U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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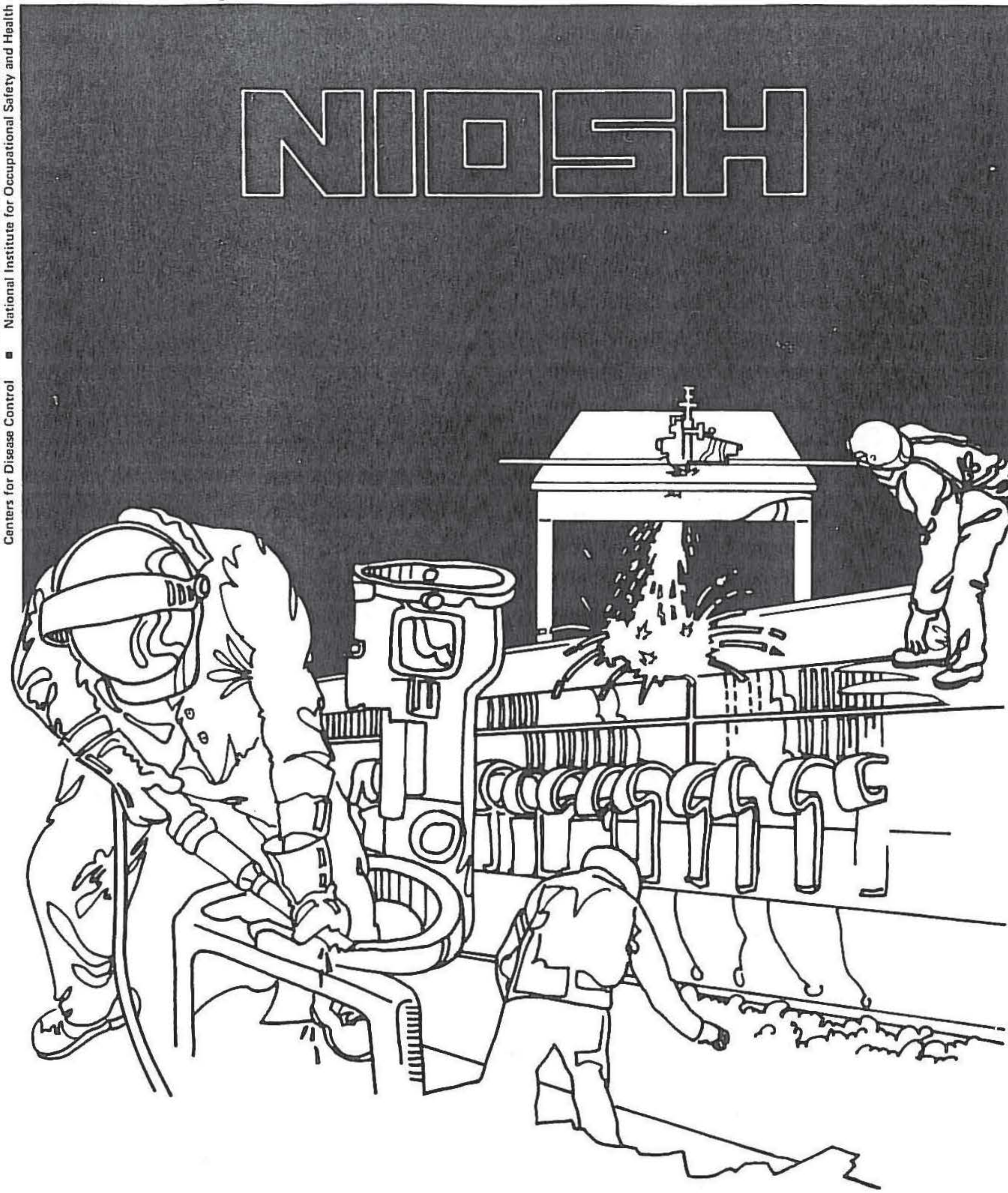

Health Hazard Evaluation Report

HHE 80-052-878
BETHLEHEM STEEL
BUFFALO, NEW YORK

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HE 80-052-878
May 1981
Bethlehem Steel
Buffalo, New York

NIOSH INVESTIGATORS:
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I. SUMMARY

On December 28, 1979 a request was submitted by Local 2603 of the United Steelworkers of America regarding employee exposure to airborne lead, nickel, and chromium at the 13" bar-rolling mill, 631 Department, LaKawanna Division of the Bethlehem Steel Corporation, Buffalo, New York.

