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PRELIMINARY SITE SURVEY REPORT OF THE COPPERWELD STEEL COMPANY, 4000 MAHONING AVENUE, NW, WARREN, OHIO (CWO001)

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ABSTRACT

At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducted investigative radiological surveys at the Copperweld Steel Company, 4000 Mahoning Avenue, NW, Warren, Ohio (CWO001) in 1988. The purpose of the surveys was to determine whether the property was contaminated with radioactive residues, principally ^{238}U, derived from the former Manhattan Engineer District (MED) project. The surveys included gamma scans; direct and removable measurements of alpha, beta, and gamma radiation levels; and floor debris sampling for radionuclide analyses.

Results of the survey demonstrated no radionuclide concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program guidelines for radium, thorium, and uranium. The radionuclide distributions were not significantly different from normal background levels in the Ohio area.

PRELIMINARY SITE SURVEY REPORT OF THE COPPERWELD STEEL COMPANY, 4000 MAHONING AVENUE, NW, WARREN, OHIO*

INTRODUCTION

Under jurisdiction of the Army Corps of Engineers in the early 1940s, the Manhattan Engineer District (MED) was established as the lead agency in the development of nuclear energy for defense-related projects. Raw materials containing uranium ores were procured, stored, and processed into various uranium oxides, salts, and metals. Fabricators were contracted as needed to form (roll and machine) the metal into various shapes. At contract termination, sites used by contractors were decontaminated according to the criteria and health guidelines then in use. The radiological criteria for site release without radiological restrictions were generally site specific and clearly defined. In some instances, however, documentation was limited or nonexistent and conditions at these sites were unknown. Therefore, it was necessary to reevaluate the current radiological conditions at these sites under the U.S. Department of Energy (DOE) Formerly Utilized Sites Remedial Action Program (FUSRAP).

For a period of 18 to 21 months from mid–1943 to early–1945, the Copperweld Steel Company researched methods of straightening uranium metal rods and developed commercial practices for annealing and out-gassing approximately 3000 uranium rods in support of the MED operations.[1] This commercial property is located at 4000 Mahoning Avenue, NW, Warren, Ohio.

The Copperweld plant is a complex of buildings covering approximately 502 acres. The current plant design is essentially the same as the 1944 exterior plot plan shown in Fig. 1 and the more detailed 1944 map in Fig 2. The work for MED was restricted to weekends and carried out in only one area of this complex, shown in Fig. 1 as Buildings Nos. 36 and 37. This building houses the Annealing Nos. 1 and 2, Finishing No. 3, and Shipping No. 3 facilities (Fig. 3). The building is a one-story construction with steel framing and sheet metal siding on a concrete floor. The material to be processed was shipped to the plant in freight cars (Figs. 4 and 5) and brought into the building on railroad siding (Figs. 6 and 7). The uranium metal could be out-gassed at a rate of 25,000 pounds per 24 hour-weekend. The equipment used was located near the center of the building. Figs. 8, 9, and 10 show the equipment currently present. Old furnaces and straighteners which might have been contaminated from the uranium processing were removed sometime in the past.

During out-gassing, approximately 300 ft^3 of argon gas were used while the uranium rods were heated to 620°C for six hours. The out-gassed bars were then machined and sample slugs analyzed for hydrogen–metal equilibrium. This uranium metal research was relatively

*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.

small scale and covered a short period of time. Because this work was apparently related to MED activities, verification of existing conditions was needed to determine whether the site met current DOE radiological guidelines. If residual radioactivity was found in excess of these guidelines and a determination was made that DOE had authority, the site could be designated for remedial action under FUSRAP. The principal radionuclide of concern is ^{238}U.

On November 4 through 7, 1988, the preliminary radiological survey at 4000 Mahoning Avenue, NW, Warren, Ohio, was conducted by members of the Measurement Applications and Development Group of the Oak Ridge National Laboratory at the request of DOE. No outdoor survey was performed. Indoor survey of the area in question is shown in Fig. 11. Floor debris samples were taken for further analyses during that time. Smear samples were also taken from the building for assessment.

SURVEY METHODS

The radiological survey included: (1) an indoor gamma scan at floor level and one meter above the floor; (2) collection and radionuclide analyses of floor debris samples; and (3) direct and removable alpha and beta-gamma activity levels. The survey methods followed the basic plan outlined in a correspondence from W. D. Cottrell to A. J. Whitman.[2]

To provide better definition of the area to be surveyed, the site was subdivided into grid blocks based on the existing columns, as shown in Fig. 3. The columns were numbered, west to east, and lettered, south to north. The columns represent the intersection of grid lines. Using a portable Victoreen Thyac-III model 490 gamma scintillation meter, a gamma scan was performed indoors in each accessible grid block between columns AA and AE. The detectors were held approximately three inches above the floor surface, and ranges of measurements were recorded. Measurements taken one meter above the floor were also recorded. Systematic floor debris samples were taken at various locations, irrespective of gamma radiation levels. The samples were analyzed for ^{226}Ra, ^{232}Th and ^{238}U content.

