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Results of the Preliminary Radiological Survey at B&T Metals, 425 West Town Street, Columbus, Ohio (CO001)

W. D. Cottrell
J. L. Quillen
J. W. Crutcher

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RESULTS OF THE PRELIMINARY RADIOLOGICAL SURVEY AT B&T METALS, 425 WEST TOWN STREET, COLUMBUS, OHIO (CO001)

W. D. Cottrell, J. L. Quillen,[1] and J. W. Crutcher

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Investigation Team

R. E. Swaja – Measurement Applications and Development Manager
W. D. Cottrell – FUSRAP Project Director
J. L. Quillen – Field Survey Supervisor

Survey Team Members

T. Christy
D. C. Landguth
W. H. Shinpaugh[2]
A. Wallo III[3]

[1]Former Martin Marietta Energy Systems, Inc., employee
[2]Don Stone and Associates, Inc.
[3]U.S. Department of Energy

Work performed by the
MEASUREMENT APPLICATIONS AND DEVELOPMENT GROUP

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6285
operated by
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CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

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ABSTRACT

As part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), the U.S. Department of Energy (DOE) is implementing a radiological survey program to determine the radiological conditions at sites that were formerly used by the department's predecessor agencies. The preliminary radiological survey discussed in this report for the B&T Metals site in Columbus, Ohio, is part of the FUSRAP effort and was conducted at the request of DOE by members of the Measurement Applications and Development Group of Oak Ridge National Laboratory in 1988 and 1989.

In the 1940s the B&T Metals site was used to provide extrusion of uranium billets into rods in support of the Manhattan Engineer District (MED) operations. The preliminary radiological survey included a surface gamma scan, collection of dust, debris, and soil samples, measurement of direct and transferable alpha and beta-gamma activity, and air sampling. Results of this radiological assessment indicate that the property contains residual radioactivity from MED activities in concentrations that exceed remedial action guidelines.

RESULTS OF THE PRELIMINARY RADIOLOGICAL SURVEY AT B&T METALS, 425 WEST TOWN STREET, COLUMBUS, OHIO (CO001)*

INTRODUCTION

In 1942, under jurisdiction of the U.S. Army Corps of Engineers, the Manhattan Engineer District (MED) was established as the lead agency in the development of nuclear energy for military objectives. Although much of the government-sponsored research was centered at the national laboratories, commercial facilities were used for storage and processing of uranium and thorium ores and for fabricating and machining metal made from these ores. As a result of these activities, equipment, buildings, and land became contaminated with naturally occurring radioactive nuclides. These sites were later decontaminated in accordance with contemporary standards. However, subsequent radiological criteria, guidelines, and proposed guidelines have become more stringent for the release of such sites for unrestricted use, and records documenting decontamination are sometimes not adequate for determining final radiological conditions. Thus, the Formerly Utilized Sites Remedial Action Program (FUSRAP) was initiated to identify these sites and to reevaluate their radiological status.[1] The preliminary radiological survey discussed in this report for the B&T Metals site in Columbus, Ohio, is part of the FUSRAP effort and was conducted, at the request of DOE, by members of the Measurement Applications and Development Group of Oak Ridge National Laboratory (ORNL).

In the mid-1940s B&T Metals became one of the first commercial firms to provide extrusion of uranium billets into rods in support of the MED operations. The extrusion and machining activities were relatively small scale and occurred over a period of approximately ten months.

B&T Metals is located at 425 West Town Street on the southwest side of Columbus, Ohio. The buildings and property cover most of a city block (Fig. 1). The site consists of three buildings: (1) the main office, (2) a storage building, and (3) an extrusion building, which did not exist at the time of the MED-sponsored activities (Fig. 2). The work performed for MED occurred in the northwest corner of the main office building, the largest of these three structures. Reportedly, shavings from these activities may have been dumped outside in what is now a parking area, west of the main office building (Fig. 3).[2] Machinery used for processing uranium has been sold or removed, with no records indicating final disposition. A review of the records indicated that part of the extrusion and machining process involved "blowing out" the heating cylinders on the extrusion press. This resulted in large quantities of uranium-bearing material being blown

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

into the room. Measurements taken in March and April of 1943 confirmed excessive amounts of airborne metals found near the rolling table, extrusion trough, and furnace. Appropriate recommendations were made to B&T Metals that this practice be discontinued.[3]

An initial screening survey of the commercial property, B&T Metals, 425 West Town Street, Columbus, Ohio, was conducted by members of ORNL's Measurement Applications and Development Group on August 22, 1988. A subsequent visit was made to the site on April 25, 1989, to collect air samples in the main office building.

SURVEY METHODS

The preliminary radiological survey included (1) a gamma scan at the surface of the main office building and at the surface of most of the property outdoors; (2) collection of dust and debris samples from the floor and from overhead beams in the main office building; (3) collection of surface soil samples; (4) measurement of direct and transferable alpha and beta-gamma activity levels inside and on the roof of the main office building; and (5) air sampling of the main office building.

Using a portable gamma scintillation meter, ranges of measurements were recorded inside the main office building and for areas of the property surface outdoors. Alpha and beta-gamma activity measurements were taken at selected surface locations in the main office building, on the structural support beams, and on the roof. Smears of 100-cm^2 areas were also obtained to establish transferable alpha and beta-gamma activity levels.

Samples of dust were collected fro- the beams in the area where MED operations were reported to have taken place. Biased soil samples were taken at locations with elevated gamma readings.

For convenience in defining areas to be surveyed, the main office building was divided into 6.1-m (20-ft) blocks, with the northwest corner of the building used as the origin (0,0) (Fig. 4). The survey methods followed the plan outlined in Reference 4. A comprehensive description of the survey methods and instrumentation has been presented in another report.[5]

SURVEY RESULTS

Applicable DOE residential guidelines for protection against radiation are summarized in Table 1.[6] Normal background radiation levels for the Columbus, Ohio, area are presented in Table 2.[7] These data are provided for comparison with survey results presented in this section. With the exception of measurements of transferable radioactivity, which are reported as net disintegrations rates, all direct measurement results presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations in soil samples.

