large areas of floor surface, particularly in Rooms 1 and 6 and in the north end of Room 5. Surfaces of some walls, fixtures and drain interiors also exhibited elevated beta-gamma activity levels. The concentrations of ^{238}U in overhead dust were elevated. However, calculated surface activity levels due to ^{238}U in selected overhead dust samples were all, with one exception, below removable guidelines. The areal extent of the contamination diminished toward the south end of the building except in Room 6 where the south end was the most extensively contaminated. As determined by measurements over and under a tile removed from the floor in Room 1, elevated readings were associated with the tile surface and dust in the joints between tiles rather than with the concrete surface beneath the tile.

Concentrations of ^{238}U were elevated in dust samples collected from overhead areas in Room 5 (6 to 110 pCi/g), and in samples obtained from within first-floor manholes (700 pCi/g) and second-floor drains (50 to 250 pCi/g). Concentrations of ^{238}U (7 to 25 pCi/g) in auger hole samples demonstrate that the significant contamination is limited to the surface. The maximum ^{238}U concentration, 1100 pCi/g, was found in a sample of beam dust (M16) from Room 6, and 700 pCi/g ^{238}U was found in samples from each of the two manholes in Room 5.

Survey findings demonstrate concentrations of ^{238}U in outdoor samples from the former Bridgeport Brass Company facility and beta-gamma activity levels over floor and wall surfaces inside the Ruffert building above DOE guidelines. It is recognized that the contaminated residuals found in manholes and drains may have been carried into connecting storm sewers. This potential redistribution will be subsequently addressed in a verification report concerning the planned radiological remedial action on the property.⁴

REFERENCES

1. U.S. Department of Energy, *A Background Report for the Formerly Utilized Manhattan Engineer District/Atomic Energy Commission Sites Program*, DOE/EV-0097, September 1980.
2. A. J. Breslin, HASL, New York, NY, correspondence to J. W. Ruch, Director, Feed Materials Division, Oak Ridge Operations Office, Oak Ridge, Tennessee
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*, ORNL/TM-8600, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., April 1987.
4. R. D. Foley and R. F. Carrier, *Results of the Independent Radiological Verification Survey at the Former Bridgeport Brass Company Facility, Seymour, Connecticut*, ORNL/TM-12390, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., in preparation.



Fig. 1. Diagram showing the general location of Seymour, Connecticut.

ORNL PHOTO 1098-93

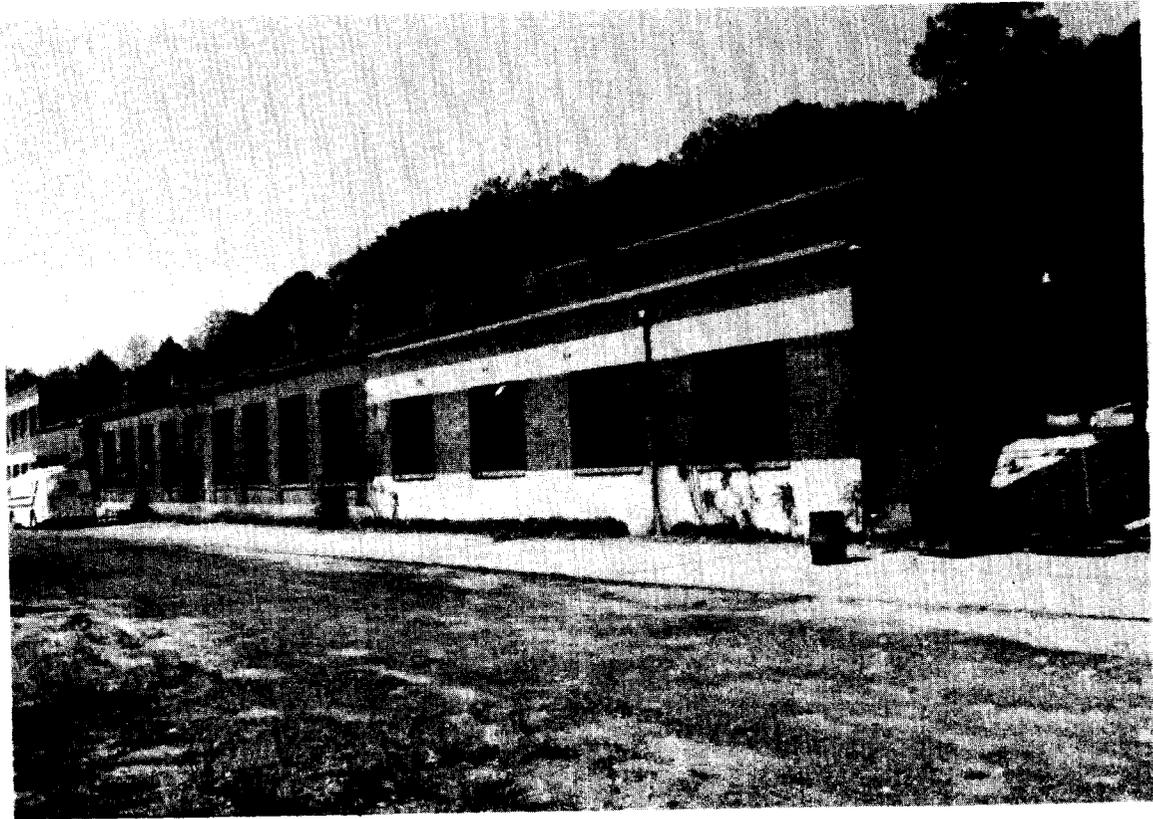


Fig. 2. View of the Ruffert building, looking southwest.

ORNL-DWG 92-10113A

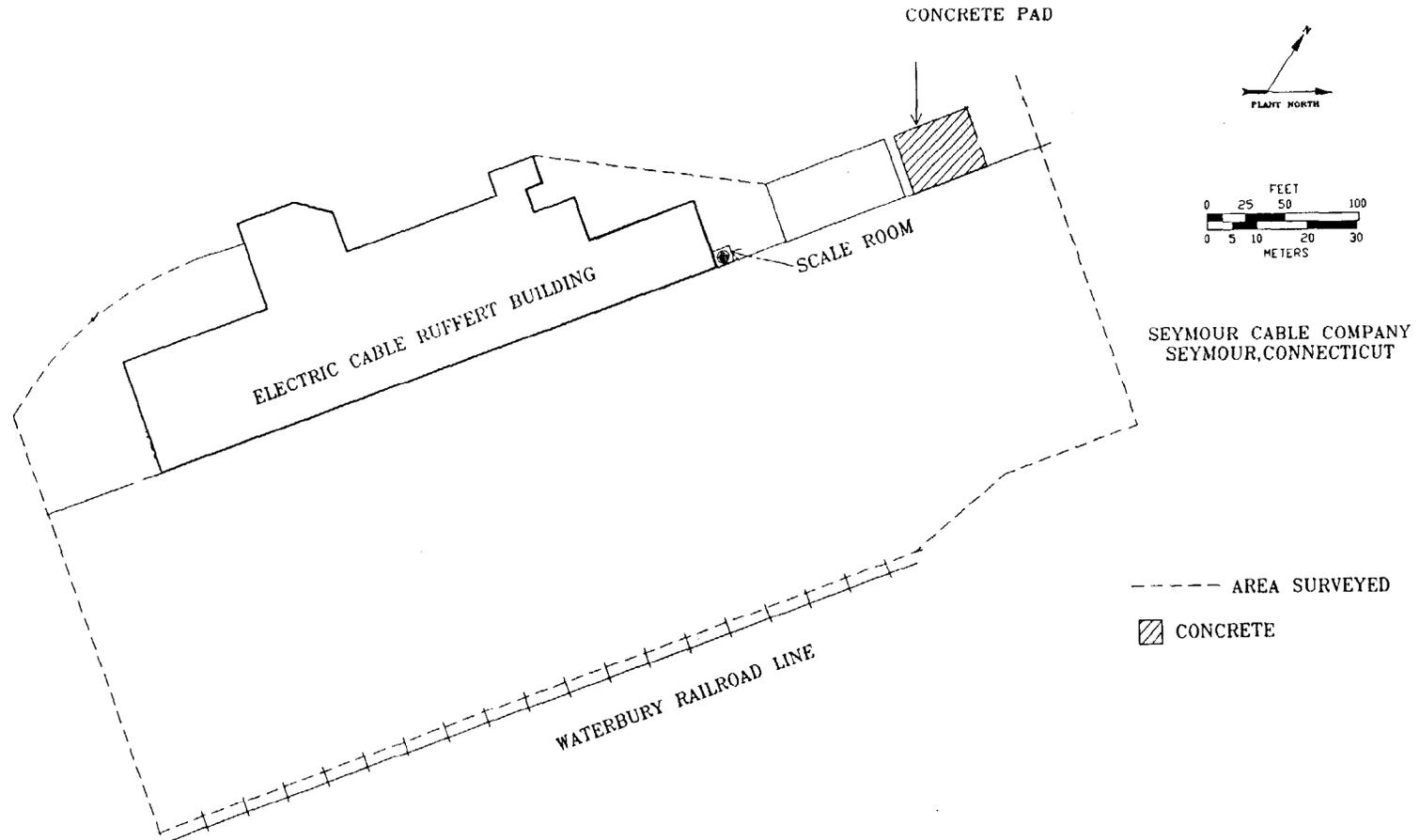


Fig. 3. Diagram showing areas surveyed outdoors at the former Bridgeport Brass Company facility, Seymour, Connecticut.