Direct alpha, beta, and gamma radiation measurements were taken at floor level; gamma measurements were also taken one meter above the floor. A beer-mug type probe (ZnS) with an ORNL meter was used to measure alpha activity levels, and a GM pancake type probe with a Bicron meter was used for the beta-gamma dose rates. Smears from 100 cm^2 areas were taken at some of these locations to establish removable alpha and beta-gamma activity levels. Comprehensive descriptions of all survey methods and instrumentation have been presented in another report.[3]

SURVEY RESULTS

Applicable DOE guidelines are summarized in Table 1.[4,5] The normal background radiation levels for the Ohio area are presented in Table 2.[6,7] These data are provided for comparison with survey results presented in this section. 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 measured in floor debris. Removable radioactivity levels (smears) are reported as net disintegrations per minute (dpm) with background subtracted. Comprehensive descrip-

tions of all analyses techniques and quality assurance procedures have been presented in another report.[3]

Gamma Radiation Levels

Gamma radiation levels measured during a scan of the floor inside the building are given in Fig. 11. Measurements were generally taken near the floor surface; in some instances, coincidental measurements were taken one meter above the floor. Gamma exposure rates at one meter above the floor ranged from 2 to 8 μR/h; the normal background level outdoors at one meter is 8 μR/h (Table 2). Gamma levels on the floor surface ranged from 2 to 8 μR/h. Exposure rates measured on the firebrick ranged from 6 to 16 μR/h. Gamma levels measured at two locations on walls along the northern side were 8 and 12 μR/h. The slight elevations in gamma levels associated with the firebrick are typical of the naturally occurring radioactive substances present in bricks, concrete, granite, and other such materials used in paving and building construction. All measurements were below the DOE indoor guideline value of 20 μR/h above background.

Systematic Floor Debris Samples

Systematic floor debris samples were collected from two locations in the building for radionuclide analyses; laboratory results are provided in Table 3. Their locations are shown in Fig. 11 as S1 and S2. Concentrations of radium, thorium, and uranium in these samples ranged from 0.60 to 1.44 pCi/g, from 0.68 to 1.44 Pci/g, and from 0.66 to 1.55 Pci/g, respectively. All samples were below the DOE guideline value of 5 Pci/g for radium and thorium, as well as values typically derived for uranium at similar sites (Table 1). In addition, all samples were near or below normal background levels for the Ohio area (Table 2).

Alpha and Beta-Gamma Measurements

Measurements of alpha and beta-gamma radiation were taken on floor surface (Fig. 11). All 81 direct alpha measurements were below the minimum detectable activity (MDA) value of 25 dpm/100 cm^2 (Table 1).* Direct beta-gamma dose rates for the 81 measurements were below the MDA of 0.01 mrad/h and well below the DOE surface dose rate limit for beta-gamma radiation of 0.20 mrad/h averaged over not more than 1 m^2 (Table 1). Twenty one smear samples were obtained from the same area. Analyses of the smears showed all measurements of removable alpha and beta-gamma radiation were below the MDA's*, as well as below DOE guidelines for removable uranium (Table 1).

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* The instrument-specific MDA's 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 the respective MDA's are 0.01 mrad/h and 200 dpm/100 cm^2.

SIGNIFICANCE OF FINDINGS

Measurements and results of floor debris sample analyses taken at 4000 Mahoning Avenue, NW, indicate that the site contained no radionuclide concentrations above DOE guideline values (Table 1). The radionuclide distributions for ^{226}Ra and ^{238}U in the sample material shown in Table 3 are indicative of the equilibrium state found in naturally occurring uranium rather than the distributions common to uranium metal. These radionuclide concentrations are not significantly different from normal background levels in the Ohio area (Table 2).

