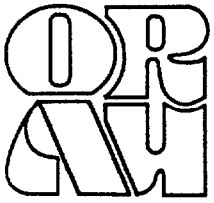
NY.54-6

8060
NY.54



Prepared by
Oak Ridge Associated
Universities

Prepared for the
Office of
Environmental
Restoration

U.S. Department
of Energy

RADIOLOGICAL SURVEY OF THE FORMER BLISS AND LAUGHLIN STEEL COMPANY FACILITY BUFFALO, NEW YORK

J. D. BERGER

Environmental Survey and Site Assessment Program
Energy/Environment Systems Division

DRAFT REPORT
APRIL 1992

RADIOLOGICAL SURVEY OF THE FORMER BLISS AND LAUGHLIN STEEL COMPANY FACILITY 110 HOPKINS STREET BUFFALO, NEW YORK

Prepared by

J. D. Berger

Environmental Survey and Site Assessment Program
Energy/Environmental Systems Division
Oak Ridge Associated Universities/Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0117

Project Staff

R. D. Condra
D. A. Gibson
M. J. Laudeman
R. B. Slaten

Prepared for

Department of Energy
Office of Environmental Restoration

DRAFT REPORT

APRIL 1992

This report is based on work performed under contract number DE-AC05-76OR00033 with the U.S. Department of Energy.

RADIOLOGICAL SURVEY
OF THE FORMER
BLISS AND LAUGHLIN STEEL
COMPANY FACILITY
110 HOPKINS STREET
BUFFALO, NEW YORK

Prepared by: _____ Date:_____

J. D. Berger, Program Director
Environmental Survey and Site Assessment Program

Reviewed by: _____ Date:_____

C. F. Weaver, Laboratory Manager
Environmental Survey and Site Assessment Program

Reviewed by: _____ Date:_____

M. R. Landis, Project Manager
Environmental Survey and Site Assessment Program

Reviewed by: _____ Date:_____

W. L. Beck, Assistant Program Director
Environmental Survey and Site Assessment Program

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

RADIOLOGICAL SURVEY
OF THE FORMER
BLISS AND LAUGHLIN STEEL
COMPANY FACILITY
110 HOPKINS STREET
BUFFALO, NEW YORK

INTRODUCTION AND SITE HISTORY

In the fall of 1952, the Bliss and Laughlin Steel Company, Buffalo, New York, performed machining and straightening operations on uranium rods. The finished rods were shipped directly to the Fernald site in Ohio; turnings were returned by the Atomic Energy Commission (AEC) to the Lake Ontario Ordnance Works (LOOW) for packaging and ultimate disposal or recycle. Available records indicate uranium machining occurred at the site during September and October of 1952, and that 53 drums of turnings were generated by the Bliss and Laughlin activities[1]. It is unknown whether these records described the full extent of the Bliss and Laughlin work; no records, indicating the total quantity of uranium handled at this site, have been located. There is also mention of possible earlier Atomic Energy Commission work at the site, in October 1951 correspondence, which indicates that several drums of dry uranium oxide had been accumulated; the nature of the earlier work is unknown[1]. In 1972 the facility was sold to Ramco Steel, Inc.; the current owner is Niagara Cold Drawn Corporation.

Based on the operations performed at this site, the potential radiological contaminant would be processed natural uranium, i.e. uranium chemically separated from its long-lived daughter products and in its naturally occurring isotopic abundances. Surveys of the facility, conducted by National Lead of Ohio at the time of the rod turning operations, identified contamination on the turning machines. The machinery used for this work has been replaced; disposition of the old equipment is not known. No records, indicating the radiological conditions of the site following the uranium machining, have been located. The U.S. Department of Energy's Office of Environmental Restoration and Waste Management recommended that the current radiological conditions be determined; the Environmental Survey and Site Assessment Program (ESSAP) of

Oak Ridge Associated Universities/Oak Ridge Institute for Science and Education (ORAU/ORISE) was requested to perform a survey of the site. This report describes the procedures and results of that survey.

PROJECT ORGANIZATION AND RESPONSIBILITY

DOE Headquarters provides overview and coordination for all FUSRAP activities. DOE Oak Ridge (DOE-OR) is responsible for implementation of FUSRAP and The Former Sites Restoration Division of DOE-OR, manages the daily activities.

Under the FUSRAP protocol, an initial investigation/survey of a potential site is performed by ORISE or Oak Ridge National Laboratory (ORNL), under contract to DOE Headquarters. If appropriate, DOE Headquarters designates the site into FUSRAP based upon the results provided by the initial investigation/survey. DOE's Project Management Contractor (PMC) for FUSRAP is Bechtel National, Inc. (BNI). BNI is responsible for planning and implementation of FUSRAP activities and managing any required remedial actions. The final phase for a FUSRAP site is independent verification, which is provided by ORISE or ORNL, after remedial action is complete. This verification activity provides independent (third party) data to assist DOE in evaluating the accuracy of the post-remedial action status of the site, as presented by the PMC, and in assuring that the documentation accurately and adequately describes the condition of the site. DOE Headquarters uses the information developed by the remediation and verification activities to certify that a site can be released for use, without restrictions.

FACILITY DESCRIPTION

The former Bliss and Laughlin facility at 110 Hopkins Street consists of a single large building,with a floor area of about 12,000 m^2 (Figures 1 and 2). There have been only minor changes to the main structure, since the uranium operations in the 1950's. Equipment inside the building has been rearranged or replaced to varying degrees. The current facility occupants indicate that machining operations, such as were performed on the uranium rods, would have

been located in the "special finishing" area, but machining is no longer performed in this section of the facility. The "special finishing" area occupies about 300 m^2 of floor space (Figure 3). The floor is concrete and contains several shallow utility (water, electricity, lubricant, and pneumatic) trenches; there are no drains in this area. Floor surfaces are generally rough and "pitted" and are covered with a thin layer of oil absorbant material and dried oil and grease. Machining equipment and material storage racks prevent access to some floor surface areas. Ceilings are approximately 12 m high and supported by a framework of trusses. The machining area of the building is open (without inside walls or partitions).