ORNL-DWG 92-9755

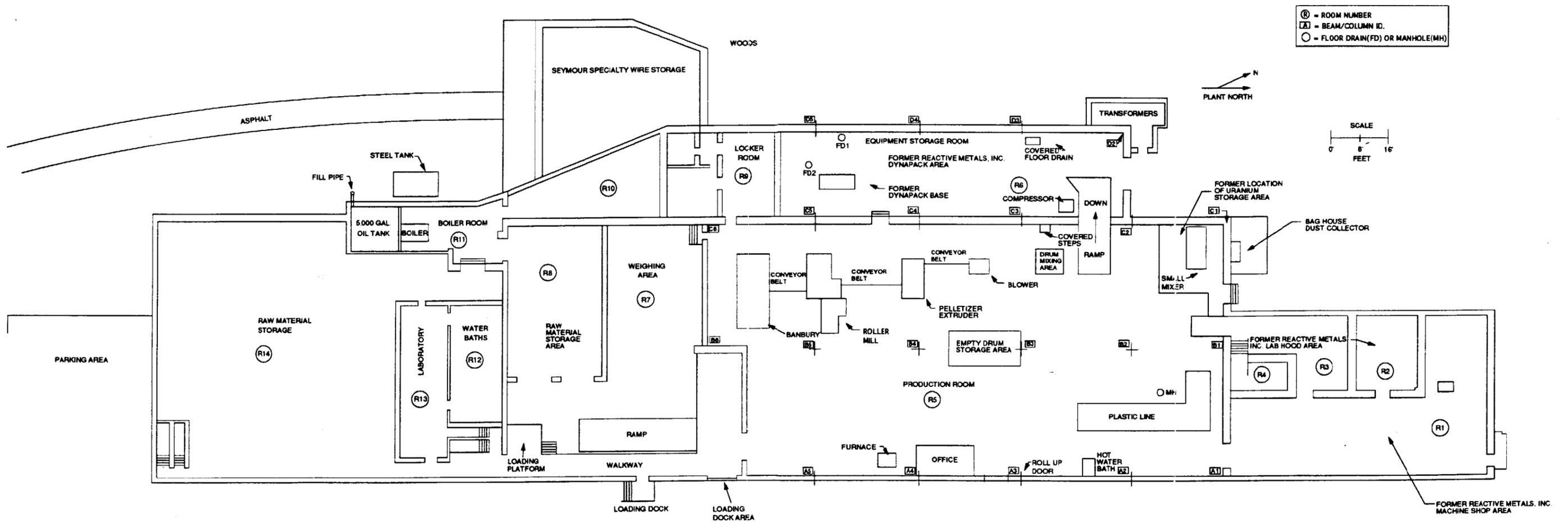


Fig. 4. Diagram showing the floor plan of the Ruffert building.

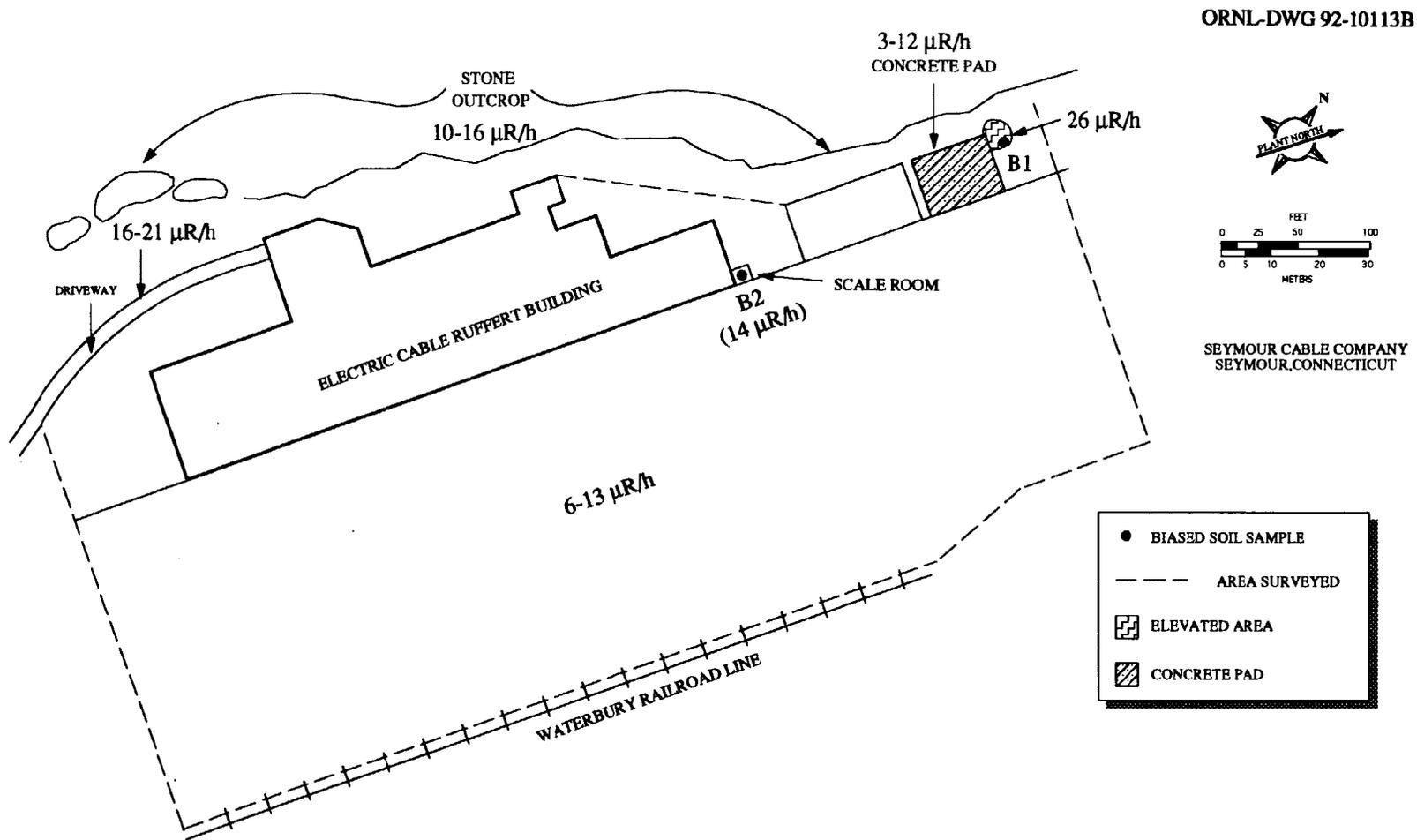


Fig. 5. Outdoor surface gamma exposure rates and locations of biased samples collected at the former Bridgeport Brass Company facility.