Indoor Survey Results

Gamma Radiation Levels

Surface gamma exposure levels measured on the floor of the main office building generally ranged from 6 to 12 μR/h, with the higher levels occurring near brick walls. By comparison, the Columbus, Ohio, area background ranges from 7 to 9 μR/h (Table 2). Because the raw materials used to make bricks frequently contain small amounts of naturally occurring radioactive substances, the finished product may exhibit slightly higher-than-background gamma levels.

Three areas in the northwest corner of the main office building (the site of the former MED activities) had gamma radiation measurements higher than 12 μR/h (Fig. 4). A crack in the concrete floor showed a gamma level of 14 μR/h. A depression in the floor, filled with a tarlike substance, measured 16 μR/h gamma, and a sump approximately 0.3 × 0.9 m (1 × 3 ft) had gamma levels of 10-50 μR/h. A sample of material from this sump was collected and analyzed for radionuclide content (Table 3, sample B2).

Roof drains from the main office building are routed from the roof to the inside of the building, where the drains apparently enter the storm-drain system beneath the floor. A cleanout plug was removed from one of these vertical drains, and gamma radiation levels of 30 μR/h were measured 0.6 to 0.9 m (2 to 3 ft) below the floor surface. These measurements indicate a significant possibility that residual radioactive materials are in the drain system, probably resulting from materials being washed from the roof and/or the floor of the building.

Alpha and Beta-Gamma Measurements

Direct alpha and beta-gamma measurements were taken at 10 locations inside the main office building (three on the floor and seven on overhead beams). These measurements and the locations are given in Table 4. Direct alpha measurements were below DOE guidelines. Direct beta-gamma measurements at the three floor locations were 0.66 mrad/h for the crack, 0.81 mrad/h for the depression, and 3.9 mrad/h for the sump (Fig. 4). These values exceed the surface dose rate guideline of 0.2 mrad/h averaged over not more than 1 m^2 (Table 1). Three of the seven overhead beam locations (Figs. 4 and 5) exceeded the 1.0 mrad/h maximum dose rate for a 100-cm^2 area. Values and locations (Fig. 4) are 1.1 mrad/h (10S, 10E), 1.5 mrad/h (20S, 10E), and 2.5 mrad/h (22S, 40E). At location 50S, 40E a measurement was taken over the dust layer on the support beam; then the dust layer was removed and another measurement was taken. With the dust intact, the measurements were 530 dpm alpha and 0.61 mrad/h beta-gamma. Following removal of the dust, the measurements dropped to 470 dpm alpha and 0.069 mrad/h beta-gamma, indicating residual radioactivity in the dust. Samples of this dust were collected for radionuclide analyses.

Thirty-three measurements of direct and transferable radioactivity levels were taken on the roof of the main office building. On the inclined portion of the sawtooth roof (Fig. 6), 29 measurements were taken, and 4 measurements were taken on the level roof of the first-floor annex. Measurements are shown in Table 5. Locations are shown in Fig. 7 (referenced to Fig. 4). All direct alpha measurements are well below DOE guidelines for fixed uranium concentration (Table 1). One direct beta-gamma measurement (location 20S, 2E) was 0.20 mrad/h. Other direct beta-gamma measurements were well below the guideline for surface dose rate averaged over an area ≤ 1 m^2.

Smear samples were obtained from the roof locations at which direct measurements were taken. Analyses of the smears showed all measurements of transferable alpha and beta-gamma radiation well below DOE guidelines for removable uranium (Table 1).

Dust and Debris Samples

Inside the main office building, samples were collected from locations showing elevated gamma measurements, and these samples were analyzed for radionuclide concentrations. Two dust samples from overhead beams, one tar sample from the floor, and one debris sample from a sump in the floor were analyzed. Results of these analyses are given in Table 3, and locations are shown on Fig. 4. Concentrations of ^{226}Ra and ^{232}Th were within typical background soil concentration ranges for the Columbus, Ohio, area (Table 2). Concentration of ^{238}U ranged from 700 to 1700 pCi/g. These values are above typical site-specific uranium guidelines for soil, derived for similar DOE FUSRAP sites (35-150 pCi/g). Concentration limits for uranium at FUSRAP remedial action sites are derived in accordance with DOE guidelines. The process ensures that doses to individuals using the sites are well below the 100 mrem/yr dose limit.

Air Samples

Sixteen air samples were taken from the main office building and analyzed for gross alpha radiation. All samples were below the minimum detectable amount of 1.5×10^{-13} μCi/cm^3 (0.5% of the maximum permissible concentration in air for ^{238}U).[8]

Outdoor Survey Results

Gamma Radiation Levels

Gamma exposure rates measured during a scan of the surface of the property outdoors are shown in Fig. 8. Over the major portion of the property, gamma radiation levels ranged from 7 to 12 μR/h, with measurements of 14 μR/h noted at the brick road behind the main office building, in the grassy area at the front of the building, and in the area west of the building, near the storage building. In the area west of the main office building, where shavings from the MED activities reportedly were dumped, surface gamma exposure rates were 40 and 50 μR/h at sample locations B10 and B9, respectively (Fig. 8).

Soil Samples

Biased soil samples were taken from three locations with elevated gamma readings and were analyzed for radionuclide concentrations. Locations of the biased (B) samples are shown on Fig. 8. Results of laboratory analyses for ^{226}Ra, ^{232}Th, and ^{238}U are shown in Table 6. Concentrations of ^{226}Ra and ^{232}Th ranged from 1.4 to 2.1 pCi/g and 0.63 to 1.3 pCi/g, respectively. These values are at or near background soil concentrations for the Columbus, Ohio, area (Table 2) and are well within the DOE guidelines shown in Table 1. Concentration of ^{238}U ranged from 3.5 to 110 pCi/g, with the higher concentrations (67 to 110 pCi/g) found in the two samples (B9 and B10) taken from the area where contaminated shavings were reportedly dumped. These values are higher than typical site-specific uranium guidelines for soil, derived for similar DOE FUSRAP sites.

SIGNIFICANCE OF FINDINGS

Radiological assessment of soil and dust samples from B&T Metals, Columbus, Ohio, demonstrated low concentrations of ^{226}Ra and ^{232}Th. Concentrations of ^{238}U ranged from 3.5 to 1700 pCi/g in the eight soil and dust samples analyzed. Areas containing residual radioactive material include:

1. three floor locations in the main office building (Fig. 4, locations 3S, 10E; 20S, 20E; and 40S, 40E) (see also Table 4);
2. the drain system beneath the floor of the main office building;
3. the support beams in the main office building (Table 4), where the source of the residual radioactive material appears to be dust from the former uranium extrusion process; and
4. one area outdoors (east of the storage building) where shavings from the former MED operations were reportedly dumped (Fig. 8, locations B9 and B10).