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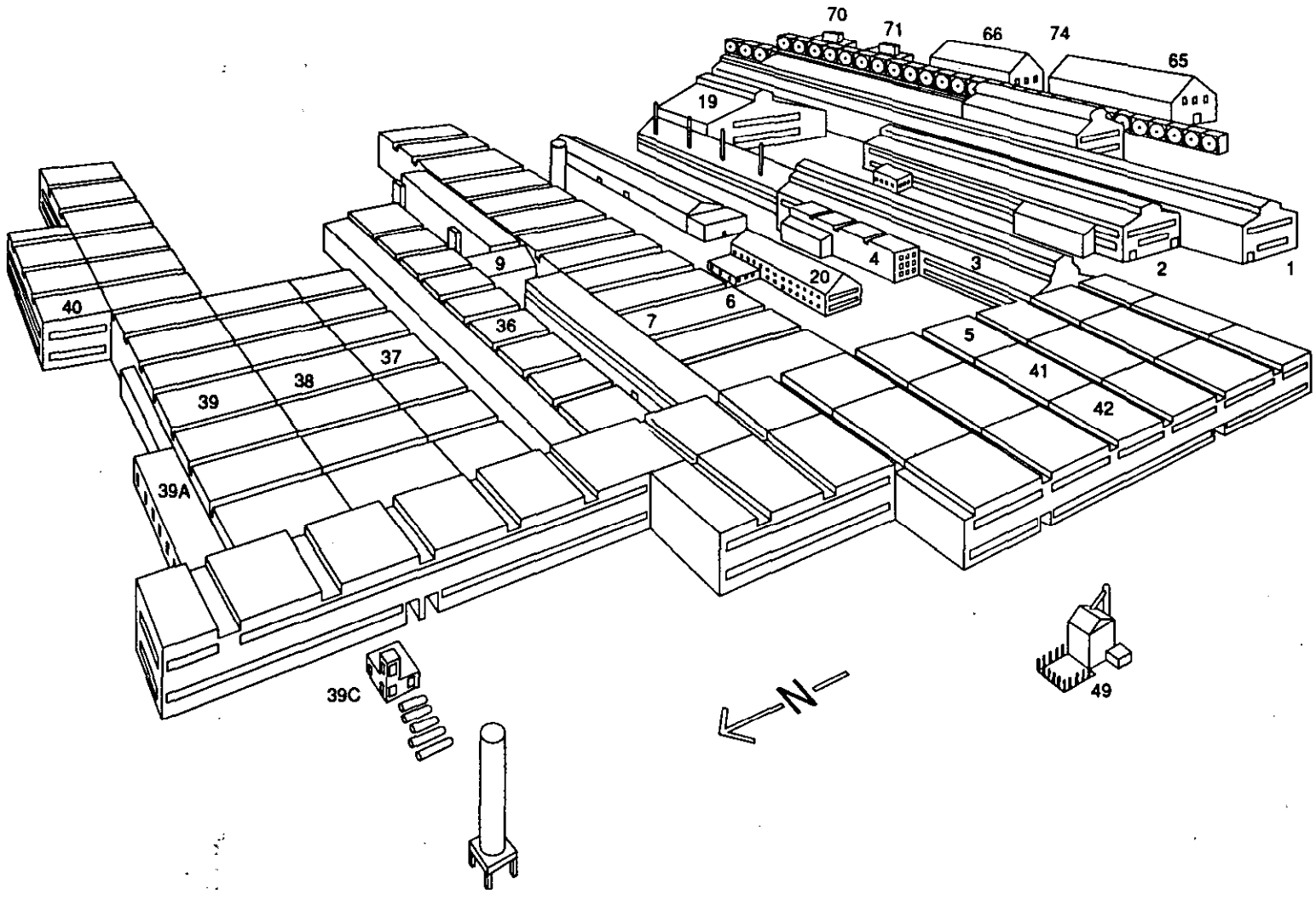

Fig. 1. Plot plan of Copperweld Steel Company in 1944, 4000 Mahoning Ave., NW, Warren, Ohio (CWO001). The current layout is essentially the same. Building Nos. 36 and 37 house the annealing facilities for the plant, area of uranium operations.

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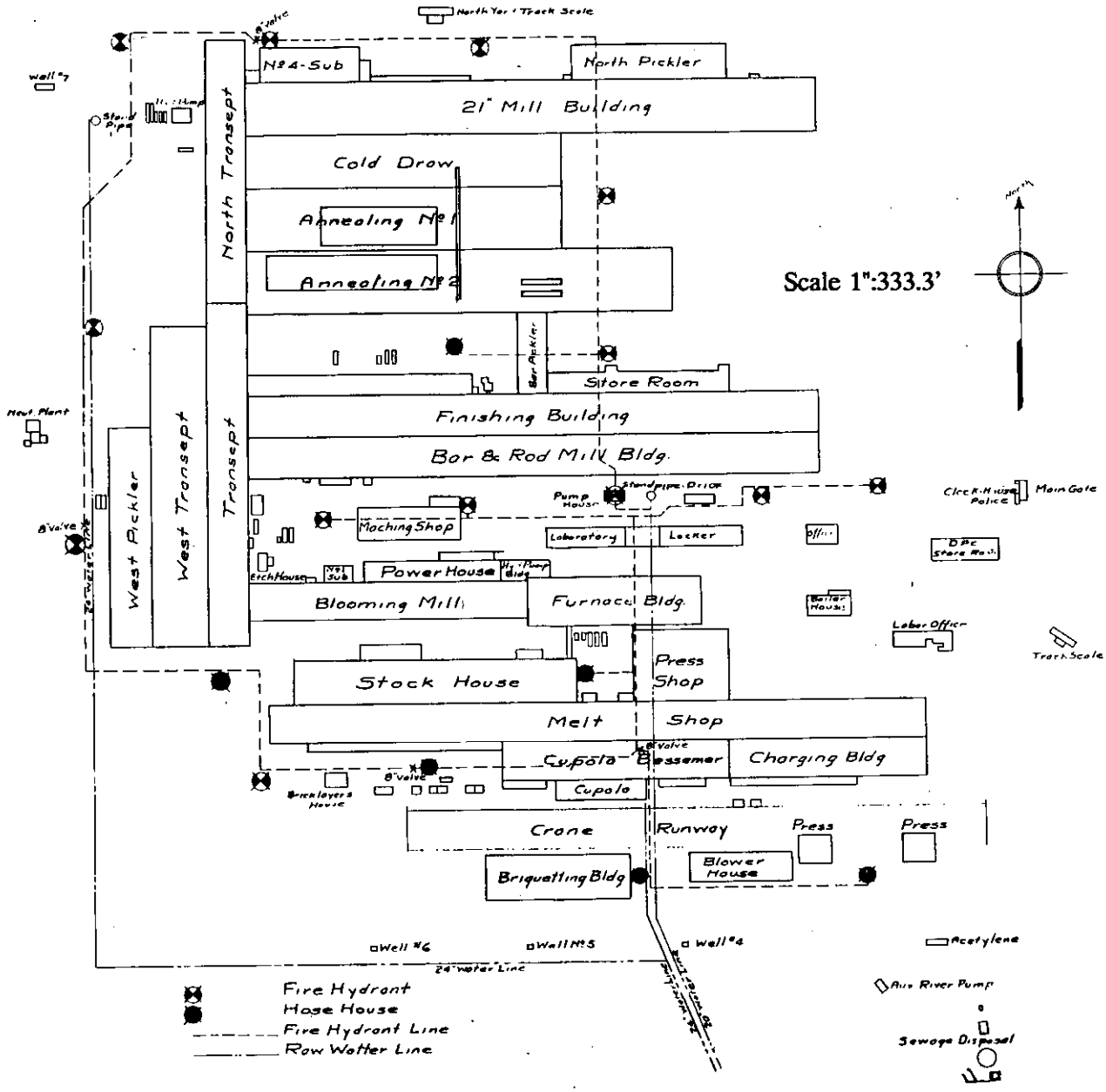