PROCEDURES

On March 14, 1992, representatives of the ORISE Environmental Survey and Site Assessment Program (ESSAP), assisted by W. A. Williams of the DOE Office of Environmental Restoration, conducted a radiological survey at the former Bliss and Laughlin Steel Company facility. The survey was conducted in accordance with a plan prepared by the ESSAP and approved by DOE/EM. Because of positive findings of residual contamination, the initial plan was modified as the survey proposed to reduce the number of surface activity and exposure rate measurements. Additional information, concerning major instrumentation and survey and analysis procedures, is provided in Appendices A and B.

OBJECTIVE

The objective of the survey was to determine the radiological status of the site, relative to the FUSRAP guidelines and DOE Order 5400.5, Chapter IV. The results will be used by DOE/EM to determine whether there is a need for further actions under FUSRAP.

SURVEY PROCEDURES

Gridding

The floor of the "special finishing" area was gridded at 2 m intervals for referencing measurement and sampling locations. Survey locations in other portions of the facility were referenced to prominent building features.

Surface Scans

The floor of the "special finishing" area was systematically scanned for alpha, beta, and gamma radiation, using large area gas proportional detectors and gamma scintillation detectors. Scans for alpha, beta, and gamma activity were also performed in other areas of the building. Scans for gamma activity were performed outside the building at entrances/exits and within 5 to 10 m of the building exterior walls. All detectors were coupled to instruments with audible indicators. Locations of elevated direct radiation, suggesting the presence of surface contamination, were marked and identified for further investigation.

Measurements of Surface Activity Levels

Direct measurements for total surface activity were performed at 8 locations of elevated direct radiation, identified by surface scans; at 10 additional locations on the floor of the "special finishing" area; and at 10 locations throughout the remainder of the building. Although processed natural uranium emits alpha and beta radiations in approximately equal proportions, initial measurements indicated that the total alpha activity levels were significantly lower than the beta levels at the same location; this suggested that the physical condition of the floor surface was resulting in absorption of a large fraction of the alpha radiation. Therefore, measurements of alpha surface activity were discontinued, and the beta measurements were used to determine the residual uranium activity level. Measurement locations are identified on

Figures 4 and 5. Smears for removable activity were obtained at locations of direct measurements.

Exposure Rate Measurements

The background exposure rate for the general building area was measured at 1 meter (3.3 ft) above the surface in the truck loading area (Figure 5). This location is similar in construction to the rest of the building, and is not believed to have a history of radioactive material use. A pressurized ionization chamber was used to perform this measurement.

Miscellaneous Samples

Scrapings and chips were obtained from locations of elevated direct radiation on the floor. Two dust and residue samples were collected from overhead beams in the "special finishing" area, and two samples of oil and sludge were obtained from trenches in the "special finishing" area. Two samples of slag-like fill material were obtained from beneath the concrete flooring at locations of elevated gamma scan findings; these samples were from excavations on the south side of the building, where new storage racks were being installed. Sampling locations are identified on Figures 4 and 5.

Sample Analysis and Data Interpretation

All samples and data were returned to the ESSAP laboratory at ORISE for analysis and interpretation. Total surface activity levels were converted to units of disintegrations per minute per 100 cm^2 (dpm/100 cm^2). Smears were analyzed for gross alpha and gross beta activity and results also converted to units of dpm/100 cm^2. Miscellaneous samples were analyzed by gamma spectrometry and content reported in units of pCi or pCi/g. The radionuclides of primary interest were those associated with processed natural uranium; however, spectra were reviewed for the presence of additional photopeaks. Findings were compared to the DOE guidelines, which are provided in Appendix C.

FINDINGS AND RESULTS

SURFACE SCANS

Gamma scans of the building interior and exterior perimeter identified levels of 2 to 3 times background in subfloor excavations along the south side of the building. The elevated levels appeared to be associated with slag and cinder-like material, which had been used as fill between the subfloor soil and the concrete flooring. No additional indoor or outdoor locations, indicating possible residual radioactive material, were identified by the gamma scans.

Alpha-beta scans identified several areas of elevated direct radiation in the "special finishing" area. These locations, shown on Figure 4, were noted for additional measurements.

Scans of other building floor surfaces did not identify additional locations of possible residual activity.

SURFACE ACTIVITY LEVELS

Results of surface activity measurements in the "special finishing" area are presented in Table 1. At locations identified by surface scans the total beta activity levels ranged from 4,700 to 700,000 dpm/100 cm^2; removable alpha and beta activities at these locations ranged from < 12 to 426 dpm/100 cm^2 and < 15 to 544 dpm/100 cm^2, respectively. Activity levels at other locations in the "special finishing" area were less than detection limits of the procedure, i.e. < 880 dpm/100 cm^2, total beta; < 12 dpm/100 cm^2, removable alpha; and < 15 dpm/100 cm^2, removable beta.

Surface activity levels, measured at all other building locations, were less than the detection limits of the procedures.

EXPOSURE RATES

The background exposure rate was 9 μR/h. Exposure rates were not specifically measured at other locations on the site; however, based on results of the gamma scans, with exception of the floor excavations (see information above on surface scan results), gamma levels within the building and around the building perimeter do not differ significantly from the background levels.

RADIONUCLIDE LEVELS IN MISCELLANEOUS SAMPLES

Metal chips and floor scrapings, collected from locations of elevated direct radiation in the "special finishing" area were combined for analysis. The composite sample contained 200,000 pCi of U-238 and 9700 pCi of U-235; this ratio of U-238 and U-235 activities is typical of natural uranium. No additional uranium series radionuclides were identified in this sample, indicating that the material is processed uranium, i.e. separated from its longer-lived daughter products.