Direct beta-gamma measurements taken inside the main office building were in excess of the surface dose rate for the three floor locations given in Table 4, and in excess of the maximum dose rate in any 100-cm^2 area for three of the overhead beam locations. Results of this radiological assessment indicate that the property contains residual radioactivity from MED activities in concentrations that exceed remedial action guidelines. However, these conservative guidelines are based on possible exposure through inhalation, ingestion, or direct contact, and are typically derived to ensure that unrestricted use (including residential use) will not result in above-guideline doses to the general public. The residual radioactivity at the B&T Metals site is very localized and limited in extent, and an examination of present-use conditions for this site suggests that no significant radiation exposures would accrue to individuals who access the areas.

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6. *Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites,* Rev. 2, U.S. Department of Energy, March 1987.

7. T. E. Myrick, B. A. Berven, and F. F. Haywood, *State Background Radiation Levels: Results of Measurements Taken During 1975–1979,* ORNL/TM-7343, Oak Ridge National Laboratory, Oak Ridge, Tenn., November 1981.

8. U.S. Department of Commerce, National Bureau of Standards, *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure,* Handbook 69, 1963.

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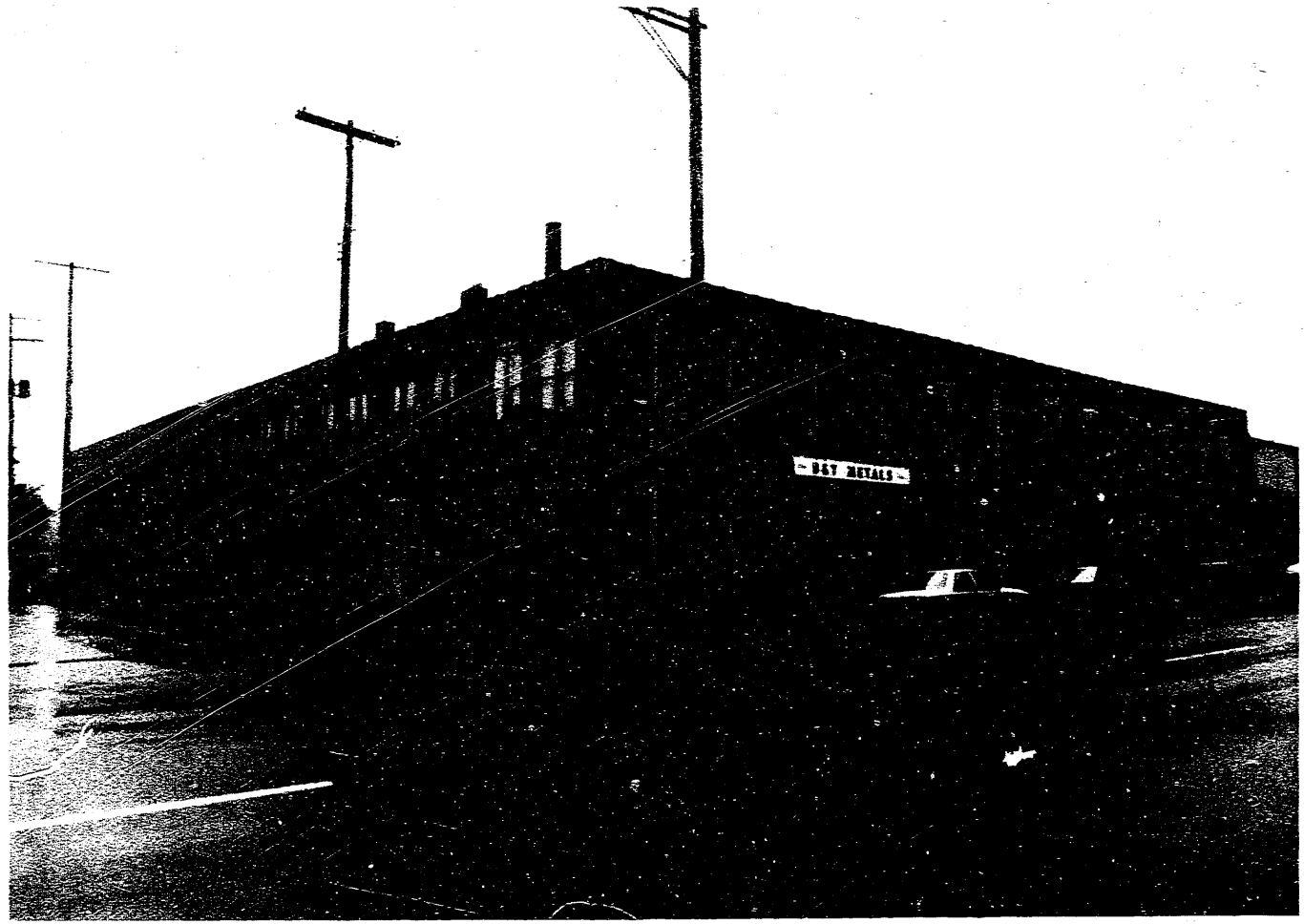

Fig. 1. B&T Metals, 425 West Town Street, Columbus, Ohio (CO001).