Fig. 2. Map of Copperweld Steel Company in 1944, 4000 Mahoning Ave., NW, Warren, Ohio (CWO001). The current layout is essentially the same.

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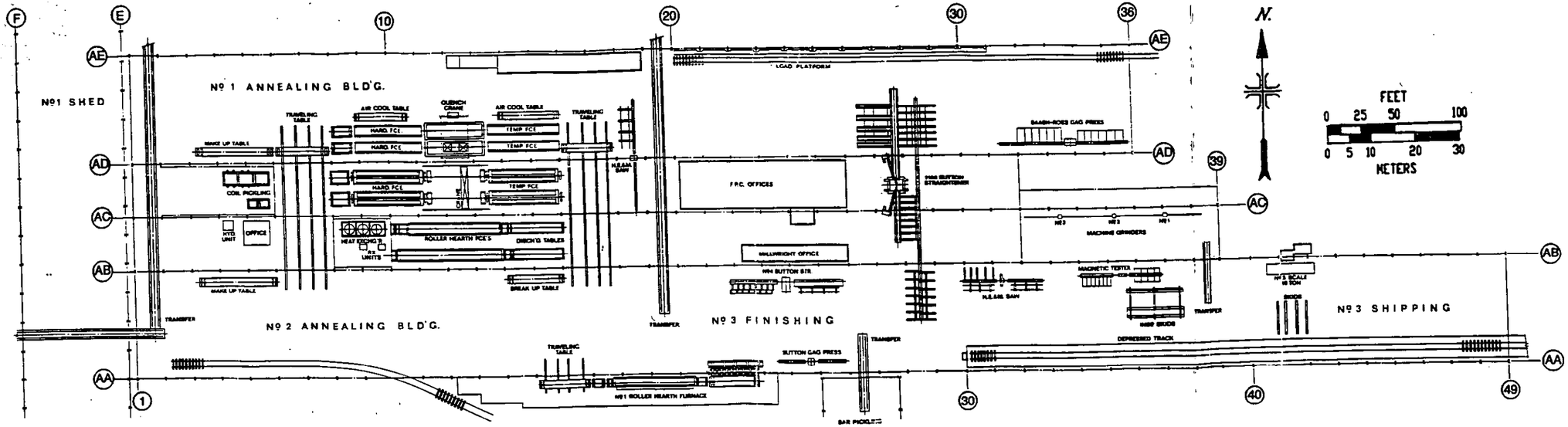

Fig. 3. Map of the Annealing facilities in building Nos. 1 and 2, Copperweld Steel Company in 1970, 4000 Mahoning Ave., NW, Warren, Ohio (CWO001). The current layout is essentially the same.

ORNL-PHOTO 3622-90

Fig. 4. Eastward view of the south wall of No. 2 Annealing facility, Copperweld Steel Company, 4000 Mahoning Ave., NW, Warren, Ohio (CWO001).