Table 3 presents the concentrations of radionuclides in other samples from the facility. Samples of slag and cinder-like material from the floor excavations contained positive levels of U-238 (up to 5.2 pCi/g) and Th-232 (up to 3.7 pCi/g). The gamma spectra revealed that longer-lived daughters of these two radionuclide series were present in approximately equal amounts, indicating that the material is of natural origin, rather than being associated with the uranium machining activities for AEC/MED. The material containing the low levels of natural uranium and thorium is similar in appearance and radionuclide content to that which has been encountered at various other sites in the Buffalo area[2-3].

Slightly elevated U-238 concentrations (up to 2.2 pCi/g) were present in the oil and sludge samples from the floor trenches and in the dust removed from overhead surfaces (up to 5.7 pCi/g). As with the samples of chips and floor scrapings, these samples did not contain the

longer-lived daughters of the uranium decay series (e.g., Ra-226), and it is therefore likely that activity in these samples is associated with the uranium machining operations.

COMPARISON OF RESULTS WITH GUIDELINES

The DOE guidelines for residual radioactive material are included as Appendix C. The DOE surface contamination guideline levels applicable for processed natural uranium are as follows:

Total Activity

5,000 dpm α/100 cm^2, averaged over a 1 m^2 area

15,000 dpm α/100 cm^2, maximum in a 100 cm^2 area

Removable Activity

1,000 dpm α/100 cm^2

Survey results indicate that measurements for beta activity levels, rather than alpha activity, provide a more accurate representation of uranium activity levels on dusty, porous, or rough surfaces, because of selective attenuation of alpha radiations; therefore, beta activity levels were used for comparison with the guideline values. Seven of the eight locations in the "special finishing" area, identified by the floor scans, had total beta activity levels exceeding the 15,000 dpm/100 cm^2 (maximum) limit. All other locations in the "special finishing" area and locations throughout the remainder of the facility were within the guideline levels. There were no measurement locations where removable activity exceeded the guideline.

Based on scanning results of general building areas, gamma radiation levels at 1 m above surfaces were not distinguishable from the background exposure rates of 9 μR/h and thus satisfied the guideline value of 20 μR/h above background.

A guideline value for U-238 in soil and other volumetric sources has not been established for this site; however, for comparison purposes, guidelines at other FUSRAP sites have typically ranged from 30 to 50 pCi/g. Samples collected from this facility contain less than those typical

levels. The slag/cinder samples contain naturally occurring activity, not associated with former AEC/MED activities at the Bliss and Laughlin site.

SUMMARY

In March 1992, ESSAP performed a radiological survey of the former Bliss and Laughlin Steel Company facility, located at 110 Hopkins Street, Buffalo, New York. Survey activities included scans for direct alpha, beta, and gamma radiation, measurements of total and removable surface activity and exposure rates, and collection and analysis of samples.

Residual uranium activity, exceeding the DOE guideline levels, was identified on the floor of the "special finishing" area. Surface contamination appears to be fixed; removable contamination levels and external gamma radiation levels are within the DOE guidelines. Some floor surfaces in this area were inaccessible, due to equipment and material storage; it is possible that additional areas of residual contamination are present.