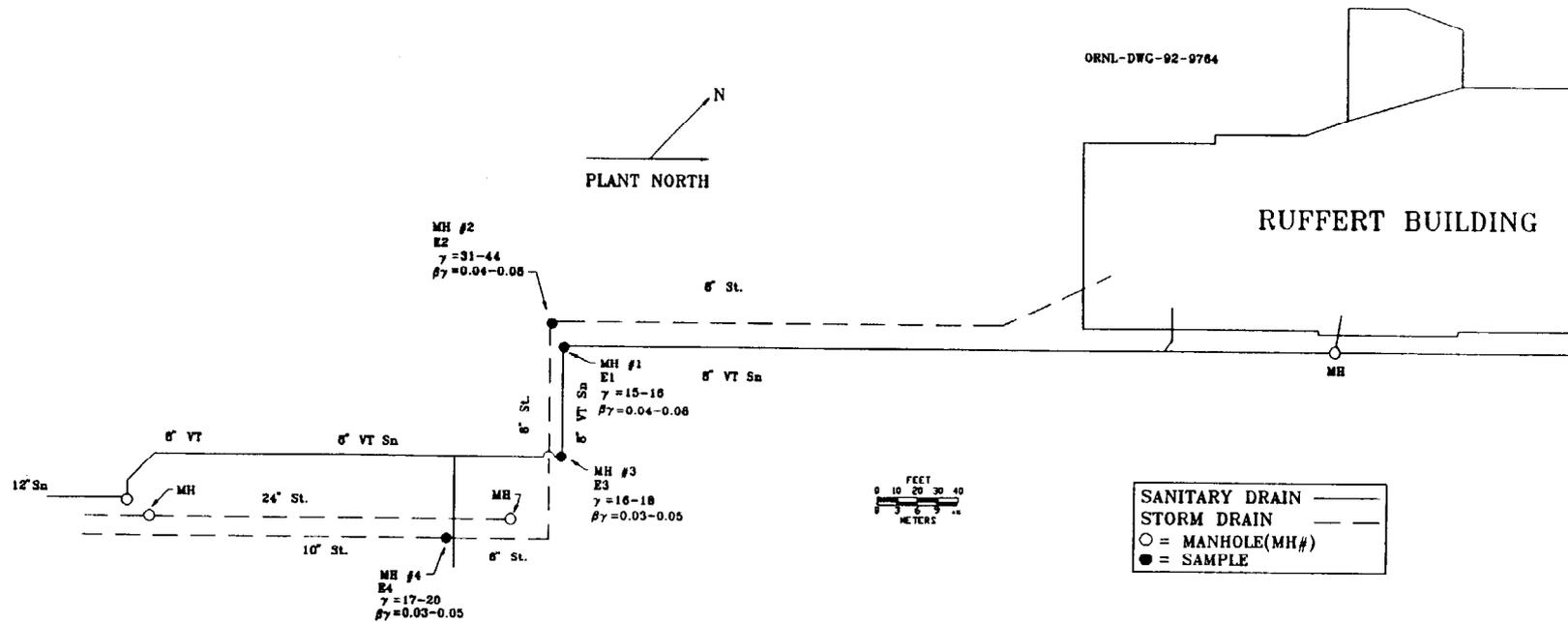


Fig. 6. Diagram showing locations of outdoor Manholes 1-4 sampled at the former Bridgeport Brass Company facility, Seymour, Connecticut. Beta-gamma activity levels (dpm/100 cm²) are given in Table 4.



Fig. 7. Photograph of outfall 007 downstream of the Ruffert building. (S1 samples were collected from the ground surface in the area shown).

ORNL PHOTO 1100-93



Fig. 8. Photograph of the north end scale room showing the location of collection of B1 samples.

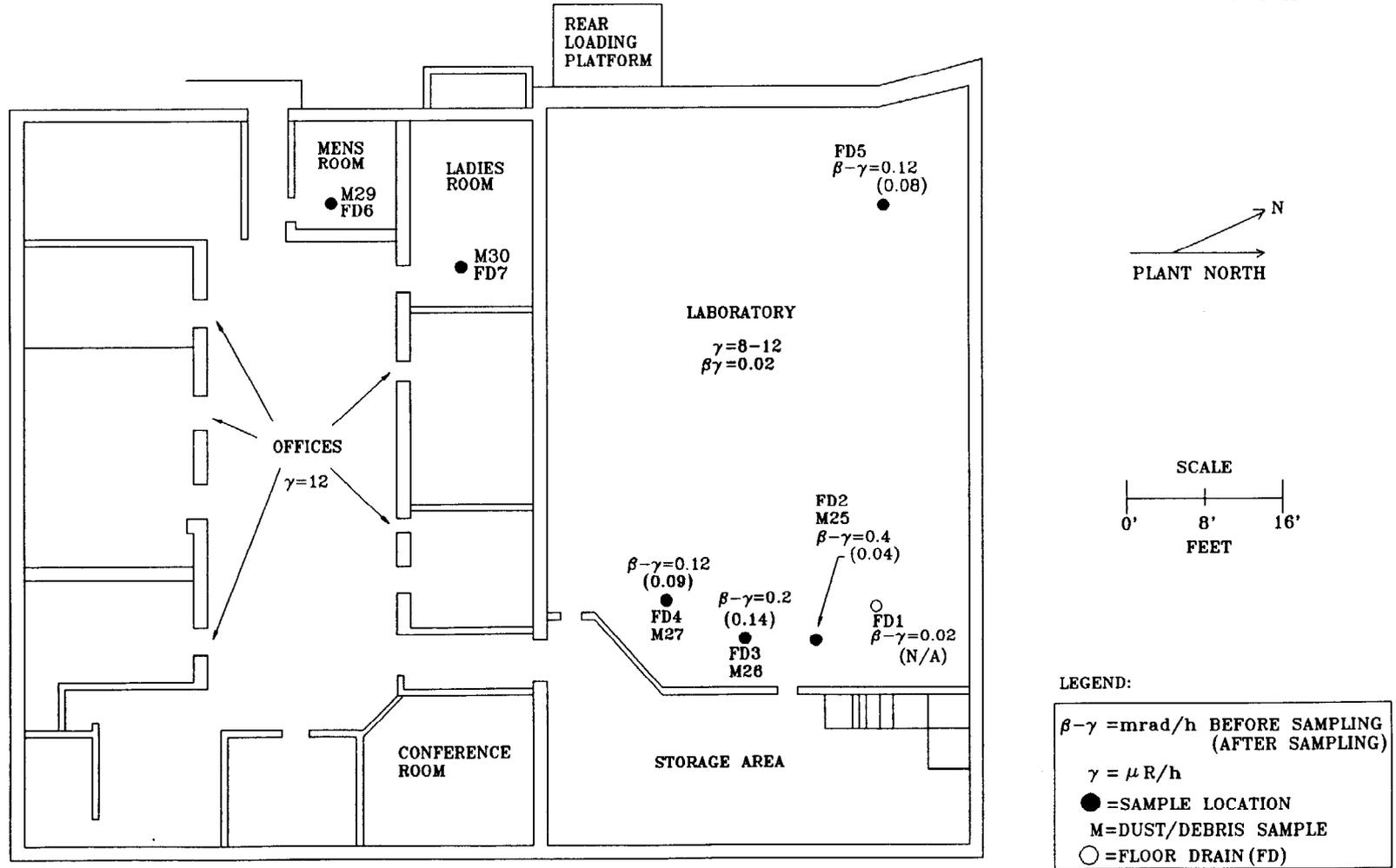


Fig. 10. Directly measured radiation levels and locations of samples collected from the second floor of the Ruffert building. Beta-gamma activity levels (dpm/100 cm²) are given in Table 4.

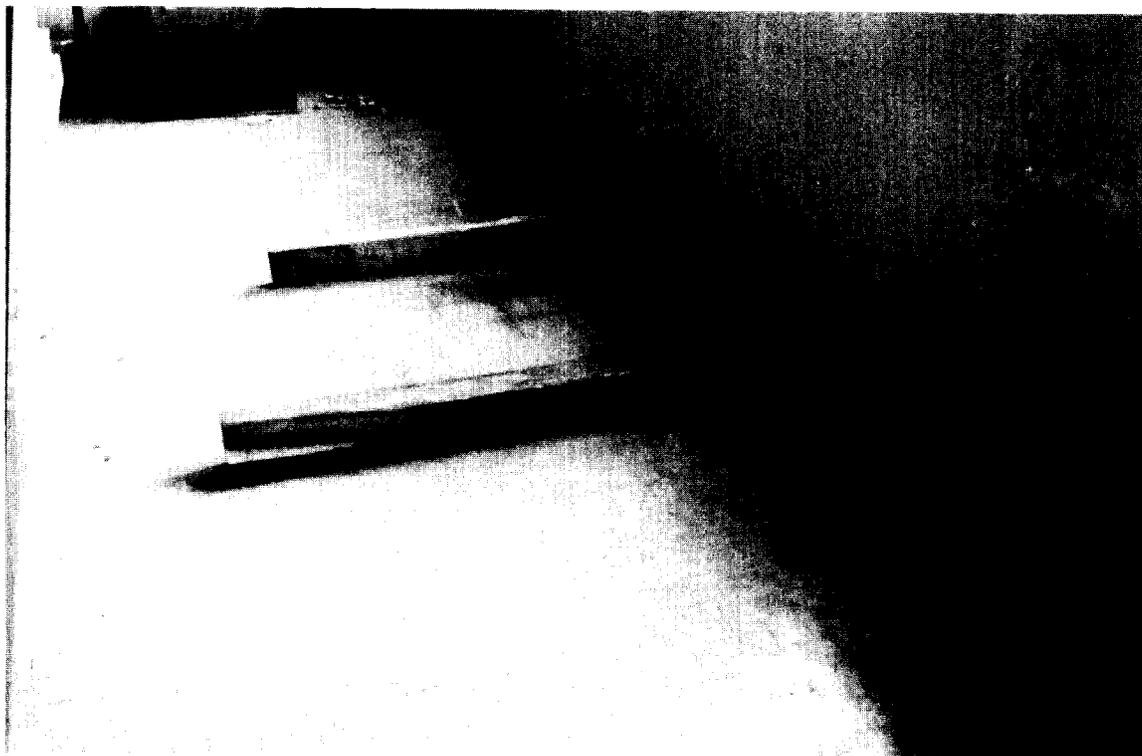


Fig. 11. View of the extreme north end of the Ruffert building, Room 1, showing location of measurements on and beneath floor tile (dark floor area, upper right corner of room).

