

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO

HEALTH HAZARD EVALUATION DETERMINATION REPORT
HE 79-110-700

GLOBE METALLURGICAL
A DIVISION OF INTERLAKE, INC.
BEVERLY, OHIO

JUNE 1980

I. SUMMARY

A health hazard evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) at Globe Metallurgical, a division of Interlake, Inc., in Beverly, Ohio between June and November 1979, to evaluate reports of various irritative, respiratory, gastrointestinal, and constitutional symptoms among workers producing rare earth silicide. The evaluation consisted of a telephone survey of employees followed by a medical-environmental study at the plant. The study included Furnace No.1 workers, where the rare earth silicide is produced, and Furnace No.6 workers, where an unrelated alloy material is processed.

Personal breathing zone samples for the rare earth metals, and for iron, lead, arsine, phosphine, and total particulate, and area samples for fluorides were collected. Sample results for the rare earth metals showed the following concentrations: lanthanum, 4 $\mu\text{g}/\text{M}^3$ to 0.52 mg/M^3 ; cerium, 1 $\mu\text{g}/\text{M}^3$ to 0.92 mg/M^3 ; praseodymium, 2 $\mu\text{g}/\text{M}^3$ to 1.6 mg/M^3 ; neodymium, 2 $\mu\text{g}/\text{M}^3$ to 2.1 mg/M^3 . Permissible exposure levels (PEL) for the rare earth metals have been established. Iron oxide concentrations ranged from 0.1 mg/M^3 to 0.94 mg/M^3 (PEL-5 mg/M^3), and lead concentrations ranged from 1 $\mu\text{g}/\text{M}^3$ to 25 $\mu\text{g}/\text{M}^3$ (PEL-50 $\mu\text{g}/\text{M}^3$). Arsine concentrations ranged from 0.001 ppm to 0.002 ppm (PEL-0.05 ppm). No phosphine was detected. Area samples for fluorides showed concentrations of 0.01 mg/M^3 to 0.07 mg/M^3 (PEL-2.5 mg/M^3). Total particulate levels on ladlemen and helpers ranged from 4.5 mg/M^3 to 69.8 mg/M^3 ; 2 of 4 exceeded the PEL of 10 mg/M^3 .

The preliminary medical survey of 98 employees indicated that Furnace No.1 workers were more likely to report one or more symptoms than other workers. Symptoms of mucous membrane irritation were the most commonly reported. The follow-up medical questionnaire showed no statistically significant difference in reported symptoms between Furnace No.1 and Furnace No.6 employees. The blood tests showed no evidence of hemolytic anemia (an effect of arsine exposure).

Although Furnace No.1 employees had greater exposures to fluoride, iron oxide, and lead than Furnace No.6 employees, none of the concentrations measured would ordinarily be expected to produce adverse health effects. Furnace No.1 employees were also exposed to greater concentrations of rare earths; the health effects of these exposures are not known. No acute work-related health effects or toxic exposure were documented during the on-site phase of the study, but symptoms reported as occurring during previous rare earth production runs suggest the possibility that phosphine exposures occurred. Ladlemen were overexposed to total particulates. Recommendations concerning these problems are given on page 8.

II. INTRODUCTION

Under the Occupational Safety and Health Act of 1970*, NIOSH investigates the toxic effects of substances found in the workplace. NIOSH received a request from the United Steel Workers of America, Local 6856 to conduct an investigation at Interlake, Incorporated. The investigation was requested to evaluate health problems experienced by employees during the production of rare earth silicide. Reported symptoms included dizziness, headaches, chest pains, nosebleeds, and weakness.

III. BACKGROUND

Globe Metallurgical, a division of Interlake, Inc., manufactures various ferroalloy materials. The rare earth production is limited to one of six furnaces, Furnace No.1, on an irregular basis. (Production is scheduled as demand for the product requires.) The process consists of charging, tapping, pouring, and casting operations. Upon completion of these operations, the rare earth silicide is removed to another building where it is stored in an open bin until it is packaged for shipment.

The main material used in the production of rare earth silicide is bastnasite ore, which consists of barium, strontium, and calcium oxides, and rare earth oxides in the form of fluorocarbonates. During the process, there is a possibility of production and release of acetylene, phosphine, arsine, and fluorides, as well as the various dusts which may be present during handling. The rare earth metals in bastnasite include lanthanum, cerium, praseodymium, and neodymium. Approximately five employees work on Furnace No.1 each shift.