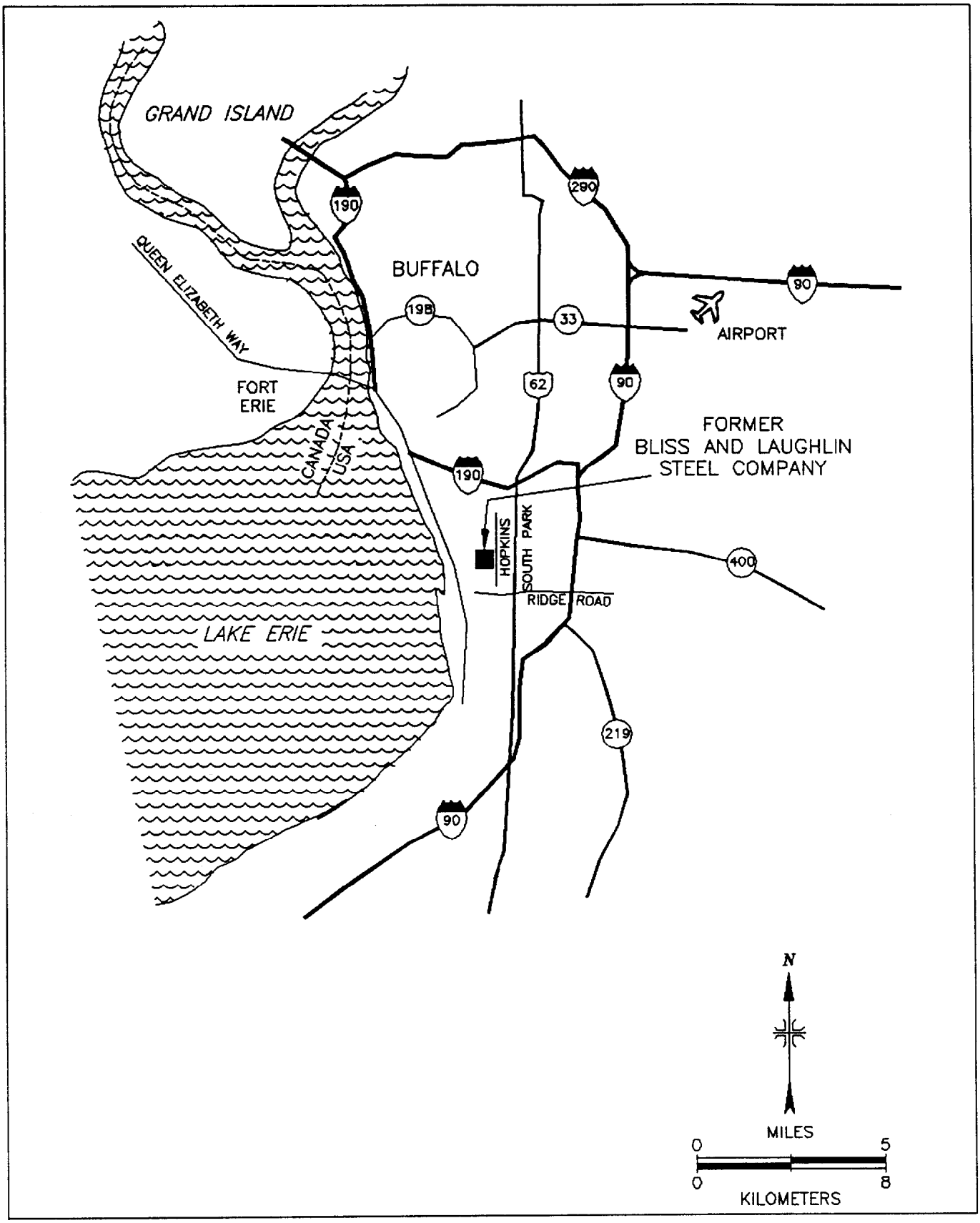


FIGURE 1: Buffalo, New York Area – Location of Former Bliss and Laughlin Steel Company Site