ORNL PHOTO 1102-93

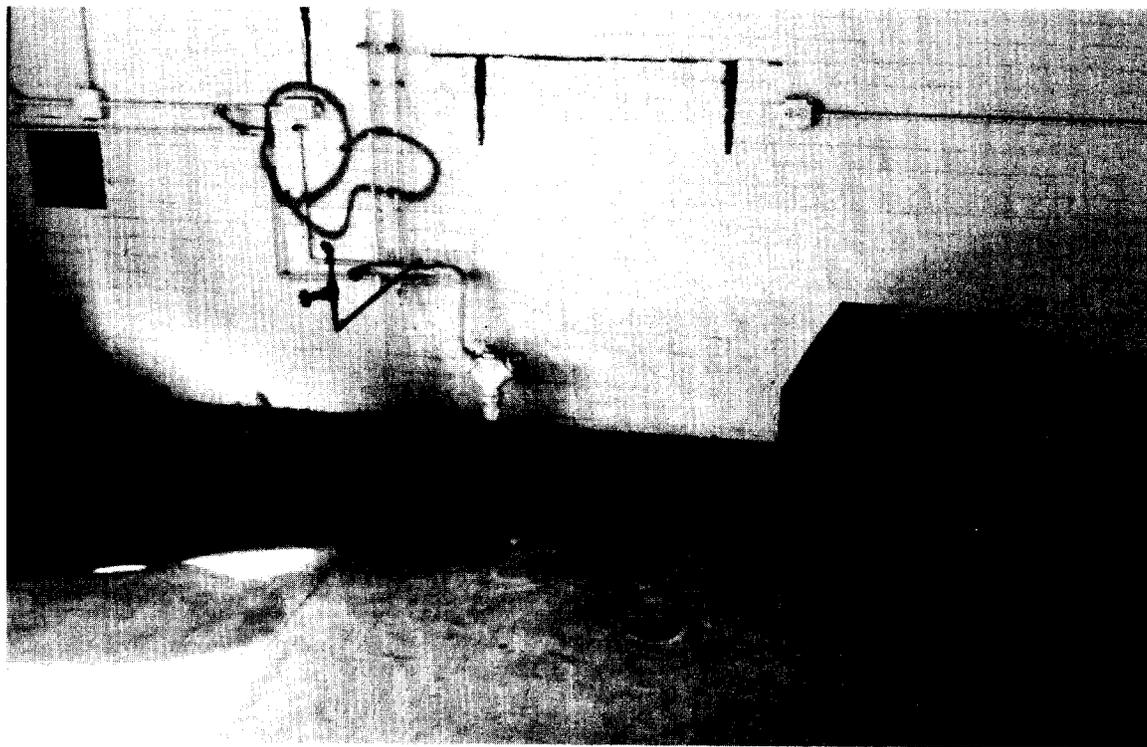


Fig. 12. Contaminated area near fixtures on north wall in Room 2.

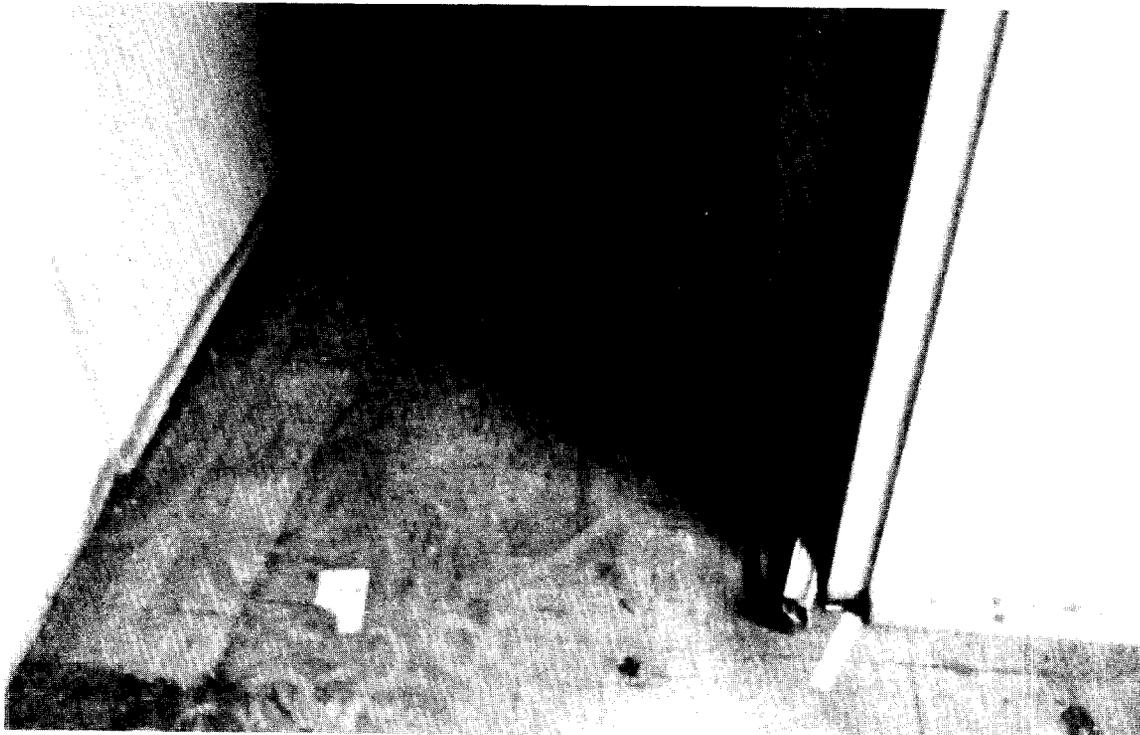


Fig. 13. View of contaminated areas along walls beneath the stairs leading to second floor from Room 4.

ORNL PHOTO 1104-93



Fig. 14. View looking north in Room 5 at contaminated floor cracks running between locations B2 and C2.

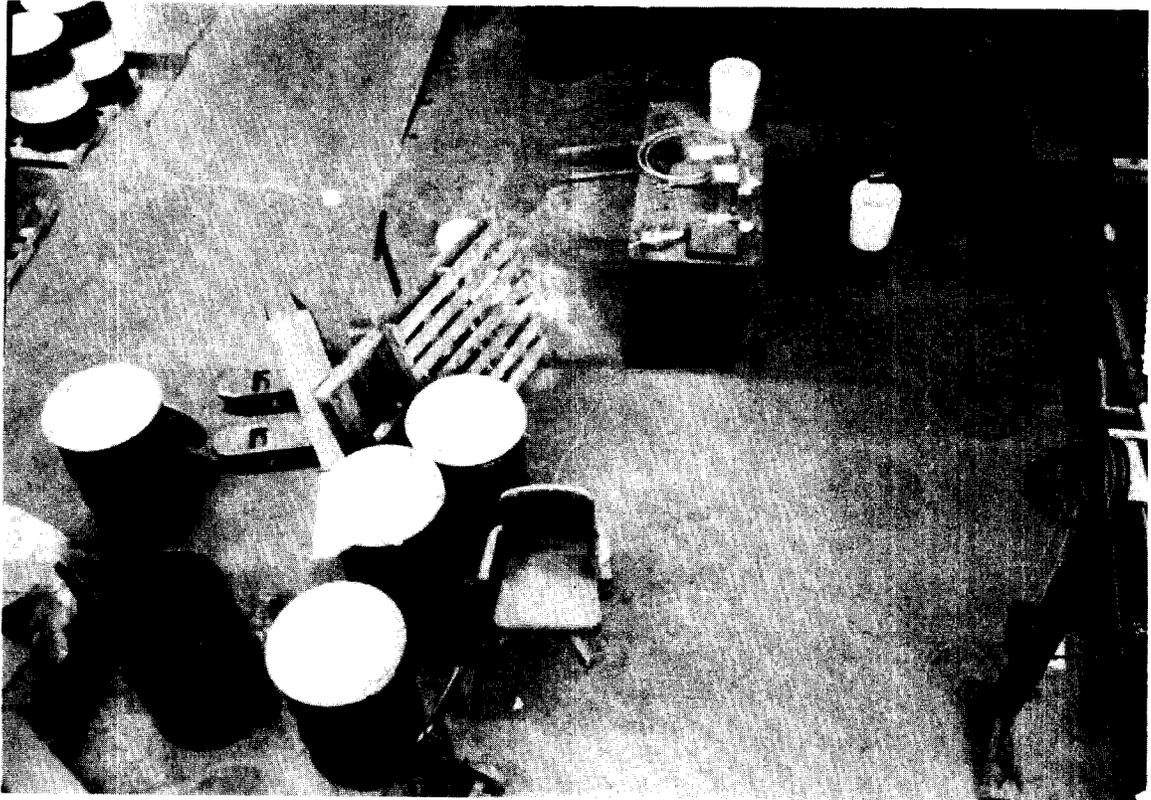


Fig. 15. View looking north in Room 5 at the contaminated areas near the ramp shown in previous photograph.