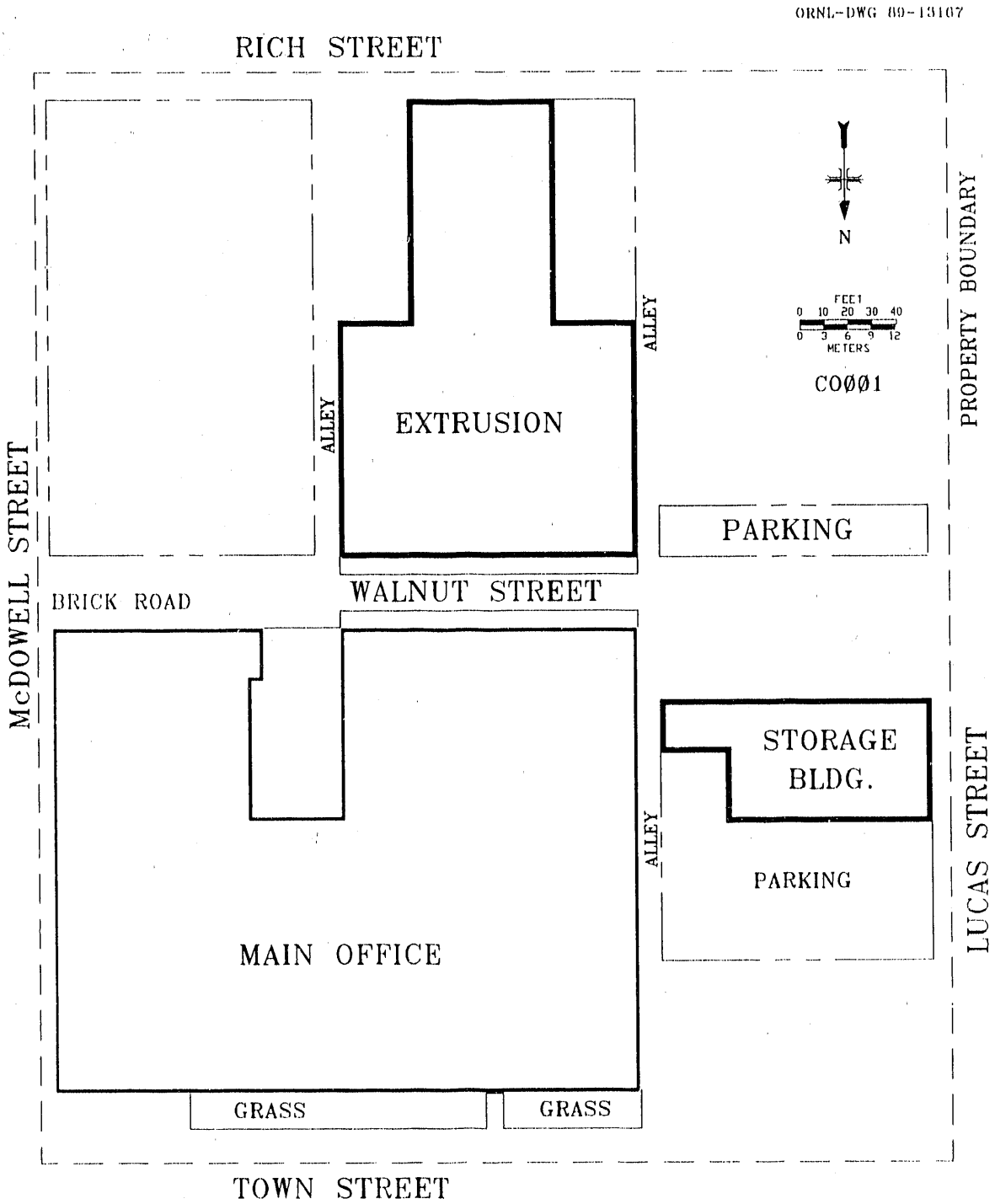

Fig. 2. Diagram showing building locations at B&T Metals, 425 West Town Street, Columbus, Ohio (CO001).

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Fig. 3. Electrical station at the storage building west of the main office building. Shavings from the former MED activities were reportedly dumped at the area along the fence.