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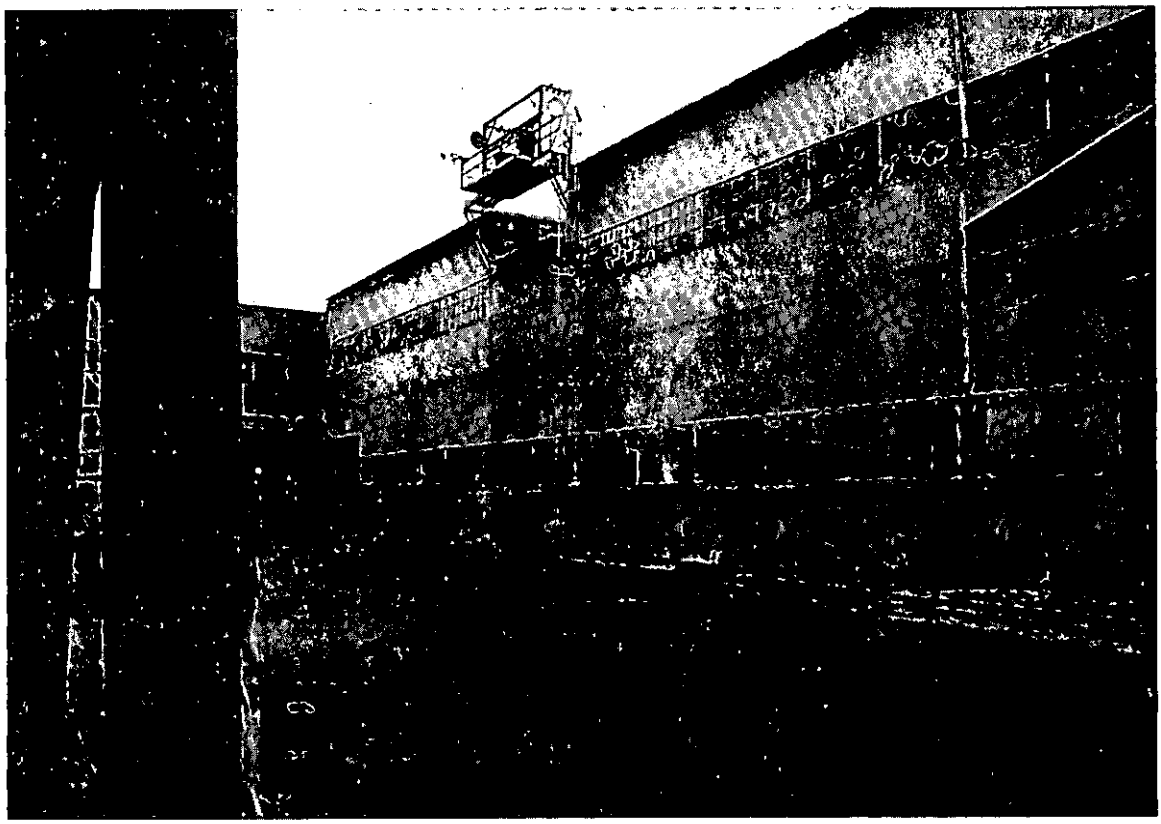

Fig. 5. Westward view of the south wall of No. 2 Annealing facility, Copperweld Steel Company, 4000 Mahoning Ave., NW, Warren, Ohio (CWO001).

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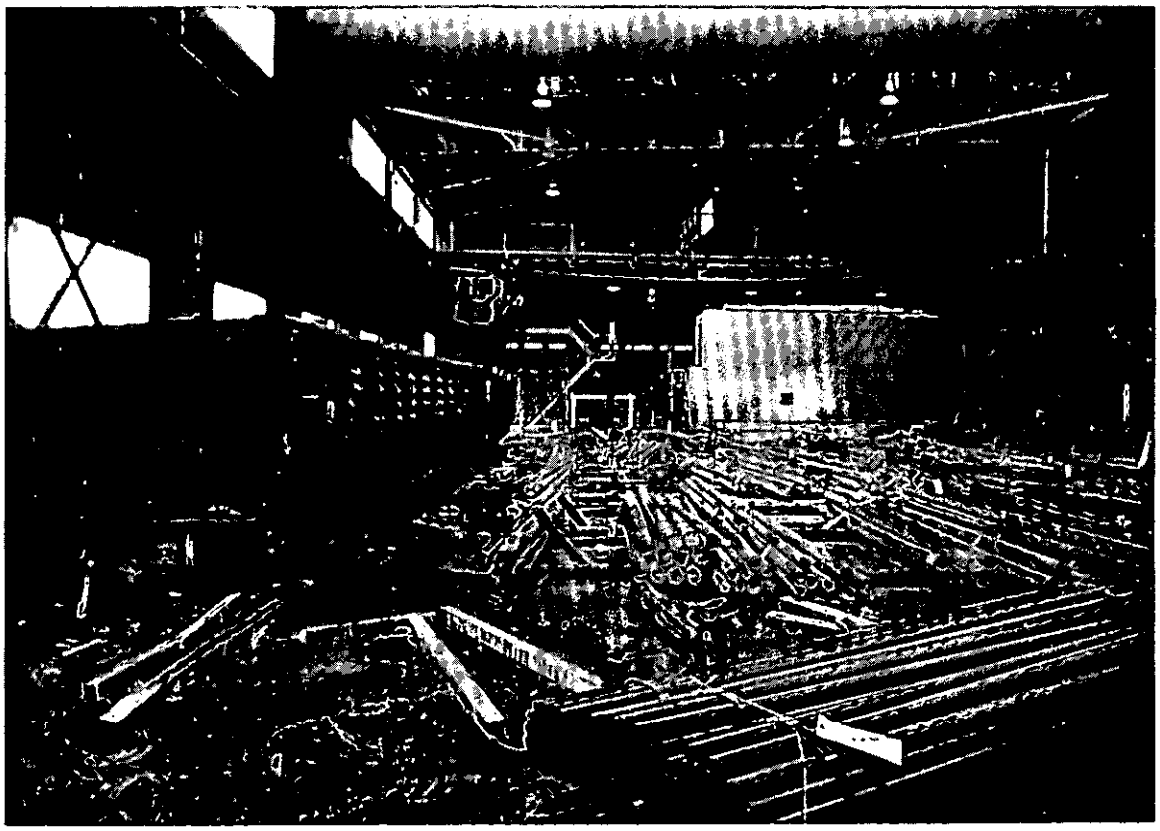

Fig. 6. Westward view in No. 2 Annealing facility between rows AA and AB, Copperweld Steel Company, 4000 Mahoning Ave., NW, Warren, Ohio (CWO001).