The process at the 13" Bar Mill involves rolling various sized, alloyed steel bars.

An initial site visit was made by the National Institute for Occupational Safety and Health (NIOSH) investigators in February, 1980. During this investigation, 12 full-shift breathing zone air samples were obtained for metal analysis and showed non-detectable exposures to nickel or chromium, and lead exposures ranging from 10 to 35 micrograms per cubic meter (ug/M^3); averaging approximately 19 ug/M^3. The current federal standard for lead is 50 ug/M^3 (8 hr. time weighted average). Environmental samples collected for total and respirable particulates, carbon monoxide, and nickel carbonyl were all either of such low concentrations as to be non-detectable or well below their respective recommended and/or federal standards.

Blood was drawn in duplicate from all consenting workers (16) in the study area and analyzed for lead and free erythrocyte protoporphyrin (FEP) level. The highest average blood lead was 33.4 micrograms/deciliter (ug/dl), within the acceptable range, and FEP levels were not suggestive of lead toxicity.

A follow-up evaluation was conducted in December, 1980, in an attempt to document "worst-case" exposure conditions (production of small sized steel bars). Environmental air samples collected for determination of metal fume exposures were analyzed for lead, chromium, and manganese. Twelve personal and 3 general area air samples of this type were collected over 2 shifts. No detectable exposures to chromium were observed and only one sample showed lead content; reported at 9 ug/M^3. Ten personal samples indicated exposure to manganese; ranging from 0.002 to 0.056 milligrams (mg)/M^3. The current federal standard for manganese is 5 mg/M^3. Two samples collected for total particulates and two for respirable particulates showed concentrations well below the current federal standards of 15 and 5 mg/M^3, respectively.

On the basis of the environmental and medical data collected during these investigations, NIOSH has determined that a health hazard does not exist from overexposures to airborne lead, nickel, chromium, manganese, respirable and total particulates, carbon monoxide, or nickel carbonyl at the 13" Bar-Rolling Mill 631 Department, of the Bethlehem Steel Corporation, Buffalo, New York.

KEYWORDS: SIC 3312 (Bar Mill; General Steel), lead, nickel, chromium, manganese, nuisance particulates, carbon monoxide, nickel carbonyl, bar-rolling mill, blood-lead, Free Erythrocyte Protoprophyrin (FEP).

II. INTRODUCTION

On December 28, 1979, a request for a Health Hazard Evaluation was received from the United Steelworkers of America. It stated that a recent environmental compliance survey (May 22, 1979) conducted by OSHA of the 13" bar rolling mill indicated a personal exposure concentration of airborne lead at 29 ug/M^3 (one microgram below the action level of the federal standard for lead). Because this result was at the upper limit of acceptable levels, the employees felt that further investigation of their work environment was warranted. The purpose of the NIOSH investigations was to evaluate employee exposures to airborne substances liberated during the rolling process; particularly lead. During the time of the initial survey, (January 24 and 25, 1980) several employees and union officials stated that production of small sized alloyed steel bars created the most severe exposure conditions, but at the time only the relatively larger bars were being produced (approximately 2.5" diameter). Therefore, a follow-up evaluation was conducted on December 5, 1980, which coincided with the production of the smaller bars (approximately 0.7" diameter).

III. BACKGROUND

Bethlehem Steel, at the Buffalo location, has been involved with production of "basic steel" since 1904. This site employs approximately 1,500 administrative and 6,000 production workers.