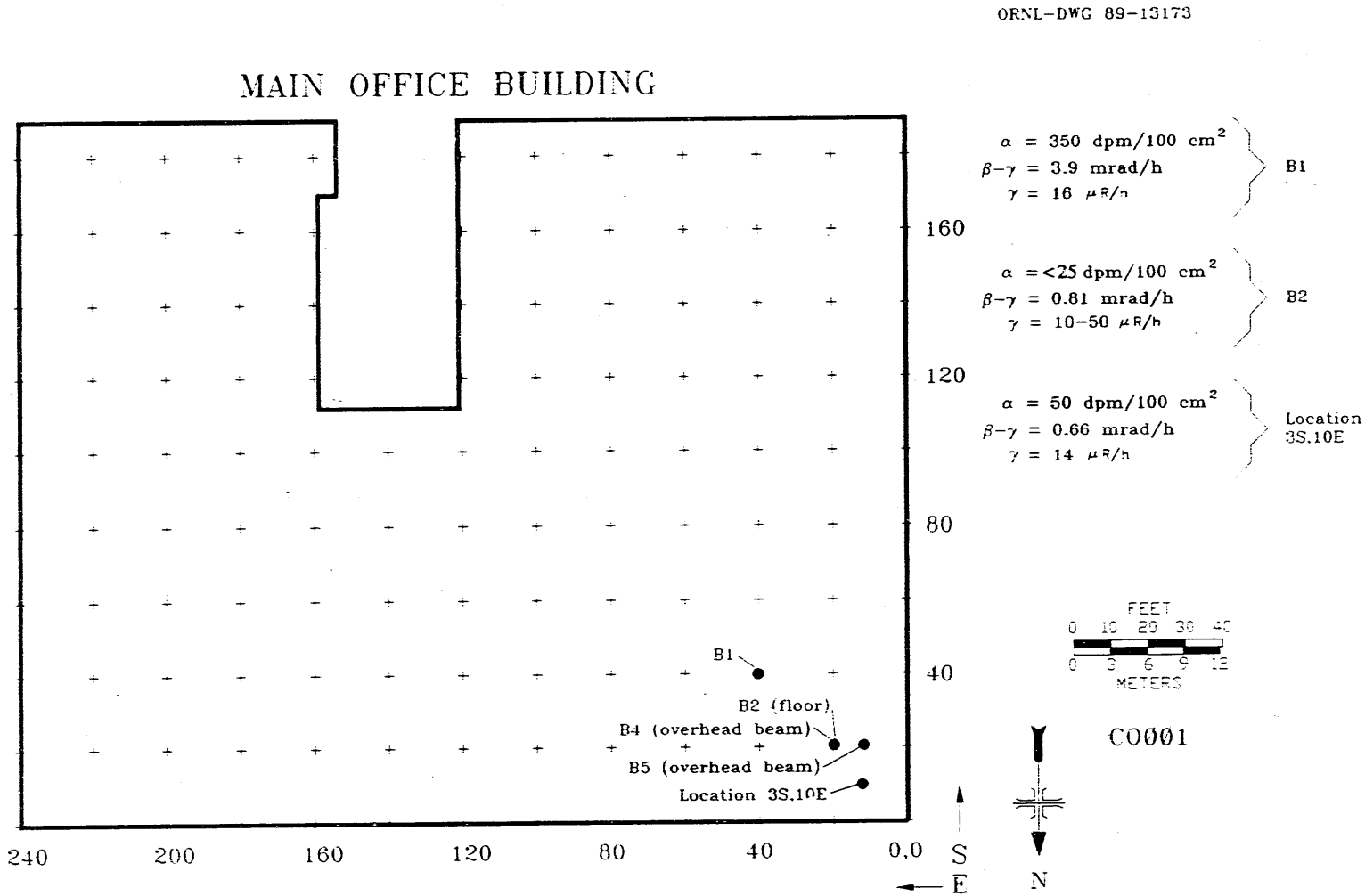

Fig. 4. Grid system, sampling locations, and results of direct radiation measurements at the floor surface inside the main office building at B&T Metals, 425 West Town Street, Columbus, Ohio (CO001).

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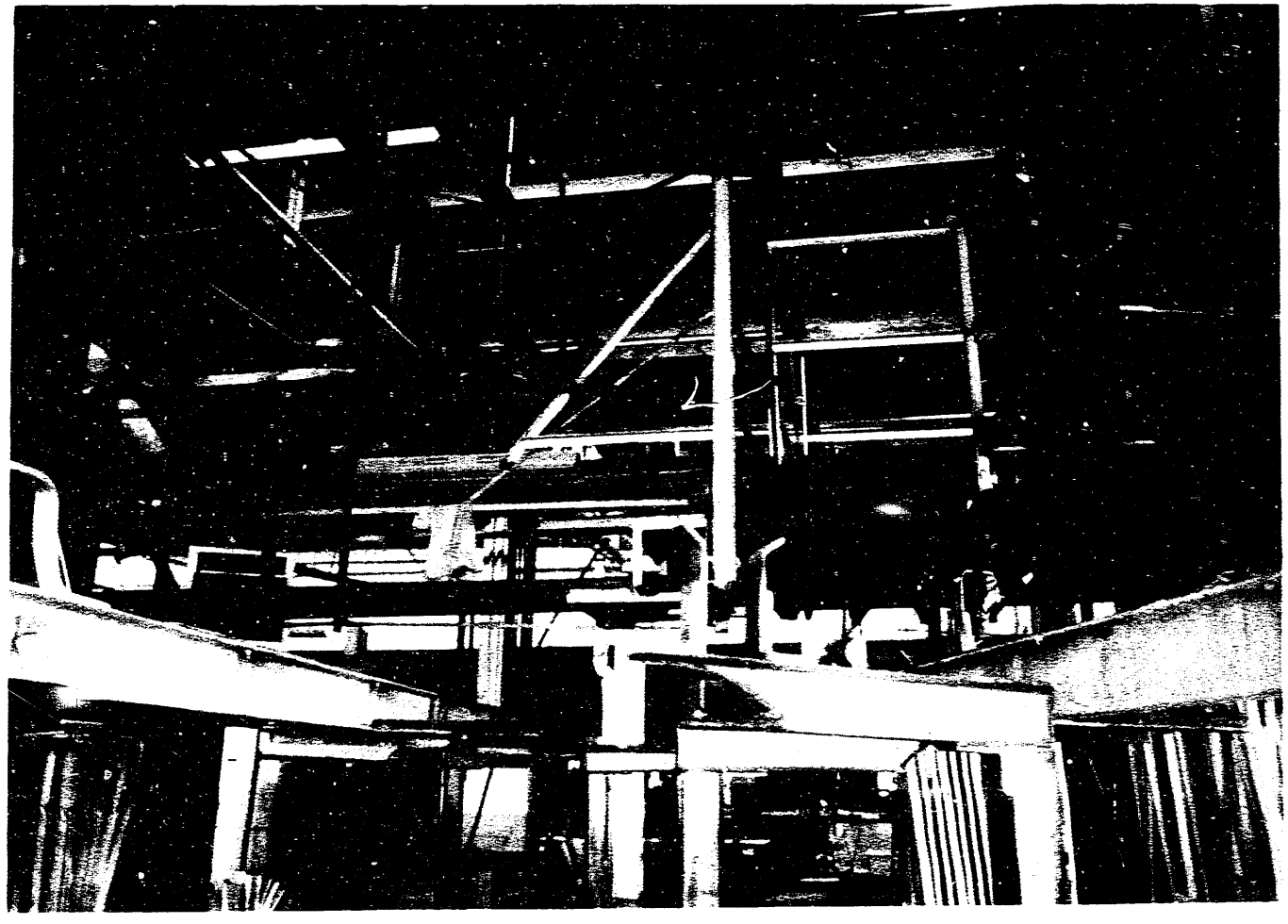

Fig. 5. Support beams inside the main office building, B&T Metals, Columbus, Ohio (CO001).