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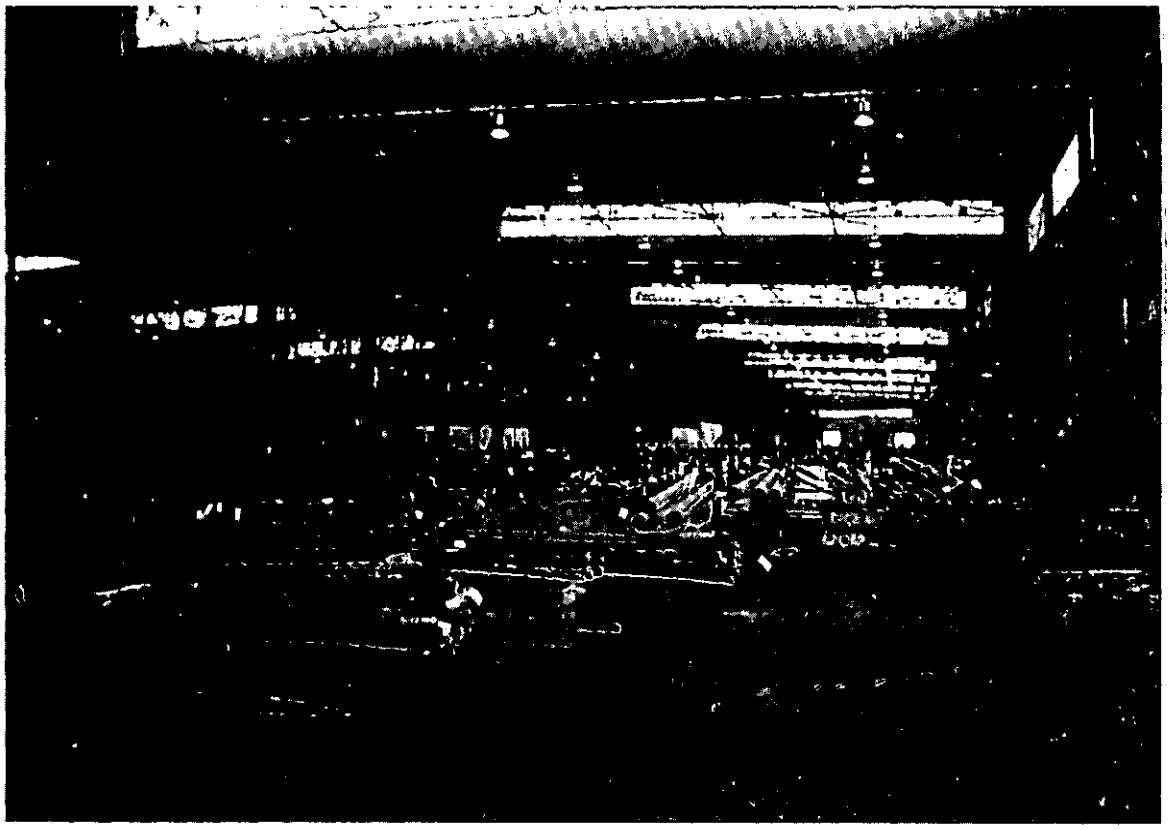

Fig. 7. Eastward view in No. 2 Annealing facility between rows AA and AB, Copperweld Steel Company, 4000 Mahoning Ave., NW, Warren, Ohio (CWO001).

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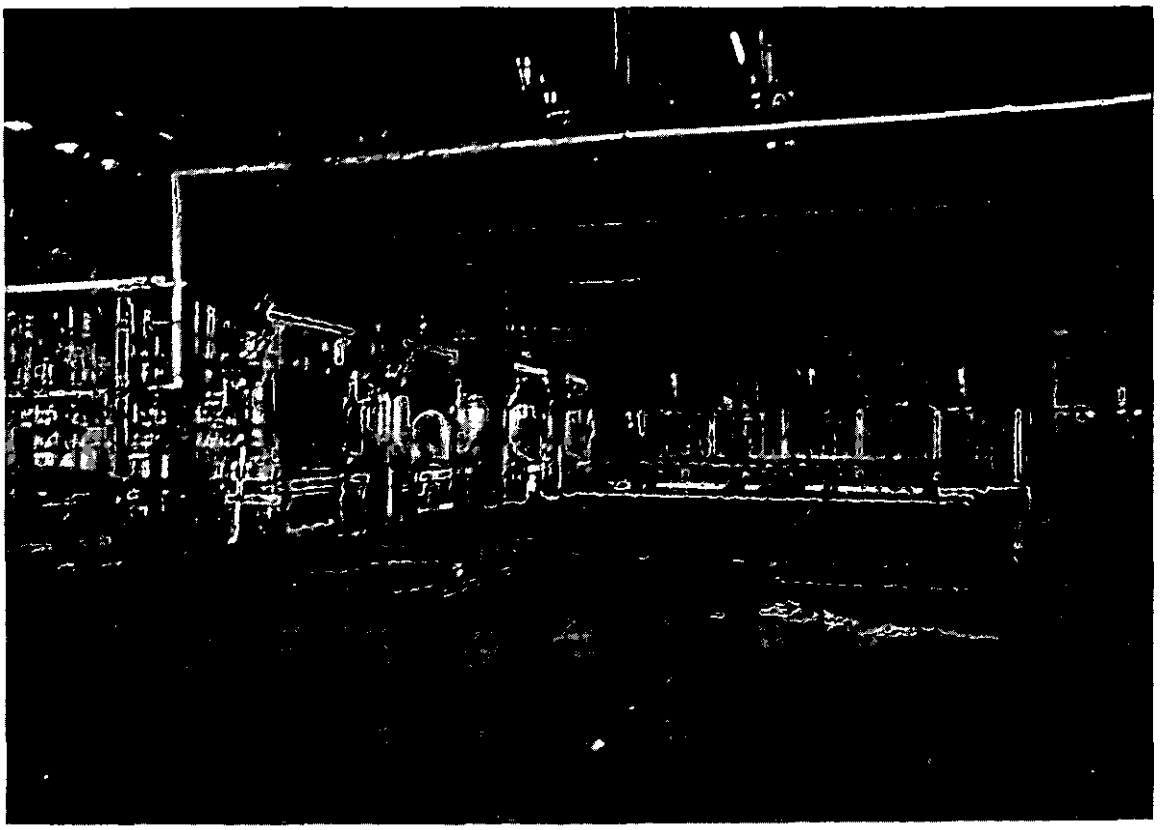