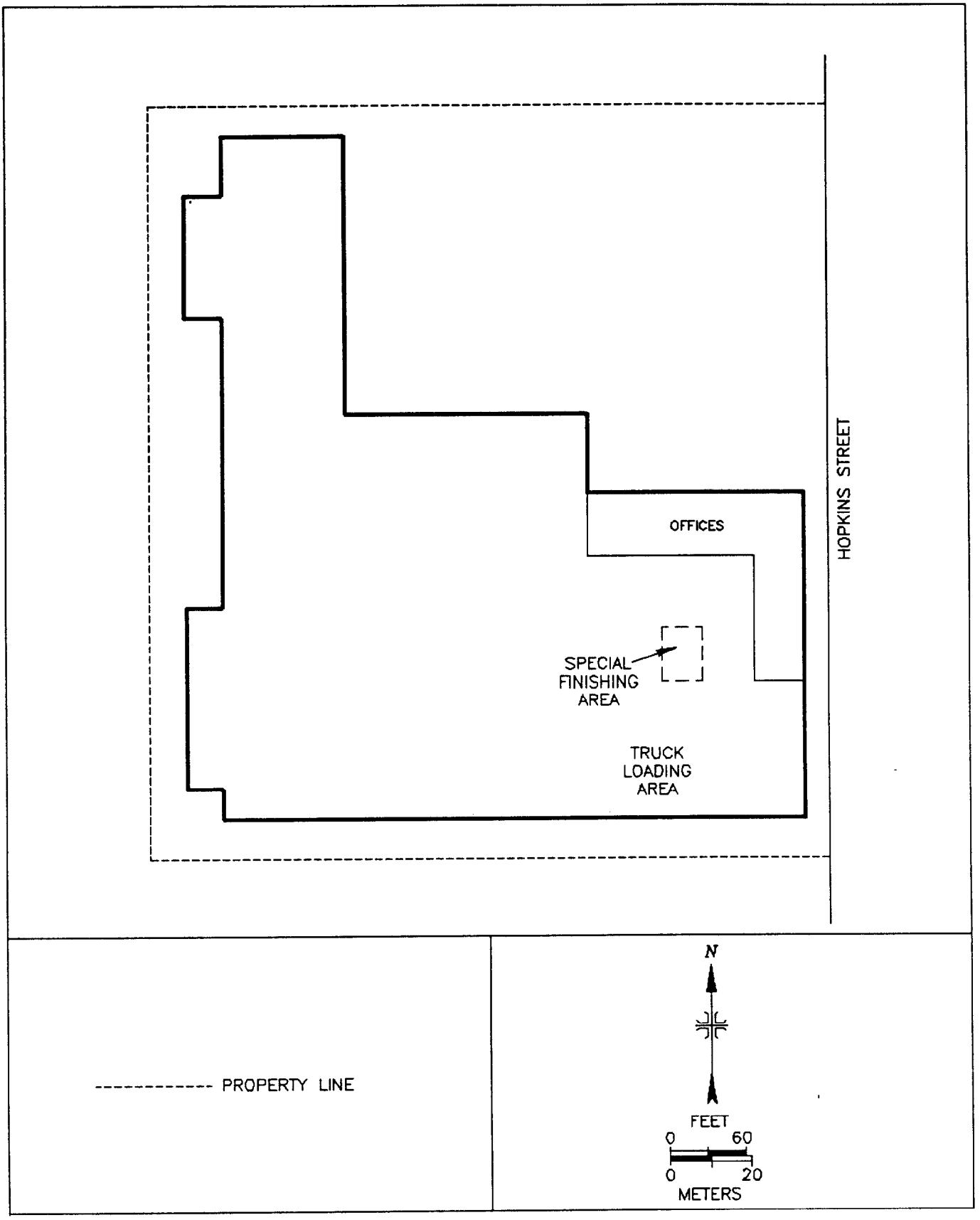


FIGURE 2: Plot Plan of Former Bliss and Laughlin Steel Company Facility

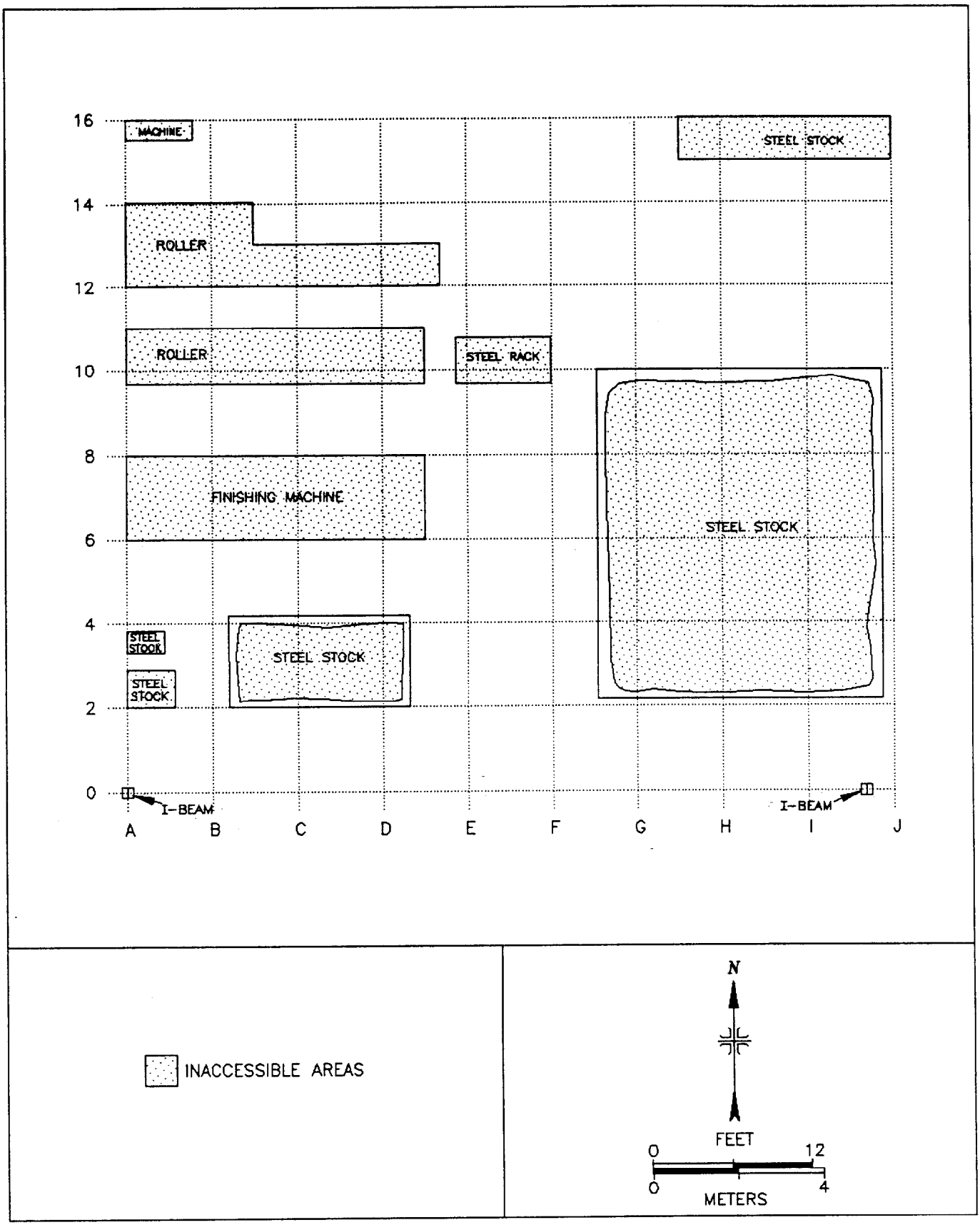


FIGURE 3: "Special Finishing" Area – Floor Plan and Reference Grid

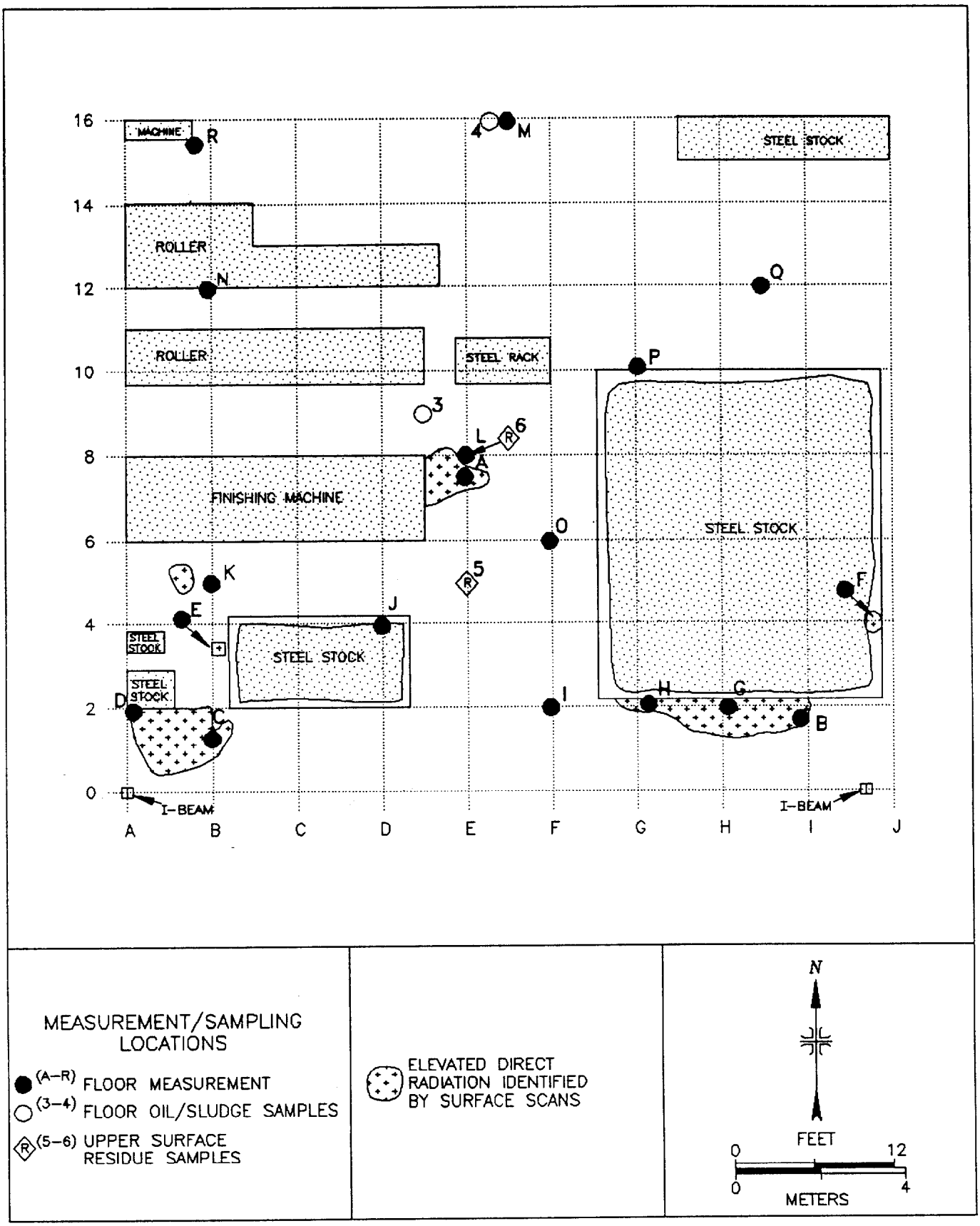


FIGURE 4: "Special Finishing" Area – Findings of Surface Scans and Measurement and Sampling Locations

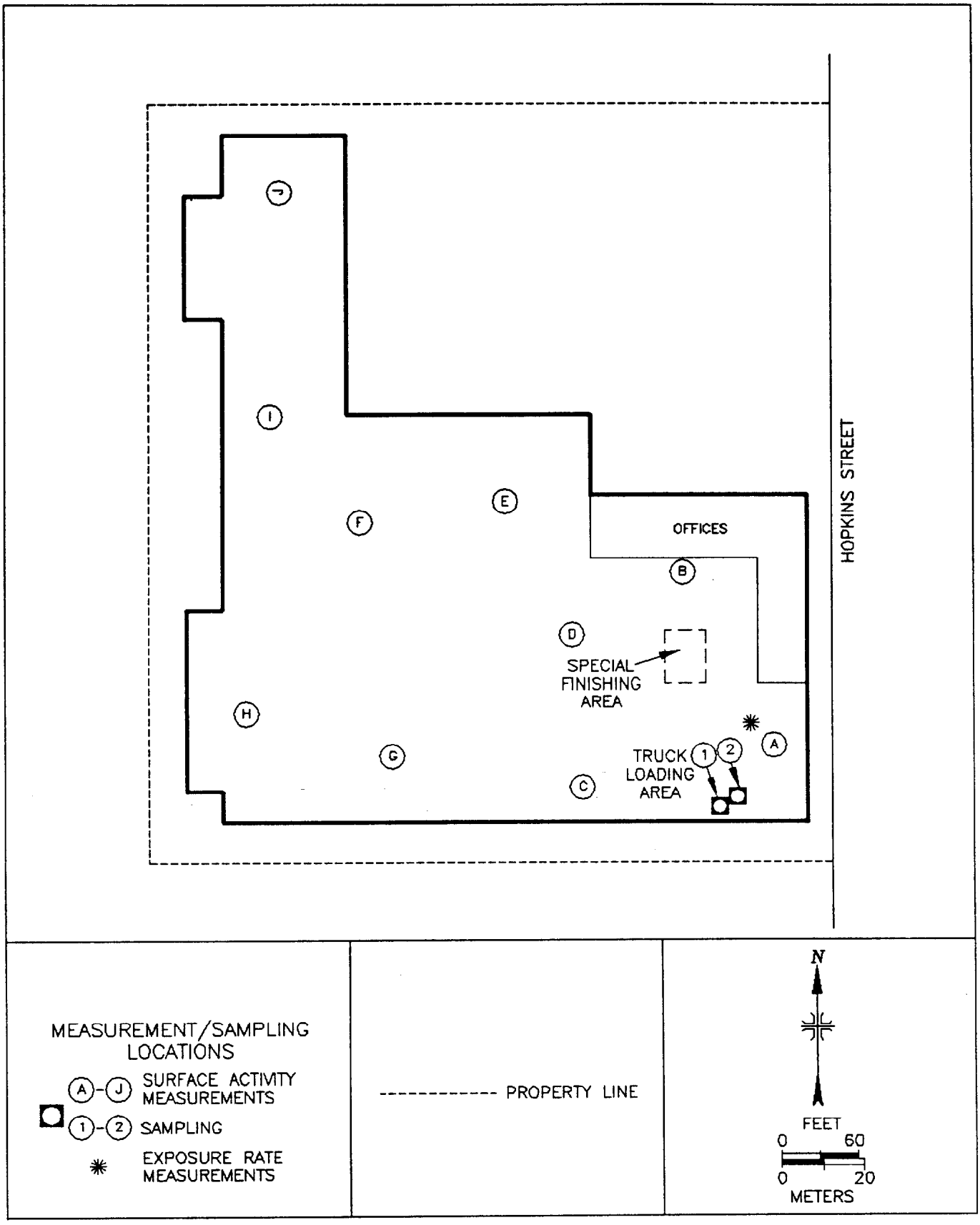


FIGURE 5: General Building Area – Measurement and Sampling Locations

TABLE 1

RESULTS OF SURFACE ACTIVITY MEASUREMENTS
"SPECIAL FINISHING" AREA
FORMER BLISS AND LAUGHLIN FACILITY
BUFFALO, NEW YORK

LOCATION[a]	SURFACE ACTIVITY LEVELS (dpm/100 cm^2)		
	TOTAL BETA ACTIVITY	REMOVABLE ACTIVITY	
		ALPHA	BETA
A	700,000	426	544
B	60,000	<12	<15
C	240,000	<12	17
D	41,000	122	336
E	27,000	<12	19
F	21,000	17	39
G	4,700	<12	<15
H	28,000	19	26
I	<880	<12	<15
J	<880	<12	<15
K	<880	<12	<15
L	<880	<12	<15
M	<880	<12	<15