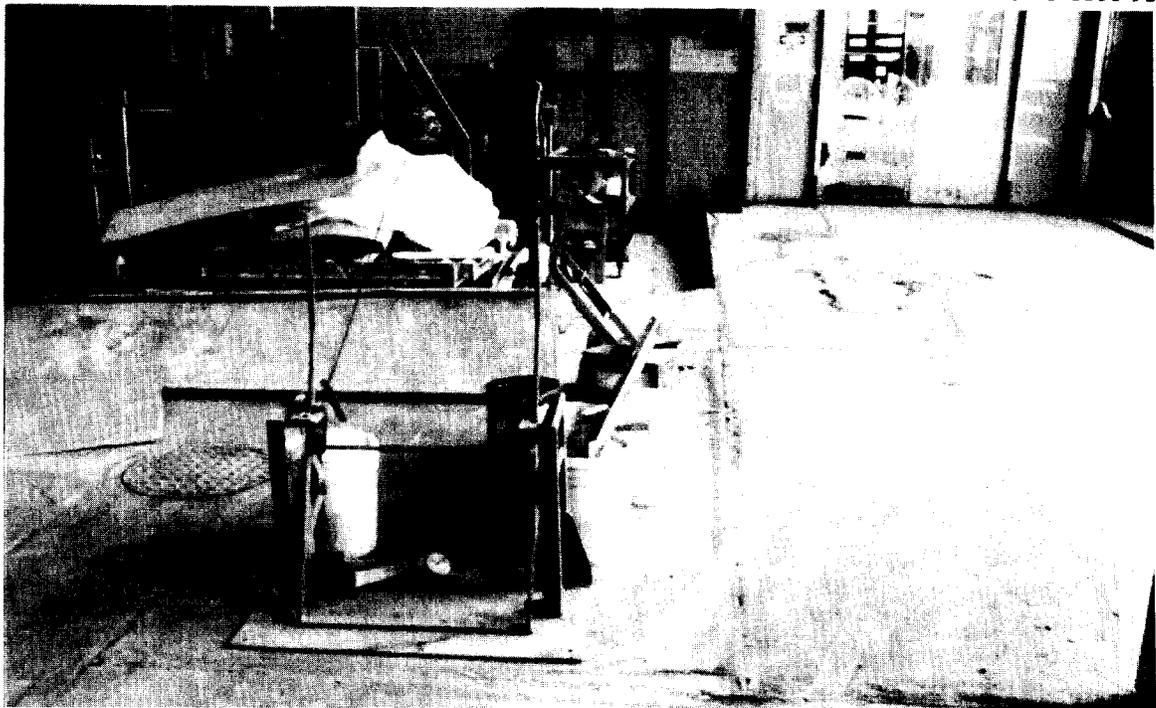


Fig. 16. Room 5, looking north toward door near location A1. Contaminated door crank is shown on the wall in the upper righthand corner of photograph.

ORNL PHOTO 1107-93



Fig 17. Dynapack room (Room 6), looking east toward stairs between locations C5 to C4.

ORNL PHOTO 1108-93

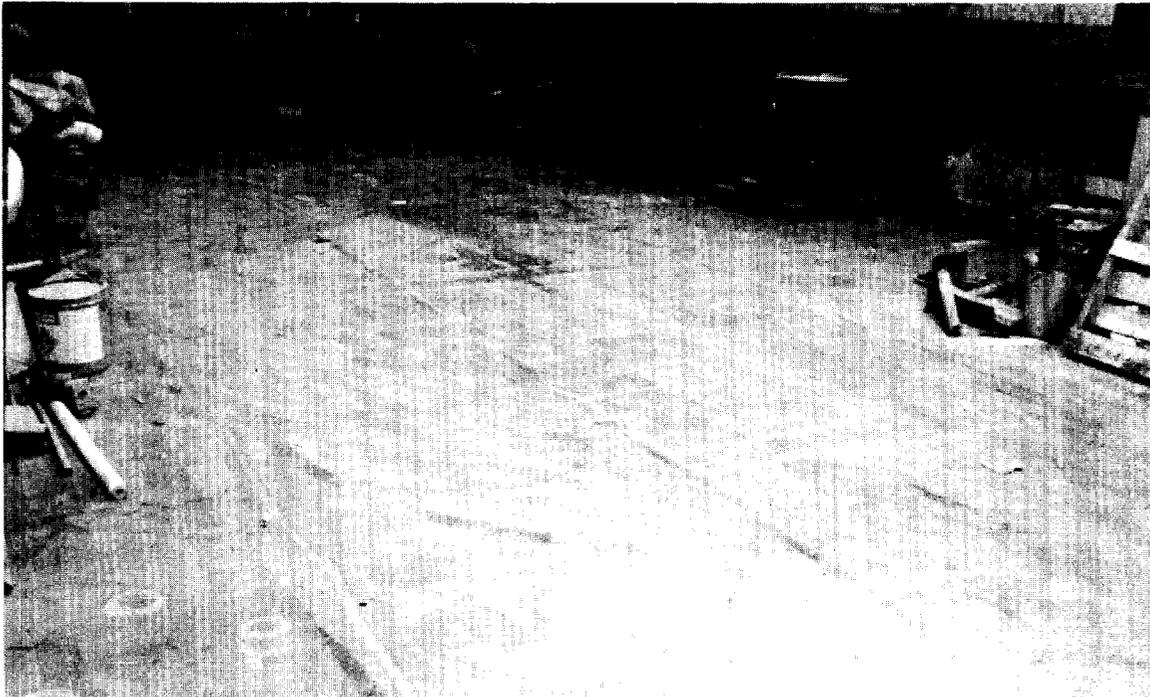


Fig. 18. Dynapack room (Room 6), looking southwest toward location D4 from C3.

ORNL-DWG 92-9831

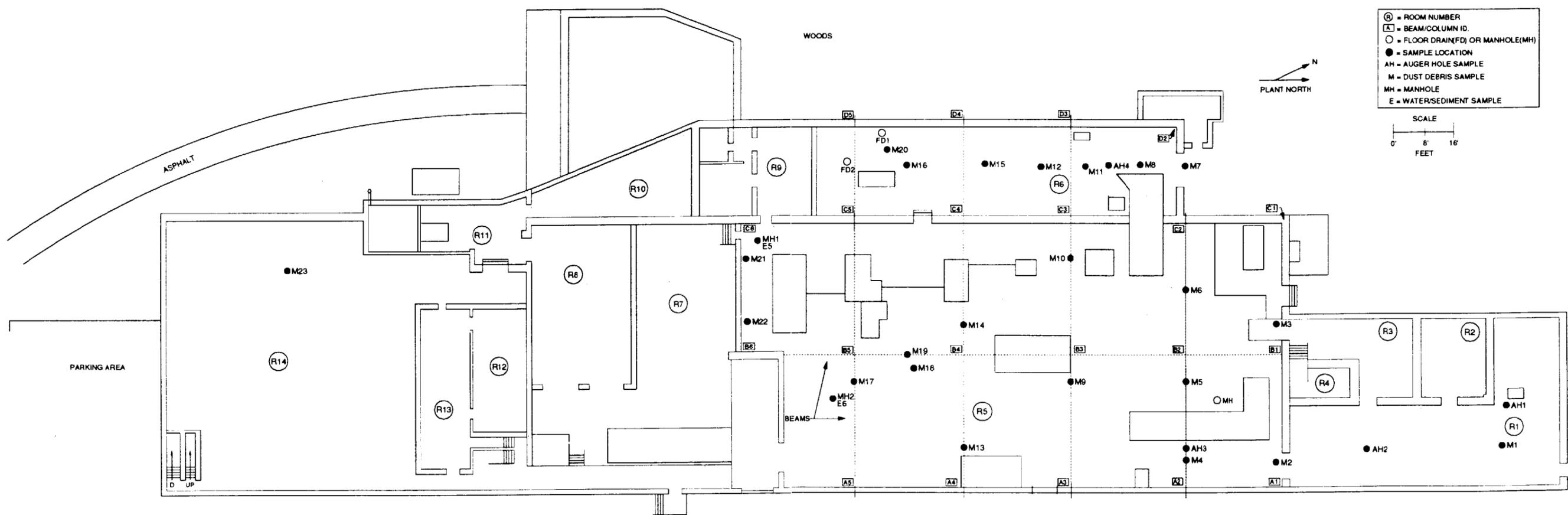


Fig. 19. Diagram of the Ruffert building showing locations of all first floor samples.