*Section 20 (a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669 (a)(6), authorizes the Secretary of Health and Human Services, following a written request by an 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.

Contact with rare earth materials also occurs during the clean-out and repair of ladles. Usually two employees work at this job. Workers are exposed to high levels of dusts during the loosening and removal of materials which have built up in the ladles. In addition, arsine and phosphine may be generated if moisture comes into contact with the phosphides in the product.

IV. EVALUATION DESIGN AND METHODS

Globe had conducted three rare earth campaigns* - December 1977, February-March 1978, and May-June 1979. The request for a health hazard evaluation was received by NIOSH during the last few days of the May-June 1979 campaign. At that time an initial walk-through survey of the plant was conducted and process information was obtained. Since there was not sufficient time to conduct an on-site medical-environmental survey before the campaign ended, a telephone survey of health effects was conducted and followed-up by a medical-environmental survey during the next rare earth campaign.

A. Preliminary Medical Survey

From July 16 through 27 a telephone survey of a sample of employees was conducted. The sample was designed to include all furnace employees exposed to the rare earth process, a comparable number of other furnace employees, and a comparable number of employees from other departments. To accomplish this, the following employees were selected: (a) all employees listed on work rosters as having worked on Furnace No.1 during the May-June 1979 rare earth campaign, (b) every second remaining furnace department employee, (c) every ladle department employee, (d) every third yard department employee, (e) every second maintenance department employee, and (f) every second shipping department employee.

Eliminating those employees who had no telephone, the actual sample eventually included 122 people: 40 presumably exposed to the rare earth process, 38 other furnace department employees, 5 ladle department employees, 9 yard department employees, 18 maintenance department employees, and 12 shipping department employees.

Unless a telephone number was incorrect or out of service, or unless specific information was received that an employee was not reachable during the survey period, at least three (and usually more) attempts were made to call an employee before giving up. Calls were made during daytime and early evening hours. Most of the interviewing was done by a physician's assistant, and the remainder by three lay interviewers.

* "Campaign" is the term used at the plant to refer to a production run of a particular material.

The questionnaire asked about a variety of symptoms occurring during the preceding two years, their perceived relationship to work, and their occurrence during the three rare earth campaigns. It also included questions about past and present medical history, occupational history at Interlake, and use of medicines, cigarettes, and alcoholic beverages.

B. Environmental Survey

A follow-up medical-environmental survey was conducted November 6 and 7, 1979. (The 2-month rare earth campaign had started September 22, 1979.) To determine if the exposure of employees working on the rare earth process varied significantly from that of other employees in similar jobs, environmental samples were collected on both Furnace No.1 and Furnace No.6 workers. Furnace No.6, which produced an unrelated alloy material, was the furnace most distant from Furnace No.1. Area samples were also collected at the two furnaces.

Personal breathing zone samples were collected during normal operating conditions over the workshift for total particulate, iron oxide, the rare earths, lead, phosphine, and arsine on Furnace No.1 and Furnace No.6 personnel as well as several ladlemen. Area samples for fluoride were also taken at the two furnaces. Samples for total particulate were collected on preweighed filters at a flowrate of 1.5 l/min, and analyzed gravimetrically. Arsine samples were collected on charcoal tubes at a flowrate of 20 cc/min and analyzed by the borohydride method of Pierce, (J. App. Spect. Vol. 30, No.1, 1976). Samples for phosphine were collected in tubes containing coated silica gel at a sampling rate of 50 cc/min. The tubes were prepared and analyzed according to NIOSH Method S332. Fluoride samples were collected using both filters and impingers containing 0.1M sodium hydroxide at a flowrate on 1 l/min. Analysis for fluoride was performed according to NIOSH Method No. P and CAM 212. Filter samples were collected at a flowrate of 1.5 l/min which were analyzed for lead, iron, cerium, lanthanum, praseodymium, and neodymium by inductively coupled plasma atomic emission spectroscopy.

C. Follow-up Medical Survey

All Furnace No.1 and Furnace No.6 employees from three consecutive shifts were invited to participate in the medical study. "Furnace employees" were those employees whose jobs necessitated them being at one, and only one, furnace during the entire shift. There were five such jobs at Furnace No.1: furnace operator, crane operator, tapper, helper, and mixman. Furnace No.6 had no mixman and thus had only four positions.