The 13" bar-rolling mill has been in operation since 1976, and currently employs approximately 66 workers, 12 of whom are classed as administrative. Work stations and jobs range from labor intensive operations requiring intermittent exposures immediately adjacent to the rolling process, to process control tasks located in enclosed booths or "pulpits". Approximately 20 of the workers have relatively "high-exposure" jobs. Job classifications of workers involved in the evaluations were as follows:

Heater - responsible for transfering heated ingots to the rolling process directly from the furnace. Majority of the shift is spent inside a control booth.
Assistant Roller - supplies Roller with process information; conducts sizing operations.
Mill Adjuster - Adjusts rollers to pre-specified tolerances.
Scrap Burner - Cuts "cobbled" bars into manageable lengths with an acetylene torch.
Roller - responsible for maintaining sequence and size of product; majority of shift is spent inside a control booth.
Crane Operator - operates overhead crane.

The bar-rolling mill is designed to mill hot metal ingots into small diameter (0.7" to 2.5"), usually round bars. Ingots of steel alloy (alloys are usually one or a combination of several metals normally making up a total of less than one percent of the final product) are heated in an oil-fired furnace, and introduced to the rolling process. Bar movement near the end of the rolling process may attain speeds of up to 4200 feet/minute. If a bar jumps the guide track or "cobbles" during the operation, it is transported via overhead crane to a point near the end of the rolling line, cut to manageable-size lengths, and scrapped.

The workers claimed that the smaller sized bars created greater amounts of dust, due to greater bar speeds at the end of the rolling process. Relatively higher exposures are experienced when process problems are encountered which require workers to become active in the process area. This is also true for the scrap burner in that his duty is to cut cobbled bars into manageable lengths.

The bar rolling area is ventilated by natural convection currents. Experimental "Roto-clone" water wash local exhaust ventilation for the rolling mills near the end of the process (these mills create higher quantities of dust due to increased bar speeds) have not as yet operated successfully.

The precise percentage of leaded steel alloy bars of the total bars produced during the evaluations could not be ascertained. Conversations with management and the workers indicated that, overall, leaded heats usually make up approximately six percent of the total. However, during small bar production, leaded heats may make up approximately 25% of the total.

IV. METHODS AND MATERIALS

Medical

During the initial evaluation two blood specimens were drawn from all consenting workers in the study area for lead and free erythrocyte protoporphyrin level. Additionally, each worker was asked what his current job was, duration of employment, previous lead determinations had elsewhere, and lead exposures other than that at work. In all, 16 participated out of a maximum possible workforce of 22 (ie. those workers with potential exposure to relatively higher concentrations of metal fumes, over the two work shifts). They were as follows:

JOB	NUMBER SEEN
Heater	2
Assistant Roller	2
Mill Burner	1
Mill Adjuster	10
Crane Operator	1

Environmental

During the initial evaluation on January 23 and 24, 1980, environmental air samples were collected during two "day" shifts. Thirteen breathing zone samples were collected for approximately 6 hr. periods; 12 of these were analyzed for lead, nickel, and chromium content and one for total dust (all for subsequent determination of time-weighted exposure concentrations in mg or ug/M^3). Eleven general area environmental samples were collected; five analyzed for lead, nickel, and chromium, four for respirable dust, and two for total dust; plus four short-term determinations for carbon monoxide and one for nickel carbonyl.

A return visit was made on December 5, 1980, to evaluate worker exposures under "worst case" conditions (during the production of smaller sized bars). However, problems were encountered and the production of smaller sized bars did not begin until the second shift. Numerous mechanical problems were also encountered during this shift, accounting for approximately 4 hrs. of down time. A total of 159 bars were produced; averaging about 0.7" in diameter. Workers stated that this was representative of a normal shift of small bar production. Only 7 of the 159 small bars were of the lead alloy type; which is a considerably lower percentage than normally occurs (6% actual vs. approximately 25% normally).

Bar production records for both shifts indicated relatively high quantities of manganese with little nickel content. Therefore, environmental air samples were analyzed for manganese instead of nickel, in addition to lead and chromium.

Table 1 presents a summary of sampling and analytical methodology.

V. EVALUATON CRITERIA

The environmental evaluation criteria used in this report as related to airborne exposures to toxic substances are 1) NIOSH recommended standards, 2) Federal Occupational Health Standards (as promulgated and enforced by the Occupational Safety and Health Administration (OSHA), U.S. Department of Labor (29 CFR 1910.1000) and 3) American Conference of Governmental Industrial Hygienists (ACGIH) Treshold Limit Values (TLV's).