TABLE 1 (Continued)

RESULTS OF SURFACE ACTIVITY MEASUREMENTS
"SPECIAL FINISHING" AREA
FORMER BLISS AND LAUGHLIN FACILITY
BUFFALO, NEW YORK

LOCATION[a]	SURFACE ACTIVITY LEVELS (dpm/100 cm^2)		
	TOTAL BETA ACTIVITY	REMOVABLE ACTIVITY	
		ALPHA	BETA
N	<880	<12	<15
O	<880	<12	<15
P	<880	<12	<15
Q	<880	<12	<15
R	<880	<12	<15

[a]Refer to Figure 4.

TABLE 2

RESULTS OF SURFACE ACTIVITY MEASUREMENTS
GENERAL BUILDING AREA
FORMER BLISS AND LAUGHLIN FACILITY
BUFFALO, NEW YORK

LOCATION[a]	SURFACE ACTIVITY LEVELS (dpm/100 cm^2)		
	TOTAL BETA ACTIVITY	REMOVABLE ACTIVITY	
		ALPHA	BETA
A	<930	<12	<15
B	<930	<12	<15
C	<930	<12	<15
D	<930	<12	<15
E	<930	<12	<15
F	<930	<12	<15
G	<930	<12	<15
H	<930	<12	<15
I	<930	<12	<15
J	<930	<12	<15

[a]Refer to Figure 5.

TABLE 3

RADIONUCLIDE CONCENTRATIONS IN MISCELLANEOUS SAMPLES FORMER BLISS AND LAUGHLIN FACILITY BUFFALO, NEW YORK

SAMPLE TYPE	SAMPLING[a] LOCATION	RADIONUCLIDE CONCENTRATION (pCi/g)			
		U-235	U-238	Th-232	Ra-226
Soil/Slag	1 Subfloor Excavation	0.4 ± 0.1[b]	5.2 ± 1.6	3.7 ± 0.7	3.5 ± 0.5
Soil/Slag	2 Subfloor Excavation	<0.1	1.7 ± 1.1	1.4 ± 0.3	1.2 ± 0.2
Oil and Sludge	3 Floor Trench	0.2 ± 0.4	2.2 ± 0.4	0.4 ± 0.1	0.5 ± 0.1
Oil and Sludge	4 Floor Trench	0.1 ± 0.2	2.1 ± 0.4	0.2 ± 0.1	0.2 ± 0.1
Dust	5 Upper Beams	0.4 ± 0.1	4.3 ± 1.0	<0.1	<0.3
Dust	6 Upper Beams	0.4 ± 0.1	5.7 ± 1.2	0.1 ± 0.1	<0.4

[a]Refer to Figure 5.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.

REFERENCES

1. Attachment to letter from W.A. Williams (DOE/EM) to F. Archer (Niagara Cold Drawn Steel Co.), regarding history of MED/AEC activities at Bliss and Laughlin Steel Company, February 21, 1991.

2. "Verification of 1983 and 1984 Remedial Actions, Niagara Falls Storage Site, Vicinity Properties, Lewiston, New York," S.A. Wical, et al., Oak Ridge Associated Universities, December 1989.

3. "Verification of 1985 and 1986 Remedial Actions, Niagara Falls Storage Site, Vicinity Properties, Lewiston, New York," J.D. Berger, et al., Oak Ridge Associated Universities, July 1990.

APPENDIX A

MAJOR SAMPLING AND ANALYTICAL EQUIPMENT

APPENDIX A

MAJOR SAMPLING AND ANALYTICAL EQUIPMENT

The display or description of a specific product is not to be construed as an endorsement of that product or its manufacturer by the authors or their employer.

DIRECT RADIATION MEASUREMENT

Instruments

Eberline Pulse Ratemeter
Model PRM-6
(Eberline, Santa Fe, NM)

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

Ludlum Floor Monitor
Model 239-1
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Reuter-Stokes Pressurized Ion Chamber
Model RSS-111
(Reuter-Stokes, Cleveland, OH)

Detectors

Eberline GM Detector
Model Hp-260
Effective Area, 15 cm^2
(Eberline, Santa Fe, NM)

Eberline ZnS Scintillation Detector
Model AC-3-7
Effective Area, 59 cm^2
(Eberline, Santa Fe, NM)

Victoreen NaI(Tl) Scintillation Detector
Model 489-55
3.2 cm x 3.8 cm crystal
(Victoreen, Cleveland, OH)

Ludlum Gas Proportional Detector
Model 43-37
Effective Area, 550 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

LABORATORY ANALYTICAL EQUIPMENT

Low Background Gas Proportional Counter
Model LB-5110
(Tennelec, Oak Ridge, TN)

High Purity Extended Range Intrinsic Detectors
Model No: ERVDS30-25195
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Detector
Model GMX-23195-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lad Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analzyer
3100 Vax Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Coaxial Well Detector
Model GWL_110210-PWS-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Applied Physical Technology, Atlanta, GA) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B
SURVEY AND ANALYTICAL PROCEDURES

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the probes slowly over the surface; the distance between the probe and the surface was maintained at a minimum - nominally about 1 cm. Identification of elevated levels was based on increases in the audible signal from the recording or indicating instrument. Scans of large surface areas on the floor of the facility were accomplished by used of a gas proportional floor monitor. The detector was slowly moved in a systematic pattern to cover 100% of the accessible floor surface in the "special finishing" area; other building floors were scanned in a random pattern to provide coverage of 10 to 20% of the surface. Equipment and overhead surfaces were scanned using smaller, hand-held detectors. Combinations of detectors and instruments used for the scans were:

Alpha	-	ZnS Scintillation detector with ratemeter-scaler.
Alpha-Beta	-	Gas Proportional detector with ratemeter-scaler.
Beta	-	GM detector with ratemeter-scaler.
Gamma	-	NaI Scintillation detector with ratemeter.