The medical study consisted of an interviewer-administered questionnaire and blood tests. The questionnaire focused on symptoms that occurred during the workshift, but also included questions about illnesses occurring over the preceding two months (the period of the rare earth campaign) and about consumption of medicines, cigarettes, and alcoholic beverages in the proceeding 24 hours. Information about work history since September 1 was obtained by a physician's assistant and was not seen by the physician or the

toxicologist who administered the medical questionnaires. The blood tests included hemoglobin, hematocrit, red blood cell count, mean corpuscular hemoglobin, mean corpuscular volume, and mean corpuscular hemoglobin concentration, and serum haptoglobin.

V. EVALUATION CRITERIA

Phosphine and arsine are the toxic substances of primary concern in this investigation since, among the ores used at Interlake, apparently only the bastnasite contains the arsenites and phosphates required for their generation. Phosphine^{1,2} is a severe respiratory tract irritant; symptoms of toxicity include chest tightness, shortness of breath, cough, nausea, vomiting, diarrhea, headache, dizziness, chills, excessive thirst, and muscle pain. Arsine³⁻⁵ is an extremely toxic agent that causes hemolysis (destruction) of red blood cells, leading to jaundice, and kidney failure. Symptoms of arsine toxicity include headache, weakness, dizziness, shortness of breath, nausea, vomiting, abdominal pain, and dark red urine.

There is no laboratory test available to detect chronic, mild phosphine toxicity. However, hemolysis (due to arsine or other causes) is readily detected. Since haptoglobin binds extracellular hemoglobin, abnormal hemolysis will result in a decrease in a serum haptoglobin. Such hemolysis will also eventually result in a decreased number of red blood cells (which will be of normal size and will have normal hemoglobin content).

There is no available information concerning the health effects of rare earth exposure.

To assess the concentrations of air contaminants found in the place of employment, three primary sources of criteria were used: (1) NIOSH criteria for recommended standards for occupational exposure to substances (Criteria Documents), (2) recommended and proposed Threshold Limit Values (TLV's) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH) (1979), and (3) occupational health standards as promulgated by the U.S. Department of Labor (29 CFR part 1910). Pertinent exposure criteria are shown below.

<u>Substance</u>	<u>NIOSH Recommended Criteria</u>	<u>ACGIH TLV</u>	<u>OSHA Standard</u>
Total Particulate	--	10 mg/M ³	15 mg/M ³
Iron Oxide	--	5 mg/M ³	10 mg/M ³
Lead	0.1 mg/M ³	0.15mg/M ³	0.05mg/M ³ *
Arsine	--	0.05 ppm	0.05 ppm
Phosphine	--	0.3 ppm	0.3 ppm
Fluoride	2.5 mg/M ³	2.5 mg/M ³	2.5 mg/M ³

*0.1 mg/M³ currently being enforced for this industry

VI. RESULTS AND DISCUSSION

A. Preliminary Medical Survey (Telephone interviews)

NIOSH contacted 98 (80 percent) of the 122 persons in the selected sample; all but one agreed to be interviewed. During all three rare earth campaigns employees working at Furnace No.1 were significantly more likely to have reported one or more symptoms than were employees who did not work at Furnace No.1 (Table 1). However, because of probable differences in recall between the two groups with respect to both the occurrence and timing of symptoms (especially minor common symptoms), the observed differences and symptom rates should not be considered to be more than suggestive of an actual difference.

Among symptomatic persons who worked at Furnace No.1, the type of symptoms were more suggestive of the effects of phosphine than arsine; mucous membrane irritation was common, and only one person reported dark or discolored urine.

B. Follow-up Medical and Environmental Study

1. Medical

One Furnace No.1 employee worked two of the shifts studied. There were thus 14 Furnace No.1 and 12 Furnace No.6 employees eligible for the study. All agreed to complete the questionnaire, and all but one, a Furnace No.1 employee, agreed to have the blood tests. All but four Furnace No.1 employees had worked only on Furnace No.1 since the rare earth campaign began, and three of these four had worked on Furnace No.1 for the preceding three weeks. The remaining person had worked on Furnace No.1 intermittently and only for the last two days of the week preceding this study. All but one Furnace No.6 employee had not worked on Furnace No.1 since the rare earth campaign began; the one exception had worked on Furnace No.1 (and other furnaces) until two days previously.

The two groups had comparable age distributions. The Furnace No.1 employees ranged in age from 19 to 57, with a median of 37 and a mean of 35; the Furnace No.6 employees' ranged from 21 to 53, with a median of 38 and a mean of 37.