The following is a summary of the evaluation criteria for sampled substances:

Substance	Evaluation Criteria*(mg/M^3)		
	NIOSH	OSHA	ACGIH
Lead	0.05	0.05	0.15
Nickel	0.015	1.0	1.0
Chromium (matalic)	-----	1.0	0.5
Manganese	-----	5.0**	5.0
Carbon Monoxide	40	55	55
Nickel Carbonyl	0.001	0.001	0.35
Respirable Particulates	-----	5.0	5.0
Total Particulates	-----	15.0	10.0

* Values represent time-weighted average exposure limits for up to a 10 hr. work-day unless otherwise specified.

** As a ceiling concentration.

VI. RESULTS AND DISCUSSION

Environmental

During the initial evaluation of January 24 and 25, 1980, all analytical results for nickel and chromium were below their respective limits of detection (2 and 3 ug/sample, respectively). A summary of the average personal, or breathing zone samples for lead by job catagory follows:

JOB CATEGORY	# SAMPLES	MEAN (mg/M^3)
Mill Adjuster	5	0.015
Assistant Roller	2	0.017
Scrap Burner	1	0.035
Crane Operator	2	0.018
Heater	2	0.020

Five general area air samples were obtained for lead, nickel, and chromium (once again, all nickel and chromium results were reported below the analytical limit of detection). Two samples each were collected on consecutive days in the hot shear and main pulpits, and one sample was collected in a conference room which was entirely removed from the 13" bar rolling process, yet housed in the same building. Samples collected in the main pulpit were reported as below the analytical limit of detection for lead. Samples collected in the hot shear pulpit were reported at 23.1 and 19.0 ug/M^3. The conference room area sample was reported at 3.7 ug/M^3. Detector tube samples collected for determination of carbon monoxide were all below 5.5 mg/M^3. The sample collected for nickel carbonyl showed airborne concentrations at less than 0.1 ppm. A complete listing of all environmental samples collected during the surveys is contained in Tables 2 and 3.

Samples for metal analysis were collected during two consecutive shifts during the follow-up survey of December 5, 1980, and analyzed for lead, chromium, and manganese. All analytical results for chromium and all but one for lead were below the limits of detection (6 and 5 ug/sample, respectively). A summary of exposures to manganese by shift follows:

1st SHIFT 12-5-80 (Manganese)

JOB CATEGORY	# SAMPLES	MEAN (ug/M^3)
Mill Adjuster	2	5
Assistant Roller	1	3
Scrap Burner	1	10
Crane Operator	1	5
Roller	1	6

2nd Shift 12-5-80 (Manganese)

JOB CATEGORY	# SAMPLES	MEAN (ug/M^3)
Mill Adjuster	2	7
Assistant Roller	1	3
Scrap Burner	1	*
Crane Operator	1	18
Roller	1	7

* Below the limit of detection

Only one of 12 breathing zone samples obtained for lead was above the limit of detection. The time-weighted average exposure for this sample, obtained from the scrap burner, was reported at 6 ug/M^3.

Area samples were collected at a point near the end of the rolling process where dust concentrations were visibly higher. Concentrations of airborne manganese at this sampling location averaged 2 ug/M^3 during the first shift and 32 ug/M^3 during the second shift. These results indicate relatively higher concentrations of airborne substances during the second shift. Similarly, a comparison of personal samples show average exposures of 5.8 ug/M^3 during the first shift versus 8.8 ug/M^3 manganese during the second shift. The probable cause for the lower descrepancy of personal sample results between the two shifts (versus area sample results) deals with the degree of worker contact with the process. During the first shift, rolling mills were changed to accommodate the smaller sized bars. This required close contact with the process while adjustments were being carried out. By the second shift, most adjustments had been made and very little direct involvment with the process was required. The mechanical difficulties experienced during the second shift were, for the most part, in areas down stream of the actual rolling process. This also explains the only detectable lead exposure value, obtained from the scrap burner. While process adjustments are carried out (during the first shift) the tendency for "cobbles" is much greater, thus requiring the services of the this worker.