Fig. 8. Northward view in Nos. 1 and 2 Annealing facilities from row AB between columns 16 and 17, showing the traveling table ahead and the tempering furnaces on the left, Copperweld Steel Company, 4000 Mahoning Ave., NW, Warren, Ohio (CWO001).

ORNL-PHOTO 3627-90

Fig. 9. Southward view in Nos. 1 and 2 Annealing facilities near row AD between columns 16 and 17, showing the tempering furnaces on the right and the traveling table immediately in front, Copperweld Steel Company, 4000 Mahoning Ave., NW, Warren, Ohio (CWO001).

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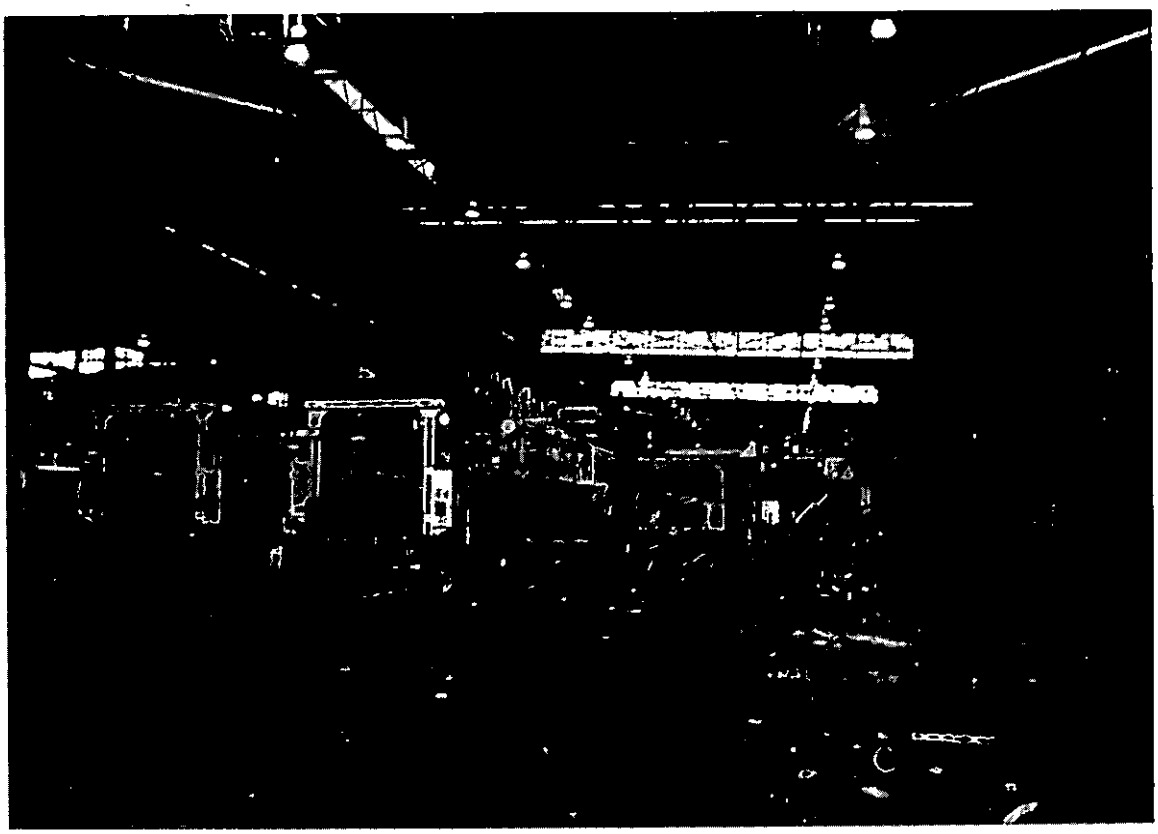

Fig. 10. Westward view in No. 1 Annealing facility between rows AD and AE, showing the tempering furnaces and traveling table on the left, Copperweld Steel Company, 4000 Mahoning Ave., NW, Warren, Ohio (CWO001).