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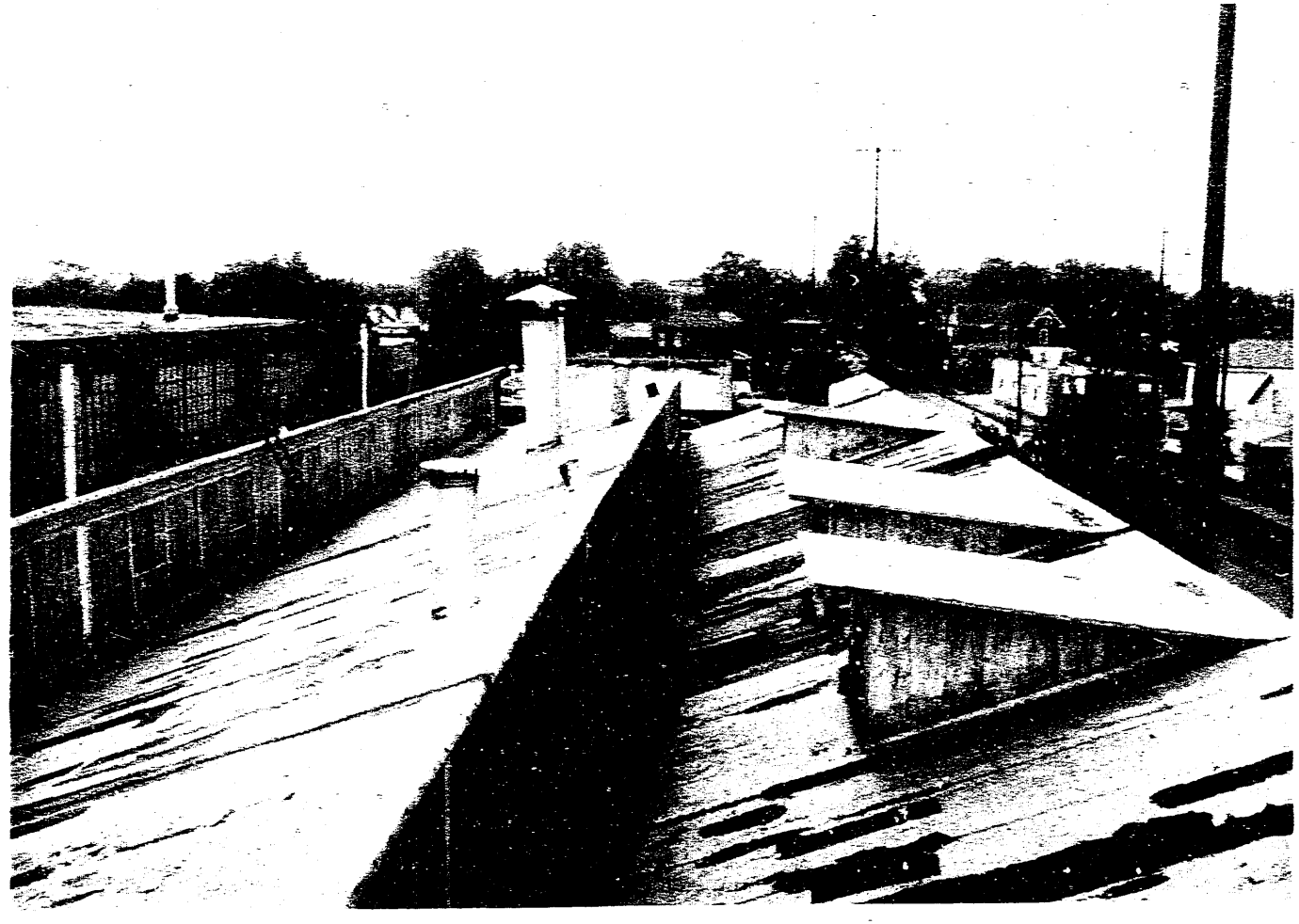

Fig. 6. Sawtooth roof over the area where the MED processing took place, looking west, B&T Metals, Columbus Ohio (CO001).

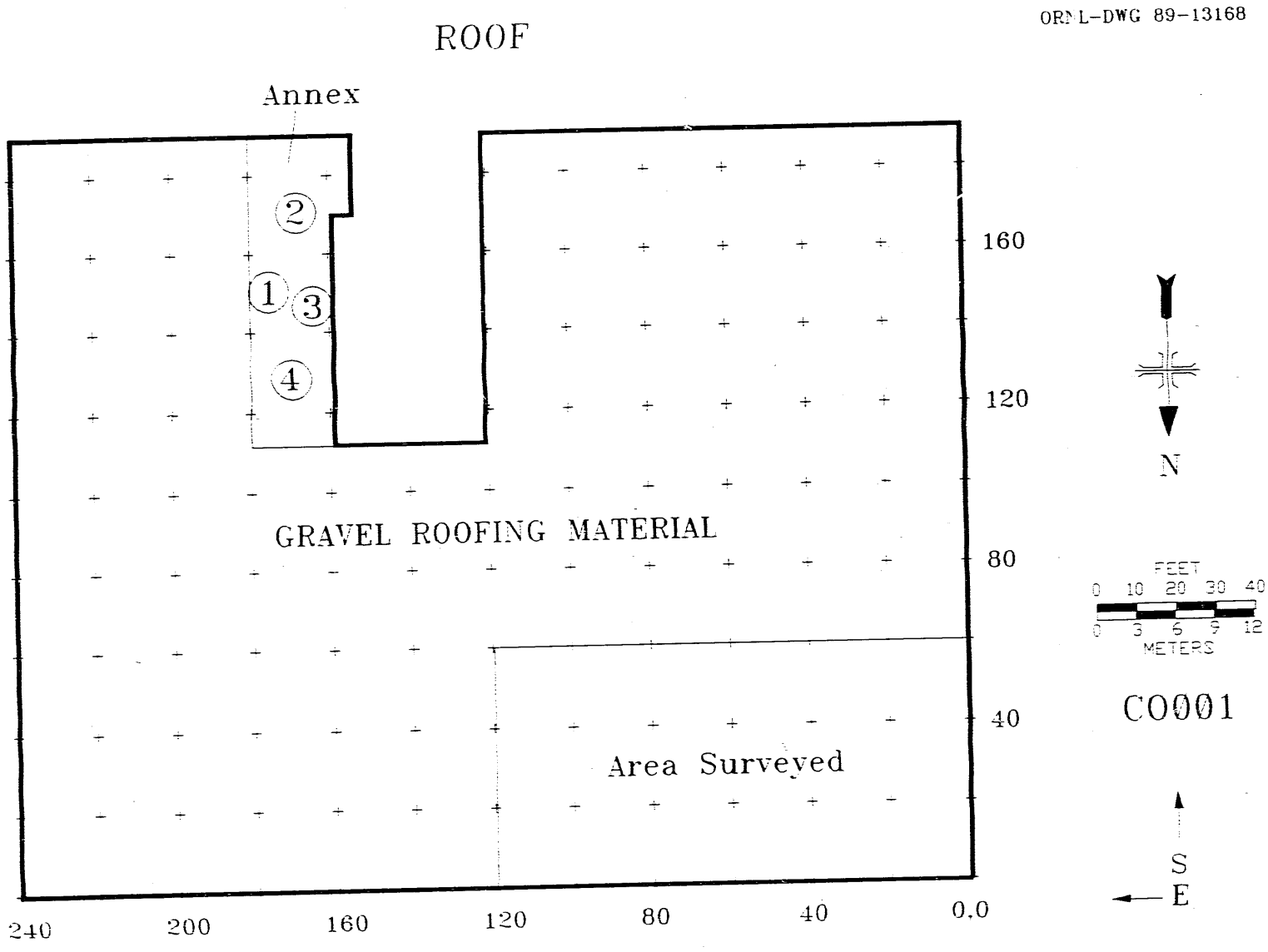

Fig. 7. Grid system, showing location of roof measurements taken at the main office building, B&T Metals, Columbus, Ohio (CO001).