The highest values of personal lead exposures recorded for both surveys was for the scrap burner, reported at 35.4 ug/M^3 during the initial evaluation, and 6 ug/M^3 during the follow-up survey (the only value above the analytical detection limit during this evaluation). It is difficult to attribute this exposure to scrap buring, or proximity to the bar rolling mill where high bar speeds create relatively greater dust concentrations. Either or both of these circumstances create significant lead exposures. It is important to note that the scrap burner received a time-weighted average exposure to lead above the 30 ug/M^3 "action level" during the initial survey. Within the guidelines of the current federal standard for lead, exceeding the action level initiates several requirements of the standard, such as exposure monitoring, medical surveillance, and training and education.

Appreciable exposures to lead were detected inside the hot shear pulpit. The physical characteristics of this essentially enclosed pulpit would seem to facilitate rather simple remedial action to reduce exposures.

An unhygienic practice was observed in the scrap burning area, involving the open burning of trash. Articles such as boxes, cups, and papers were deposited on hot, scraped bars and ignited.

Medical

Table 4 presents results of blood lead and FEP analysis. Both NIOSH and the Utah Biomedical Test Laboratory analyzed the specimens for blood lead levels. Since the mean difference between the two values is only -0.4 with a standard deviation of 5.0, the average of the two measurements is used as the most reliable figure for a worker's blood lead level. The mean blood lead level is 18.3 ug per deciliter of whole blood (ug/dl) with a standard deviation of 4.8. The highest average blood lead is only 33.4 ug/dl, within the acceptable range (less than 40 ug/dl).

The mean of the logarithms of the FEP values shows a slight elevation, but not to excessive levels. Twelve of the 16 workers had an FEP value above the normal range, but none were high enough to suggest excessive exposures to lead over the three to four months prior to testing. No differences in lead levels were noted between job classifications. The highest blood lead was found from a mill adjuster.

VII. CONCLUSIONS AND RECOMMENDATIONS

Based on the blood lead and FEP determinations there appears to be consistent lead exposure to the workers. Blood lead levels are within the normal range, and FEP's are slightly elevated. Based on the medical data, there is no hazard from lead exposure at this site.

At the time of the surveys, hazardous exposure conditions did not exist with regard to airborne concentrations of lead, chromium, nickel, manganese, total and respirable particulates, carbon monoxide, or nickel carbonyl.

Comparative evaluations of the environmental survey results indicate that bar size is not necessarily related to the extent of lead exposure. Although it was not possible to compare the proportion of leaded bars produced during each survey, this parameter is most likely responsible for the degree of worker exposure.

Obvious difficulties were encountered in coordinating the NIOSH hazard evaluation with the intermittent small bar production and use of lead alloy in significant quantities during this production. Although blood lead determinations and corresponding FEP's indicated nonhazardous chronic exposures, there is a concern for short-term, or acute exposure conditions. On this basis, the following recommendation is made.

1) Environmental data obtained by the Bethlehem Steel Department of Environmental Health at the 13" Bar Rolling Mill should be thoroughly discussed with the appropriate employees and union personnel. Furthermore, if employees and union officials feel that the "worst case" situations have not been sufficiently evaluated toward acute exposure conditions, then the company should further study the situation. Special consideration should be given to rate of production, bar size, and the percentage of leaded heats during sample collection.

The following recommendation is based on results of environmental monitoring.

2) Follow-up environmental monitoring at the scrap burner position should be conducted. A time-weighted exposure to airborne lead was measured in excess of the "action level", as discussed in the Federal Register, appearing October 23, 1979, Vol. 44, No. 206.

The following recommendation is based on observations made during the site visits.

3) Discontinue the practice of burning trash in the bar mill.