ORNL PHOTO 1109-93

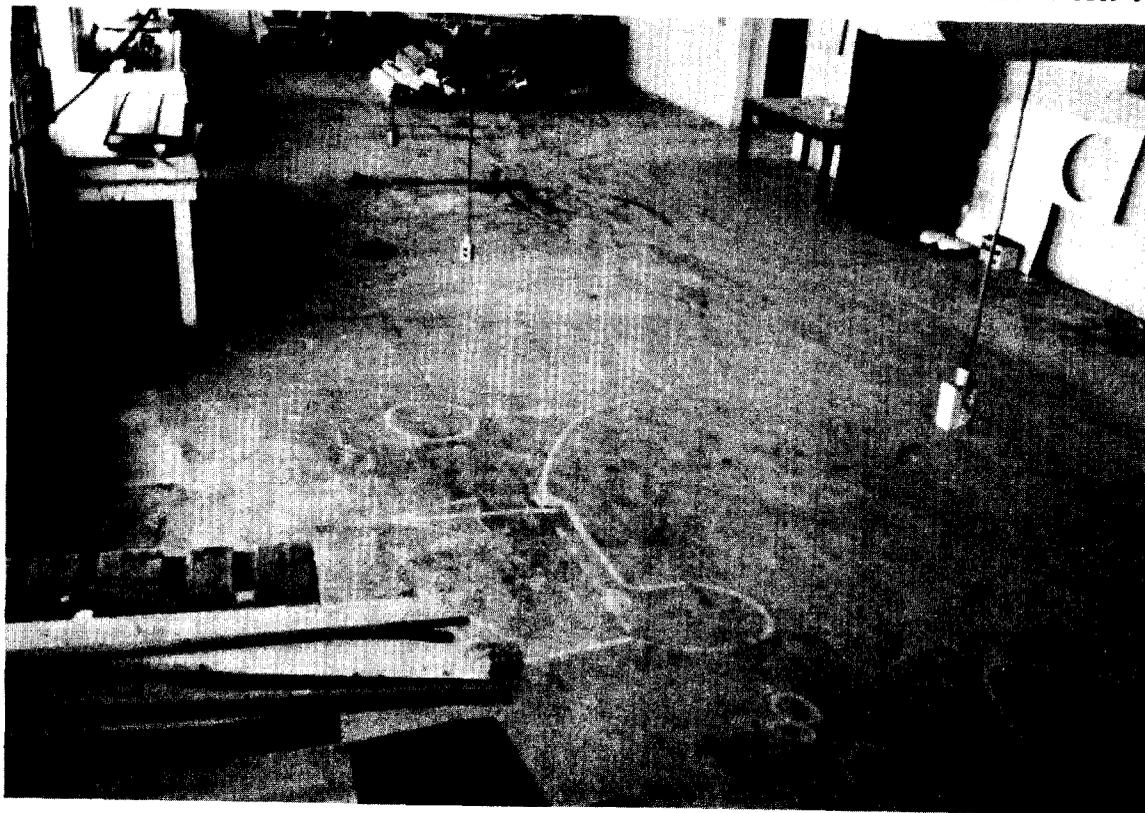


Fig. 20. View looking south in Room 1 toward location of Auger hole 1. Hole was dug beneath the suspended receptacle to the rear.

ORNL PHOTO 1110-93



Fig. 21. Photograph showing three of the floor drains in the laboratory on the second floor of the Ruffert building, looking north.

Table 1. Applicable guidelines for protection against radiation
(Limits for uncontrolled areas)

Mode of exposure	Exposure conditions	Guideline value
Gamma radiation	Indoor gamma radiation level (above background)	20 $\mu\text{R}/\text{h}^a$
Total residual surface contamination ^b	²³⁸ U, ²³⁵ U, U-natural (alpha emitters) or Beta-gamma emitters ^c Fixed and removable	15,000 dpm/100 cm ²
	Average	5,000 dpm/100 cm ²
	Removable	1,000 dpm/100 cm ²
	²³² Th, Th-natural (alpha emitters) or ⁹⁰ Sr (beta-gamma emitter) Fixed and removable	3,000 dpm/100 cm ²
	Average	1,000 dpm/100 cm ²
	Removable	200 dpm/100 cm ²
	²²⁶ Ra, ²³⁰ Th, transuranics Fixed and removable	300 dpm/100 cm ²
	Average	100 dpm/100 cm ²
	Removable	20 dpm/100 cm ²
	Beta-gamma dose rates	Surface dose rate averaged over not more than 1 m ²
Maximum dose rate in any 100-cm ² area		1.0 mrad/h
Radionuclide con- centrations in soil (generic)	Maximum permissible con- centration of the following radionuclides in soil above background levels, averaged over a 100-m ² area ²²⁶ Ra ²³² Th ²³⁰ Th	5 pCi/g averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15-cm-thick soil layers more than 15 cm below the surface

Table 1 (continued)

Mode of exposure	Exposure conditions	Guideline value
Derived concentrations	²³⁸ U	Site specific ^d

^aThe 20 μ R/h shall comply with the basic dose limit (100 mrem/yr) when an appropriate-use scenario is considered.

^bDOE surface contamination guidelines are consistent with *NRC Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source, or Special Nuclear Material*, May 1987.

^cBeta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ⁹⁰Sr, ²²⁸Ra, ²²³Ra, ²²⁷Ac, ¹³³I, ¹²⁹I, ¹²⁶I, ¹²⁵I.

^dDOE guidelines for uranium are derived on a site-specific basis. Guidelines of 30-50 pCi/g have been applied at other FUSRAP sites. Sources: R. E. Rodriguez, et al., *Results of the Radiological Survey at the town of Tonawanda Landfill, Tonawanda, New York (TNY001)*, ORNL/RASA-92/12, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., October 1992; B. A. Berven et. al., *Radiological Survey of the Former Kellex Research Facility, Jersey City, New Jersey*, DOE/EV-0005/29, ORNL-5734, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., February 1982.

Sources: Adapted from U.S. Department of Energy, *Radiation Protection of the Public and the Environment*, DOE Order 5400.5, April 1990 and U.S. Department of Energy, *Guidelines for Residual Radioactive Material at FUSRAP and Remote SFMP Sites*, Rev. 2, March 1987; and U. S. Department of Energy *Radiological Control Manual*, DOE N 5480.6 (DOE/EH-256T), June 1992.

Table 2. Background radiation levels and concentrations of selected radionuclides in soil in the Seymour, Connecticut, area

Type of radiation measurement or sample	Radiation level or radionuclide concentration
Gamma exposure rate at 1 m above ground surface ($\mu\text{R/h}$) ^a	8
Concentration of radionuclides in soil (pCi/g) ^a	
²³² Th	0.9
²²⁶ Ra	0.9
²³⁸ U	0.9

^aValues obtained from locations in northern New Jersey area, southwest of Bridgeport and Seymour, Connecticut.

Sources: U. S. Department of Energy *Radiological Survey of the Middlesex Municipal Landfill, Middlesex, New Jersey*, DOE/EV-0005/20, April 1980; T. E. Myrick, B. A. Berven, and F. F. Haywood, *State Background Radiation Levels: Results of Measurements Taken During 1975-1979*, ORNL/TM-7343, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., November 1981.