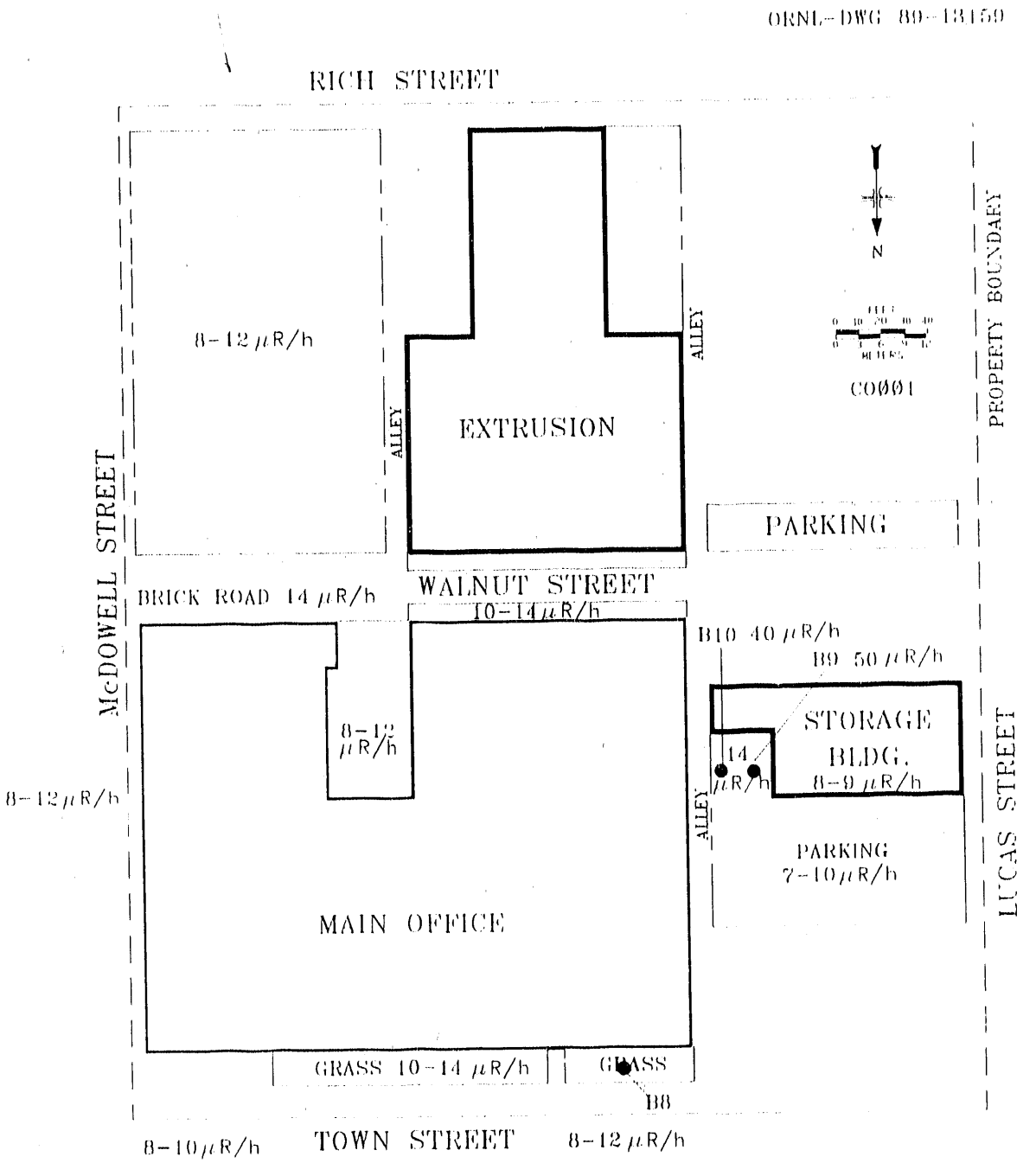

Fig. 8. Gamma radiation levels (μR/h) at the surface and soil sample locations at B&T Metals, 425 West Town Street, Columbus, Ohio (CO001).

Table 1. Applicable guidelines for protection against radiation

Mode of exposure	Exposure conditions	Guideline value
Gamma radiation	Indoor gamma radiation levels (above background)	20 μR/h
Surface contamination[a]	^{238}U and U-natural	
	Fixed on surfaces	5000 dpm/100 cm^2
	Removable	1000 dpm/100 cm^2
	^{232}Th and Th-natural	
	Fixed on surfaces	1000 dpm/100 cm^2
	Removable	200 dpm/100 m^2
	^{226}Ra	
	Fixed on surfaces	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	0.2 mrad/h
	Maximum dose rate in any 100 cm^2 area	1.0 mrad/h
Radionuclide concentrations in soil	Maximum permissible concentration of the following radionuclides in soil above background levels, averaged over a 100 m^2 area	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
	^{226}Ra	
	^{228}Ra	
	^{230}Th	
	^{232}Th	
	^{238}U	Derived (site specific)

[a]As used in this table, disintegrations per minute (dpm) 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.

Source: Adapted from *Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites,* Rev. 2, U.S. Department of Energy, March 1987.

Table 2. Background radiation levels for the Columbus, Ohio, area

Type of radiation measurement or sample	Radiation level or radionuclide concentration[a]	
	Average	Range
Gamma exposure rate at 1 m (μR/h)	8	7–9
Concentration of radionuclides in soil (pCi/g)		
^{226}Ra	2.0	1.5–2.5
^{232}Th	0.72	0.71–0.74
^{238}U	1.8	1.3–2.2

Source: T. E. Myrick, B. A. Berven, and F. F. Haywood, *State Background Radiation Levels: Results of Measurments Taken During 1975–1979,* Oak Ridge National Laboratory, ORNL/TM-7343 (November 1981).