VIII. ACKNOWLEDGEMENTS

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Table 1

Air Sampling and Analysis Methodology
Bethlehem Steel
Buffalo, New York

HE 80-52

Substance	Collection Device	Flow Rate (lpm)	Duration	Analysis	Detection Limit	Reference
Lead	"AA" Millipore Filter	1.5	6-8 hrs	Atomic-spec	3/5 ug*	P&CAM 173
Nickel	"AA" Millipore Filter	1.5	6-8 hrs	Atomic-spec	2 ug	P&CAM 173
Chromium	"AA" Millipore Filter	1.5	6-8 hrs	Atomic-spec	3/6 ug*	P&CAM 173
Manganese	"AA" Millipore Filter	1.5	6-8 hrs	Atomic-spec.	1 ug	P&CAM 173
Total Dust	FWSB pre-wieghed filter	1.5	6-8 hrs	Electrobalance	0.01 mg	# 29.02**
Respirable Dust	FWSB filter w/cyclone	1.7	6-8 hrs	Electrobalance	0.01 mg	# 29.02**
Nickel Carbonyl	Detector Tube	---	1-2 min	Visual	0.1 ppm	----------
Carbon Monoxide	Detector Tube	---	1-2 min	Visual	5.0 ppm	----------

* Jan. 1980/Dec. 1980 evaluations; limits of detection varied.
** NIOSH Manual of Sampling Data Sheets.

TABLE 2

Analytical Results of Breathing Zone and
Area Environmental Air Samples
Bethlehem Steel
Buffalo, New York

January 23-24, 1980
HE 80-52

BREATHING ZONE RESULTS

Job Category	Date	Duration	Substance and Concentrations (ug/M³)		
			Lead	Nickel*	Chromium*
Mill Adjuster	1-23-80	07:50 - 14:30	17	Lt 3**	Lt 5
Assistant Roller	1-23-80	07:45 - 14:30	20	Lt 3	Lt 5
Scrap Burner	1-23-80	07:55 - 14:30	35	Lt 3	Lt 5
Mill Adjuster	1-23-80	08:03 - 14:30	12	Lt 3	Lt 5
Crane Operator	1-23-80	08:09 - 14:15	20	Lt 4	Lt 6
Mill Adjuster	1-23-80	08:08 - 14:30	24	Lt 4	Lt 5
Heater	1-23-80	08:20 - 14:14	25	Lt 4	Lt 6
Assistant Roller	1-24-80	07:25 - 13:40	15	Lt 4	Lt 7
Mill Adjuster	1-24-80	07:30 - 14:10	12	Lt 3	Lt 5
Mill Adjuster	1-24-80	07:32 - 13:57	10	Lt 4	Lt 5
Crane Operator	1-24-80	07:40 - 13:47	16	Lt 4	Lt 5
Heater	1-24-80	07:56 - 14:06	16	Lt 4	Lt 5
AREA RESULTS					
Area Location					
Conference Room	1-23-80	07:31 - 14:16	4	Lt 3	Lt 4
Hot Shear Pulpit	1-23-80	08:15 - 14:30	23	Lt 4	Lt 5
Main Pulpit	1-23-80	08:27 - 14:35	Lt 5***	Lt 4	Lt 5
Hot Shear Pulpit	1-24-80	07:42 - 14:07	19	Lt 4	Lt 6
Main Pulpit	1-24-80	07:56 - 14:06	Lt 6***	Lt 4	Lt 6
			Carbon Monoxide (ppm)		
Roller Station	1-23-80	-----		Lt 5	
Center of Mill	1-23-80	-----		Lt 5	
Hot Shear Pulpit	1-23-80	-----		Lt 5	
Top of Furnace	1-23-80	-----		Lt 5	
			Nickel Carbonyl (ppm)		
Center of Mill	1-23-80	-----		Lt 0.1	
			Respirable Dust (mg/M³)		
Crane Cab	1-23-80	08:10 - 14:35		0.26	
Hot Shear Pulpit	1-23-80	08:15 - 14:30		0.33	
Hot Shear Pulpit	1-23-80	07:42 - 14:07		0.41	
			Total Dust (mg/M³)		
Main Pulpit	1-23-80	08:27 - 14:35		0.11	
Main Pulpit	1-24-80	07:55 - 13:53		0.04	

* All values reported below the 2 ug limit of detection for nickel and 3 ug limit of detection for chromium.