Surface Activity Measurements

Measurements of total beta surface activity were performed using portable ratemeter-scalers with thin-window "pancake" GM detectors. Count rates (cpm) were converted to disintegration rates (dpm/100 cm^2) by dividing the net rate by the 4 π efficiency and correcting for the active area of the detector. The effective window area was 15 cm^2 for the GM detectors; the average background count rate for the GM detectors was 55 cpm and the average efficiency was 27%.

Removable Activity Measurements

Smears for determination of removable activity were performed using numbered filter paper disks, 47 mm in diameter; smears were sealed in labeled envelopes with the locations and other pertinent information recorded. The smears were returned to laboratories in Oak Ridge and counted on a low-background gas-proportional counter for alpha and gross beta activity.

Exposure Rate Measurements

Measurement of gamma exposure rate at the background location was performed using a Reuter-Stokes pressurized ionization chamber; the detector was placed 1 m above the floor and a series of consecutive readings obtained and averaged to determine the exposure rate.

ANALYTICAL PROCEDURES

Gamma Spectrometry

Samples were placed in appropriate containers, chosen to reproduce calibrated counting geometries. The net weights were determined and the samples counted using germanium detectors coupled to a Canberra pulse height analyzer system. Background and Compton striping, peak search, peak identification, and concentration calculations were performed using

the computer capabilities inherent in the analyzer 3100 Vax workstation system. Energy peaks, used for determination of radionuclides of concern, were:

U-235	0.185 MeV
U-238	0.093 MeV from Th-234*
Th-232	0.911 MeV from Ac-228*
Ra-226	0.609 MeV from Bi-214*

*Secular equilibrium assumed.

Spectra were reviewed for other identifiable photopeaks.

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. When the net sample count was less than the 95% statistical deviation of the background count, the sample concentration was reported as less than the detection limit of the measurement procedure. Because of variations in background levels, measurement efficiencies, and contributors from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument. Additional uncertainties of $\pm$ 6 to 10%, associated with laboratory procedures, have not been propagated into the data presented in this report.

QUALITY ASSURANCE

Analytical and field survey activities were conducted in accordance with procedures from the following documents:

- Survey Procedures Manual, Revision 6, February 1991
- Quality Assurance Manual, Revision 4, April 1991
- Laboratory Procedures Manual, Revision 6, April 1991

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6B and ANSI/ASME-NQA1.

Calibration of all field laboratory instrumentation is based on NIST-traceable standards, when such standards are available. In cases where they are not available, standards of an industry recognized organization are used. Calibration of pressurized ionization chambers is performed by the manufacturer.

Quality Control procedures include:

- Daily instrument background and check-source measurements to confirm that the equipment operation is within acceptable statistical fluctuations
- Participation in EPA and EML Quality Assurance Programs
- Training and certification of individuals performing procedures
- Periodic internal and external audits

APPENDIX C

SUMMARY OF U.S. DEPARTMENT OF ENERGY GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL AT FORMERLY UTILIZED SITES

APPENDIX C

SUMMARY OF U.S. DEPARTMENT OF ENERGY GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL AT FORMERLY UTILIZED SITES[1,2]

BASIC DOSE LIMITS

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

STRUCTURE GUIDELINES

Indoor/Outdoor Structure Surface Contamination

Radionuclides[a]	Allowable Total Residual Surface[b] (dpm/100 cm^2) Average[c,d]	Maximum[d,e]	Removable[d,f]
Transuranics, Ra-226, Ra-228, Th-230 Th-228, Pa-231, Ac-227, I-125, I-129[g]	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000α	15,000α	1,000α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above[h]	5,000β-γ	15,000β-γ	1,000β-γ

External Gamma Radiation

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

SOIL GUIDELINES

Radionuclides	**Soil Concentration (pCi/g) Above Background**[i,j,k]
Radium-226 Radium-228 Thorium-230 Thorium-232	5 pCi/g when averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over any 15-cm-thick soil layer below the surface layer.
Other Radionuclides	Soil guidelines are calculated on a site-specific basis, using the DOE manual developed for this use.

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

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

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

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

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

[f] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of

surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels, if direct scan surveys indicate that total residual surface contamination levels are within the limits for removable contamination.

[g] Guidelines for these radionuclides are not given in DOE Order 5400.5; however, these guidelines are considered applicable until guidance is provided.

[h] This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90, which has been separated from the other fission products, or mixtures where the Sr-90 has been enriched.

[i] These guidelines take into account ingrowth of radium-226 from thorium-230 or thorium-232 and radium-228 and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit, or (2) the sum of ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity").

[j] These guidelines represent allowable residual concentrations above background averaged across any 15-cm-thick layer to any depth and over any contiguous 100 m^2 surface area.

[k] If the average concentration in any surface or below-surface area, less than or equal to 25 m^2, exceeds the authorized limit of guideline by a factor of $(100/A)^{½}$, where A is the area or the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the DOE Manual for Implementing Residual Radioactive Materials Guidelines, DOE/CH/890/. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

REFERENCES

1. "U.S. Department Of Energy Guidelines For Residual Radioactive Material At Formerly Utilized Sites Remedial Action Program And Remote Surplus Facilities Management Program Sites", Revision 2, March 1987.

2. "DOE Order 5400.5, Radiation Protection of the Public and the Environment", February 1990.