[a]Data from two locations in the Columbus, Ohio, area.

Table 3. Concentrations of radionuclides in dust and debris samples taken from the main office building, B&T Metals, 425 West Town Street, Columbus, Ohio (CO001)

Sample ID	Location[a]	Radionuclide concentration (pCi/g)[b]		
		^{226}Ra	^{232}Th	^{238}U
	Biased samples[c]			
B1[d]	40S, 40E, Floor	0.91 ± 0.25	<0.59	700 ± 20
B2[e]	20S, 20E, Floor	0.7[illegible] ± 0.03	0.13 ± 0.03	1000 ± 2
B4	20S, 20E, Overhead beam	<1.1	<1.6	1700 ± 50
B5	20S, 10E, Overhead beam	<0.96	<1.2	1200 ± 20

[a]Locations are shown on Fig. 4.

[b]Indicated counting error is at the 95% confidence level (± 2σ).

[c]These biased samples were taken from areas with elevated alpha and beta-gamma measurements.

[d]A tar sample taken from a depression in the floor of the main office building.

[e]Debris from a floor sump in the main office building.

Table 4. Direct alpha and beta-gamma measurements taken inside the main office building, B&T Metals, 425 West Town Street, Columbus, Ohio (CO001)

Location[a]	Direct measurements: Alpha (dpm/100 cm²)	Direct measurements: Beta gamma (mrad/h)	Description of location
		Floor	
3S, 10E	50	0.66	Floor, crack in concrete slab, ~ 3.8 cm x 1.1 m (~ 1.5 in. x 3.5 ft)
20S, 20E	<25[b]	0.81	Hole in floor, ~ 0.3 x 0.9 m (~ 1 x 3 ft), at drain pipe
40S, 40E	350	3.9	Floor
		Overhead beams	
10S, 10E	[c]	1.1	Wooden beam
20S, 10E	[c]	1.5	Beam near electric transformer
20S, 120E	40	0.16	Beam over platform at east end of anodizing area
22S, 40E	50	2.5	Beam extending over floor area 40S, 40E
50S, 40E	530	0.61	Beam extending over floor area 40S, 40E; measurement taken over dust layer
50S, 40E	470	0.069	Beam extending over floor area 40S, 40E; measurement taken after dust layer was removed
50S, 80E	50	0.29	Beam, ~ 3.7 m (~ 12 ft) high

[a]Locations are shown on Fig. 4.
[b]Minimum detectable activity level = 25 dpm/100 cm².
[c]Not taken.

Table 5. Systematic roof measurements taken at B&T Metals, 425 West Town Street, Columbus, Ohio (CO001)

Location[a]	Direct measurements		Transferable radioactivity[c]	
	Alpha[b] (dpm/100 cm^2)	Beta gamma (mrad/h)	Alpha[d] (dpm/100 cm^2)	Beta gamma[e] (dpm/100 cm^2)
10S, 2E	260	0.041	<10	<200
10S, 20E	120	0.054	<10	<200
10S, 40E	300	0.044	<10	<200
10S, 60E	140	0.047	<10	<200
10S, 80E	180	0.041	<10	<200
10S, 100E	80	0.032	<10	<200
10S, 120E	60	0.041	<10	<200
20S, 2E	220	0.20	*f*	<200
20S, 60E	60	0.070	<10	<200
20S, 120E	60	0.047	<10	<200
30S, 3E	160	0.026	<10	<200
30S, 20E	260	0.036	<10	<200
30S, 40E	160	0.033	<10	<200
30S, 60E	180	0.028	<10	<200
30S, 80E	240	0.032	<10	<200
30S, 100E	160	0.035	<10	<200
30S, 120E	140	0.061	<10	<200
40S, 2E	80	0.047	<10	*f*
40S, 60E	100	0.041	<10	<200
50S, 3E	100	0.051	<10	<200
50S, 20E	180	0.037	<10	<200
50S, 40E	180	0.051	<10	<200
50S, 60E	160	0.039	<10	<200
50S, 80E	180	0.032	<10	<200
50S, 100E	160	0.052	17	<200
50S, 120E	100	0.059	<10	<200
60S, 3E	40	0.061	<10	<200

Table 5 (continued)

Location[a]	Direct measurements		Transferable radioactivity[c]	
	Alpha[b] (dpm/100 cm^2)	Beta gamma (mrad/h)	Alpha[d] (dpm/100 cm^2)	Beta gamma[e] (dpm/100 cm^2)
60S, 60E	60	0.070	<10	<200
60S, 120E	<25	0.038	<10	<200
1	160	0.047	<10	<200
2	100	0.052	<10	<200
3	140	0.053	<10	<200
4	100	0.044	<10	<200

[a]Locations are shown on Fig. 7.

[b]Minimum detectable activity (MDA) level = 25 dpm/100 cm^2.

[c]Measurements of transferable radioactivity are net disintegration rates. Background radiation levels have been subtracted.

[d]MDA = 10 dpm/100 cm^2.

[e]MDA = 200 dpm/100 cm^2.

[f]Not taken.

Table 6. Concentrations of radionuclides in soil samples from B&T Metals, 425 West Town Street, Columbus, Ohio (CO001)

Sample ID[a]	Depth (cm)	Radionuclide concentration (pCi/g)[b]		
		^{226}Ra	^{232}Th	^{238}U
		Biased samples[c]		
B8	0–7.6	2.1 ± 0.02	1.3 ± 0.02	3.5 ± 0.5
B9A	0–7.6	1.4 ± 0.04	0.63 ± 0.06	110 ± 2
B9B	7.6–13	1.8 ± 0.01	1.0 ± 0.02	110 ± 0.8
B10A	0–7.6	1.4 ± 0.03	0.71 ± 0.04	89 ± 2
B10B	7.6–15	2.0 ± 0.03	1.1 ± 0.06	67 ± 3

[a]Locations are shown on Fig. 8.
[b]Indicated counting error is at the 95% confidence level (± 2σ).
[c]Biased samples are taken from areas shown to have elevated gamma exposure rates.

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Internal Correspondence

MARTIN MARIETTA ENERGY SYSTEMS, INC.

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Authors: W. D. Cottrell, J. L. Quillen, and J. W. Crutcher

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J. L. Langford
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