Table 3. Concentrations of radionuclides in samples collected outdoors at the former Bridgeport Brass Company Facility, Seymour, Connecticut

Sample I.D.	Location ^a	Depth (cm)	Radionuclide concentration (pCi/g) ^b			
			²²⁶ Ra	²³² Th	²³⁸ U	²¹⁰ Pb
<i>Systematic soil samples^c</i>						
S1A	Bldg. 2, outfall 7	0-15	0.6 ± 0.02	0.7 ± 0.03	2.4 ± 0.8	<i>d</i>
S1B	Bldg. 2, outfall 7	15-30	0.7 ± 0.02	0.8 ± 0.03	1.6 ± 0.7	<i>d</i>
S2	Outfall 7, 25 ft north	0-15	0.7 ± 0.02	0.8 ± 0.03	1.4 ± 0.4	<i>d</i>
S3	Route 8, under bridge	0-15	0.7 ± 0.02	0.8 ± 0.03	1.0 ± 0.4	1.2 ± 0.5
<i>Biased samples^e</i>						
B1A	1 ft north of concrete pad	0-15	0.7 ± 0.08	0.7 ± 0.2	130 ± 20	<i>d</i>
B1B	1 ft north of concrete pad	15-30	0.7 ± 0.07	1.7 ± 0.12	140 ± 20	<i>d</i>
B1AB ^f	1 ft north of concrete pad	<i>g</i>	<2.0	<2.0	700 ± 50	<i>d</i>
B2	North scale room	0-5	0.8 ± 0.09	0.9 ± 0.06	55 ± 5.0	<i>d</i>
M24 ^h	Pad, north end	<i>g</i>	0.5 ± 0.2	<0.6	140 ± 5.0	<i>d</i>
M31 ^h	Near north pad	<i>g</i>	0.3 ± 0.07	0.3 ± 0.1	1.5 ± 0.2	1.9 ± 0.3
<i>Water/sediment samples from manholes south of Ruffert building</i>						
E1	Manhole 1		1.0 ± 0.1	0.8 ± 0.05	3.0 ± 0.4	0.10 ± 0.06
E2	Manhole 2		1.5 ± 0.2	1.8 ± 0.06	5.3 ± 0.7	2.4 ± 0.6
E3	Manhole 3		0.9 ± 0.1	0.8 ± 0.1	4.0 ± 1.7	<i>d</i>
E4	Manhole 4		0.8 ± 0.04	0.9 ± 0.07	4.1 ± 0.8	2.7 ± 0.7

^aLocations are shown on Figs. 3, 5, and 6.

^bIndicated counting error is at the 95% confidence level ($\pm 2\sigma$).

^cSystematic samples are taken at selected locations irrespective of radiation levels.

^dAnalysis not performed.

^eBiased samples are collected at locations shown to have elevated radiation levels.

^fSample B1AB is composed of concrete chips.

^gNot applicable.

^hSamples M24 and M31 are pieces of rusted metal debris.

Table 4. Directly measured radiation levels in the Ruffert building at the former Bridgeport Brass Company facility

Room no. &/or beam/column I.D. ^a	Gamma exposure rates (μ R/h)	Beta-gamma dose rates (mrad/h)	Beta-gamma activity levels (dpm/100 cm ²)	Alpha activity levels (dpm/100 cm ²)	Comments
<i>First floor</i>					
Room 1	9-15	0.05-7.5	3,000-450,000	7-49	60-70% of floor elevated at room perimeter in several large areas and spots as well as in all cracked floor joints in the south end
	22	<i>b</i>	<i>b</i>	<i>b</i>	At floor anchor bolt
	12	0.31	186,000	<i>b</i>	At auger holes 1 & 2
	<i>b</i>	1.0	60,000	49	On floor tile surface before removal;
	<i>b</i>	0.04	2,400	42	on surface under tile after tile removal; and
	<i>b</i>	1.8	110,000	<i>b</i>	on dust in joint beneath tile.
Room 2	10-14	0.05-0.6	3,000-36,000	<7-750	Elevated areas include grill-covered floor drain; pipe with brass plug, W wall at outside exit at floor/wall interface; north
Room 3	9-15	0.05- 0.25	3,000-15,000	<7-80	wall around pipe, drain, and electrical outlet (0.25 m ² area) Elevated areas include one floor drain, 6 small areas, and small area on N wall
Room 4	11-15	1.0	60,000	10-350	Junction of floor/wall at each side of, and under, steps
Room 5, A1	9-15	0.05-1.5	3,000-90,000	7-21	Extensive floor contamination, decreasing from N to S end
	<i>b</i>	0.05	3,000	140	Maximum α at south wall at A1
	<i>b</i>	0.14	8,400	<i>b</i>	Door crank at A1
	<i>b</i>	0.2	12,000	<i>b</i>	Faucet wrench on wall
	<i>b</i>	0.05-0.30	3,000-18,000	<i>b</i>	Wall ledge
A2	8-10	0.05-3.1	3,000-186,000	7-28	~12 spotty areas
A3	5-11	0.05-0.91	3,000-55,000	<7-21	~15 spotty areas
A4	5-11	0.05-0.7	3,000-42,000	7-21	~9 spots
A5	6-12	0.05-0.09	3,000-5,400	7-28	3 spots
	<i>b</i>	0.05-0.1	3,000-6,000	<i>b</i>	100 cm ²
	<i>b</i>	0.09	5,400	<i>b</i>	100 cm ²
	<i>b</i>	0.13	7,800	<i>b</i>	100 cm ²

Table 4 (continued)

Room no. &/or beam/column I.D. ^a	Gamma exposure rates (μ R/h)	Beta-gamma dose rates (mrad/h)	Beta-gamma activity levels (dpm/100 cm ²)	Alpha activity levels (dpm/100 cm ²)	Comments
B1	6-11	0.05-1.8	3,000-110,000	7-150	Extensive floor contamination & scattered spots Floor joint, B2/C2 Spots, floor cracks Floor, northwest at B2
	<i>b</i>	0.05-3.0	3,000-180,000	<i>b</i>	
	<i>b</i>	0.08-0.6	4,800-36,000	<i>b</i>	
	<i>b</i>	0.05-1.5	3,000-90,000	<i>b</i>	
B2	5-12	0.05-3.0	3,000-180,000	7-21	Scattered spots
B3	5-12	2.7	160,000	7-35	~2 spots, 2 areas
B4	5-11	0.05-1.8	3,000-110,000	7-28	~5 spots, 1 area
B5	6-14	0.05-0.67	3,000-40,000	7-21	~5 small, spotty areas
Room 6, C2	6-11	0.21	13,000	<7-126	All horizontal surfaces including beams had elevated readings Beams Window ledges 6th window ledge from N wall
	<i>b</i>	0.21-0.30	13,000-18,000	Elevated	
	<i>b</i>	0.04-0.07	2,400-4,200	<i>b</i>	
	<i>b</i>	0.04-0.1	4,200-6,000	<i>b</i>	
C3	6-11	0.05-6.2	3,000-370,000	7-190	All horizontal surfaces including beams had elevated readings Wall near column D3, 3 ft from floor (4 ft ²)
	19	0.5-1.3	30,000-78,000	1,450	
C4	10-14	0.05-4.2	3,000-250,000	7-3,100	Elevated areas include: Plant line handle, W wall Floor drain 1, interior, 4 in. down 6 in. down drain 15 in. down drain Floor drain 2 at 12 in., most of activity at bottom, floor generally elevated
	<i>b</i>	0.28	16,800	<i>b</i>	
	<i>b</i>	72	4,300,000	<i>b</i>	
	100	1.5	90,000	<i>b</i>	
	100	0.3	18,000	<i>b</i>	
C5	<i>b</i>	1.1	66,000	<i>b</i>	
Room 7	10-16	0.04	2,400	<i>b</i>	60% accessible; 5 small spots at doorway in SE corner and nearby drain line plug Raw material storage
	35	<i>b</i>	<i>b</i>	<i>b</i>	
Rooms 8-12	10-16	<i>b</i>	<i>b</i>	<i>b</i>	No elevated areas
Room 13	10-12	0.05-0.1	3,000-6,000	<i>b</i>	Maximum on ceramic tile walls
Room 14	10-15	0.02-0.04	1,200-2,400	<i>b</i>	No elevated areas

Table 4 (continued)

Room no. &/or beam/column I.D. ^a	Gamma exposure rates (μ R/h)	Beta-gamma dose rates (mrad/h)	Beta-gamma activity levels (dpm/100 cm ²)	Alpha activity levels (dpm/100 cm ²)	Comments
<i>Second floor</i>					
Lab/offices	8-12	0.02	1,200	<i>b</i>	No elevated floor or wall areas
Central hall	12	<i>b</i>	<i>b</i>	<i>b</i>	No elevated floor or wall areas
Floor drain 1	<i>b</i>	0.02	1,200	<i>b</i>	No elevated readings
Floor drain 2	<i>b</i>	0.4	24,000	<i>b</i>	Before sampling
	<i>b</i>	0.04	2,400	<i>b</i>	After sampling
Floor drain 3	<i>b</i>	0.2	12,000	<i>b</i>	Before sampling
	<i>b</i>	0.14	8,400	<i>b</i>	After sampling
Floor drain 4	<i>b</i>	0.12	7,200	<i>b</i>	Before sampling
	<i>b</i>	0.09	5,400	<i>b</i>	After sampling
Floor drain 5	<i>b</i>	0.12	7,200	<i>b</i>	Before sampling
	<i>b</i>	0.08	4,800	<i>b</i>	After sampling

^aLocations shown on Figs. 19 and 20.