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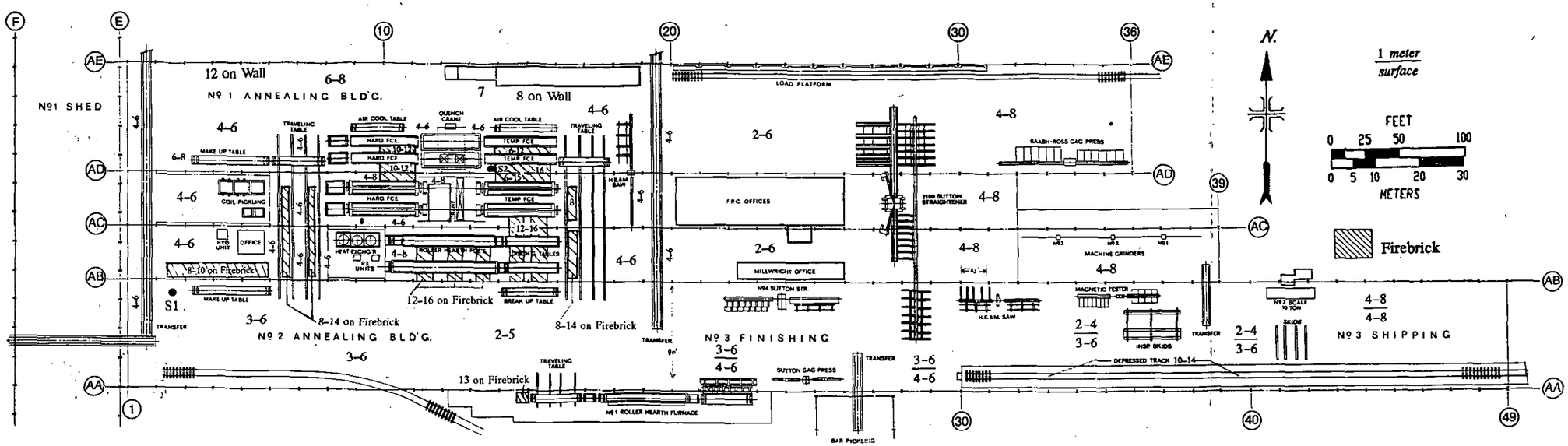

Fig. 11. Diagram of surface gamma radiation levels (μR/h) measured in Nos. 1 and 2 Annealing facilities, Copperweld Steel Company, 4000 Mahoning Ave., NW, Warren, Ohio (CWO001). Locations of the two floor debris samples are shown as S1 and S2.

Table 1. Applicable guidelines for protection against radiation[a]

Mode of exposure	Exposure conditions	Guideline value
Gamma radiation	Indoor gamma radiation level (above background)	20 μR/h
Surface contamination[b]	^{238}U, U-natural(Alpha emitters), or Beta-gamma emitters[c]	
	Total residual maximum	15,000 dpm/100 cm^2
	Total residual average	5,000 dpm/100 cm^2
	Total residual removable	1,000 dpm/100 cm^2
	^{232}Th, Th-natural	
	Total residual maximum	3,000 dpm/100 cm^2
	Total residual average	1,000 dpm/100 cm^2
	Total residual removable	200 dpm/100 cm^2
	^{226}Ra	
	Total residual maximum	300 dpm/100 cm^2
	Total residual average	100 dpm/100 cm^2
	Total residual removable	20 dpm/100 cm^2
Beta–gamma dose rates[c]	Surface dose rate averaged over not more than 1 m^2	0.20 mrad/h
	Maximum dose rate in any 100 cm^2	1.0 mrad/h
Radionuclide concentrations in soil	Maximum permissible concentration of the following radionuclides in the soil above background levels averaged over 100 m^2 area: ^{226}Ra, ^{228}Ra, ^{230}Th, ^{232}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.
	^{238}U	Derived (site specific)[d]

[a]Reference 4.

[b]DOE surface contamination guidelines are consistent with the Nuclear Regulatory Commission guidelines found in Reference 5.

[c]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, ^{125}I.

[d]DOE guidelines for uranium are derived on a site-specific basis. While none have been derived for this site, guidelines for ^{238}U typically range between 35 and 150 pCi/g.

Table 2. Background radiation levels for the Ohio area

Type of exposure	Level of exposure
Gamma radiation at 1 m above ground surface	Radiation level (μR/h) 8[a]
Radionuclide in soil	Concentration (pCi/g)[b]
^{226}Ra	1.5[c]
^{232}Th	1.0[c]
^{238}U	1.4[c]

[a]Reference 6.

[b]These values represent an average of normal radionuclide concentrations in this part of the state. Actual values may fluctuate.

[c]Reference 7.

Table 3. Concentrations of radionuclides in floor debris at Copperweld Steel Company, 4000 Mahoning Avenue, NW, Warren, Ohio (CWO001)

Sample[b]	Depth (cm)	Radionuclide concentration (pCi/g)[a]		
		^{226}Ra	^{232}Th	^{238}U
		Systematic samples[c]		
S1	0–15	1.44±<0.02[d]	1.44±<0.01[d]	1.55±0.36
S2	0–15	0.60±<0.01[d]	0.68±<0.01[d]	0.66±0.16

[a]Indicated counting error is at the 95% confidence level ($\pm 2\sigma$).

[b]Locations of floor debris samples are shown in Fig. 11.

[c]Systematic samples are taken at locations irrespective of gamma exposure rates.

[d]Indicated counting error is less than 0.01.

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