** Lt = "Less than". "Less than" values are indicative of the highest average exposures possible during the sampling period, but do not necessarily indicate that these compounds were present. Sampled air volume and minimum detection limits/sample were used to calculate these values.

*** Reported below the 3 ug limit of detection.

TABLE 3

Analytical Results of Breathing Zone and Area
Environmental Air Samples
Bethlehem Steel
Buffalo, New York

December 5, 1980
HE 80-52

BREATHING ZONE RESULTS

Job Category	Shift	Duration	Exposure Concentration (ug/M^3)		
			Lead	Manganese	Chromium*
Mill Adjuster	First	07:05 - 15:32	Lt 8**/***	5	Lt 9
Roller	First	07:56 - 15:26	Lt 8	6	Lt 9
Scrap Burner	First	07:07 - 14:41	6	10	Lt 9
Mill Adjuster	First	07:51 - 14:05	Lt 9	4	Lt 11
Assistant Roller	First	07:02 - 15:06	Lt 7	3	Lt 8
Crane Operator	First	08:05 - 15:02	Lt 8	5	Lt 10
Assistant Roller	Second	15:28 - 22:34	Lt 8	6	Lt 9
Mill Adjuster	Second	16:02 - 22:36	Lt 9	7	Lt 10
Mill Adjuster	Second	16:12 - 22:41	Lt 9	7	Lt 10
Crane Operator	Second	15:55 - 22:53	Lt 8	18	Lt 10
Scrap Burner	Second	15:20 - 22:07	Lt 8	Lt 2	Lt 10
Roller	Second	16:05 - 22:49	Lt 8	7	Lt 10

AREA RESULTS

Location					
# 22 Mill	First	08:15 - 14:25	Lt 9	2	Lt 11
Between # 18 & # 20 Mills	Second	15:12 - 21:02	Lt 10	23	Lt 11
Between # 18 & # 20 Mills	Second	21:02 - 23:00	Lt 28	57	Lt 34

* All values reported below the 6 ug limit of dection.

** Lt = "Less than". "Less than" values are indicative of the highest average exposures possible during the sampling period, but do not necessarily indicate that these compounds were present. Sampled air volume and minimum detection limits/sample were used to calculate these values.

*** Reported below the 5 ug limit of detection.

TABLE 4

BLOOD LEAD (PbB) and FREE ERYTHROCYTE
PROTOPORHYRIN (FEP) LEVELS
Bethlehem Steel
Buffalo, New York

January 22-24, 1980
HE 80-52

PbB (ug/deciliter whole blood)*			FEP (ug/liter whole blood)**	
UBTL	NIOSH	Average	Actual Value	Log FEP
14	13	13.5	405	2.6075
17	12	14.5	355	2.5502
18	11	14.5	355	2.5502
15	14	14.5	405	2.6075
17	14	15.5	405	2.6075
14	18	16	405	2.6075
16	18	17	255	2.4065
14	20	17	505	2.7033
11	24	17.5	455	2.6580
18	19	18.5	405	2.6075
21	16	18.5	455	2.6580
19	19	19	455	2.6580
22	18	20	405	2.6075
23	19	21	405	2.6075
24	20	22	355	2.5502
33	34	33.5	505	2.7033
Totals				
Number				
16	16	16	16***	16
Mean				
18	18.1	18.3	408.1	2.6056
Std. Dev.				
5.3	5.5	4.8	61.8	0.0713

* Normal = less than 40 ug/dl. Greater than 60 ug/dl is considered unacceptable.

** Normal = 92 - 365. Actually normal values are given for FEP in microgram/l, Red Blood Cells. Because hemanalysis required results be reported in microgram/l whole blood the normals were transformed assuming a hematocrit of 42%. An FEP of greater than 1050 is suggestive of lead toxicity.

*** Based on antilogs of the log FEP data. Std. Deviation line gives the values at -1 std. dev. and +1 std. dev.

Estimated blood-lead for the mean Log FEP is 20.3 microgram/dl. whole blood.

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