^bMeasurement not taken.

Table 5. Concentrations of radionuclides in samples collected inside the Ruffert building at the former Bridgeport Brass Company facility

Sample I.D. ^a	Location ^b	Radionuclide concentration (pCi/g) ^c			
		²²⁶ Ra	²³² Th	²³⁸ U	²¹⁰ Pb
<i>First floor, beam and overhead samples</i>					
M1	Rm 1, <i>N</i> beam	<1.0	<1.2	600 ± 100	<i>d</i>
M2	A1/B1, <i>E</i>	1.0 ± 0.5	1.8 ± 0.8	210 ± 40	<i>d</i>
M3	B1/C1, <i>E</i>	0.8 ± 0.2	1.0 ± 0.3	100 ± 12	<i>d</i>
M4	A2/B2, <i>E</i>	0.5 ± 0.3	1.1 ± 0.5	130 ± 10	<i>d</i>
M5	A2/B2, <i>W</i>	<0.05	1.2 ± 0.5	150 ± 11	<i>d</i>
M6	B2/C2, <i>C</i>	1.1 ± 0.3	0.9 ± 0.5	73 ± 10	<i>d</i>
M7	C2/D2, <i>C</i>	<1.0	<1.0	190 ± 6.0	<i>d</i>
M8	C2.5/D2.5, <i>C</i>	0.7 ± 0.4	<1.2	210 ± 20	<i>d</i>
M9	A3/B3, <i>W</i>	1.5 ± 0.5	2.0 ± 0.6	110 ± 35	<i>d</i>
M10	B3/C3, <i>W</i>	0.7 ± 0.2	1.2 ± 0.3	70 ± 20	<i>d</i>
M11	C3/D3, <i>C</i>	0.5 ± 0.2	0.6 ± 0.3	220 ± 20	2.8 ± 1.6
M12	C3.5/D3.5, <i>C</i>	1.0 ± 0.4	1.6 ± 0.5	460 ± 27	<i>d</i>
M13	A4/B4, <i>E</i>	0.9 ± 0.29	1.3 ± 0.50	55 ± 7.1	<i>d</i>
M14	B4/C4, <i>E</i>	1.0 ± 0.2	1.6 ± 0.4	33 ± 5.0	4.2 ± 1.8
M15	C4/D4	0.6 ± 0.4	1.4 ± 0.8	480 ± 40	<i>d</i>
M16	C4.5/D4.5, <i>E</i>	0.6 ± 0.2	1.0 ± 0.3	1100 ± 100	<i>d</i>
M17	A5/B5, <i>W</i>	1.7 ± 0.30	2.4 ± 0.48	31 ± 5.0	6.0 ± 1.8
M18	B4/B5, platform	1.0 ± 0.2	2.4 ± 0.3	13 ± 0.7	2.2 ± 0.58
M19	B5, 6ft <i>N</i>	0.5 ± 0.1	1.1 ± 0.2	6.2 ± 1.0	<1.2
M20	C5/D5, <i>W</i>	2.1 ± 0.7	1.9 ± 0.59	190 ± 18	<i>d</i>
M21	B6/C6	1.1 ± 0.6	1.2 ± 0.4	36 ± 6.7	<1.6
M22	B6/C6, <i>E</i>	1.5 ± 0.2	1.7 ± 0.4	36 ± 14	<i>d</i>
M23	Rm 14, <i>W</i> lights, 3rd row <i>N</i> of <i>S</i> wall	0.3 ± 0.1	0.6 ± 0.2	7.0 ± 1.0	2.8 ± 1.2
<i>First floor, auger holes</i>					
A1B	Room 1, <i>N</i>	0.7 ± 0.08	0.7 ± 0.2	0.7 ± 0.3	<i>d</i>
A1C	Room 1, <i>N</i>	0.7 ± 0.06	0.7 ± 0.04	1.1 ± 0.6	0.9 ± 0.5
A2B	Room 1, <i>S</i>	1.0 ± 0.02	1.0 ± 0.04	10 ± 2.0	<2.4
A2C	Room 1, <i>S</i>	0.6 ± 0.02	0.7 ± 0.03	1.0 ± 0.6	<i>d</i>
A3B	A2/B2	1.7 ± 0.07	1.3 ± 0.05	1.6 ± 0.8	<i>d</i>
A3C	A2/B2	0.9 ± 0.02	1.0 ± 0.03	1.0 ± 0.7	<i>d</i>
A4B	Room 6	0.8 ± 0.02	0.9 ± 0.04	1.3 ± 0.6	<i>d</i>
A4C	Room 6	0.7 ± 0.02	0.8 ± 0.03	1.4 ± 0.7	<i>d</i>
A4AB	Room 6	0.6 ± 0.08	0.6 ± 0.2	25 ± 8.0	<i>d</i>

Table 5 (continued)

Sample I.D. ^a	Location ^b	Radionuclide concentration (pCi/g) ^c			
		²²⁶ Ra	²³² Th	²³⁸ U	²¹⁰ Pb
<i>First floor, manhole samples</i>					
E5	Manhole 1	0.9 ± 0.2	2.3 ± 0.1	700 ± 50	<i>d</i>
E6	Manhole 2	0.5 ± 0.1	1.7 ± 0.2	700 ± 50	<i>d</i>
<i>Second floor, drain samples</i>					
M25	FD2	1.4 ± 0.4	1.1 ± 0.7	110 ± 19	<i>d</i>
M26	FD3	0.6 ± 0.2	<0.8	138 ± 10	2.7 ± 1.8
M27	FD4	0.7 ± 0.4	1.9 ± 0.67	250 ± 35	<i>d</i>
M28	FD5	<0.8	<1.0	250 ± 20	<i>d</i>
M29	FD6	1.1 ± 0.4	<2.0	110 ± 13	<i>d</i>
M30	FD7	1.1 ± 0.3	1.7 ± 0.5	50 ± 15	<i>d</i>

^aM = dust/debris sample; A#B = auger hole sample collected at a depth of 0–15 cm; A#C = auger hole sample collected at a depth of 15–30 cm; A#AB = concrete sample; E# = water sediment sample.

^bLocations of samples are shown on Fig. 19. Rm = room; A#/B# = column/beam I.D.; N = north; S = south; W = west; E = east; C = center; FD = floor drain.

^cIndicated counting error is at the 95% confidence level ($\pm 2\sigma$).

^dAnalysis not performed.

Table 6. Derived surface contamination levels for selected dust samples collected from beams and overhead structures in the Ruffert building

Sample I.D.	Location ^a	Weight (g)	Area (in ²)	²³⁸ U (pCi/g) ^b	Beta-gamma activity levels (dpm/100 cm ²)
<i>Rooms 1, 5, and 14</i>					
M1	Rm 1, N beam	3	100	500	520
M2	A1/B1, E	2.7	116	210	170
M3	B1/C1, E	5.9	90	100	230
M4	A2/B2, E	4.5	90	130	220
M5	A2/B2, W	3.2	113	150	140
M6	B2/C2, C	7.6	105	73	180
M9	A3/B3, W	1.2	90	110	50
M10	B3/C3, W	3.6	99	70	89
M13	A4/B4, E	2.8	56	55	95
M14	B4/C4, E	3.8	68	33	64
M17	A5/B5, W	4.6	79	31	62
M18	B4/B5, platform	18	143	13	57
M19	B5, 6 ft N	32	40	6.2	170
M21	B6/C6	3.6	86	36	52
M22	B6/C6, E	4.9	144	36	42
M23	Rm 14, W lights	7.2	76	7	23
<i>Dynapack room (Room 6)</i>					
M7	C2/D2, C	11	192	190	377
M8	C2.5/D2.5, C	10	192	190	380
M11	C3/D3, C	18	272	220	500
M12	C3.5/D3.5, C	5	292	460	270
M15	C4/D4	6.3	192	480	540
M16	C4.5/D4.5, E	16	156	1100	3900

^aLocations are shown on Fig. 19. Rm = room; A#/B# = column/beam I.D.; N = north; S = south; W = west; E = east; C = center.

^bUranium concentrations from Table 5.

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