The prevalences of the 33 symptoms included in the questionnaire are shown in Table 2. The most commonly reported symptom in both groups was "congested or runny nose"; seven of the fourteen Furnace No.1 employees and four of the twelve Furnace No.6 employees reported this. There was no statistically significant difference between Furnace No.1 and Furnace No.6 employees for any of the symptoms.

There were two symptoms which more than one person reported occurring only after starting work the day of the interview. Three (21 percent) of the Furnace No.6 employees reported "headache". Four (29 percent) of the Furnace No.1 employees reported "congested or runny nose". Neither of these differences is statistically significant at the 0.1 level.

None of the blood tests showed any significant differences between Furnace No.1 and Furnace No.6 employees (Table 3). None of the haptoglobin levels were below the laboratory's normal range, 25-180 mg/dl, and none of the blood cell analyses showed a pattern suggestive of hemolytic anemia. Thus, there was no evidence of arsine toxicity at the time of the follow-up medical survey.

2. Environmental

The individual sample results from the environmental monitoring are presented in Tables 4-7. Arsine concentrations of Furnace No.1 workers were found to be between 0.001 ppm and 0.002 ppm. Of the three samples collected on Furnace No.6 employees, two showed 0.002 ppm levels and one had no detectable level. The recommended exposure limit for arsine is 0.05 ppm. Total fluoride concentrations, as determined by area samples, ranged from 0.01 mg/M³ to 0.07 mg/M³. The current standard for fluoride is 2.5 mg/M³. Sample results for iron oxide, lead, lanthanum cerium, praseodymium, and neodymium are presented in Table 6. Iron oxide levels range from 0.1 mg/M³ to 0.94 mg/M³ (PEL-5 mg/M³). Lead concentrations ranged from non-detected to 25 μ g/M³ (PEL-50 μ g/M³). The rare earth concentrations were as follows: lanthanum, 4 μ g/M³-0.52 mg/M³; cerium, 1 μ g/M³-0.92 mg/M³; praseodymium, 2 μ g/M³-1.6 mg/M³; neodymium, 2 μ g/M³-2.1 mg/M³.

Permissible exposure levels have not been established for the rare earth metals. A total of 16 personal breathing zone samples were collected for phosphine; 6 on Furnace No.1 workers, 7 on Furnace No.6 personnel, 2 on ladlemen, and one on the slag truck driver. No detectable levels of phosphine were found. The limit of detection for phosphine was 0.5 μ g/sample.

To determine if significant differences in exposure existed between Furnace No.1 and Furnace No.6 employees, mean concentrations for the various substances were compared for the two groups of workers. The mean arsine exposure of the five Furnace No.1 employees monitored (0.0014 ppm) was similar to that of the three Furnace No.6 employees monitored (0.0013 ppm). Compared to Furnace No.6 workers, Furnace No.1 employees had a greater mean exposure to iron oxide (0.30 mg/M³, 8 samples vs. 0.14 mg/M³, 6 samples), lead (6.1 μ g/M³, 8 samples vs. 1.4 μ g/M³, 6 samples) and total fluoride (0.03 mg/M³ vs. 0.0075 mg/M³, 4 area samples each), but all exposures were well below the levels at which symptoms would ordinarily be expected to occur.

Furnace No.1 employees were exposed to greater concentrations of rare earths than Furnace No.6 employees; mean concentrations were: lanthanum, 150 μ g/M³ vs. 8 μ g/M³; cerium, 147 μ g/M³ vs. 0.17 μ g/M³; praseodymium, 243 μ g/M³ vs. 7.6 μ g/M³; and neodymium, 285 μ g/M³ vs. 5.5 μ g/M³. In the absence of any measured biological effects at the time of the testing or any available information on effects of exposure to rare earth metals, NIOSH is unable to determine the significance of these exposures to workers' health.

Total particulate levels measured on the ladlemen and helpers showed concentrations ranging from 4.5 mg/M³ to 69.8 mg/M³ (Table 7). Two of the four sample concentrations exceeded both the ACGIH TLV of 10 mg/M³ for total particulate and the OSHA standard of 15 mg/M³.

VII. RECOMMENDATIONS

1. Management has developed an excellent training program on rare earth materials for supervisory personnel. This training should be extended to all personnel working with any form of the rare earth materials.
2. Employees should inform management of any symptoms experienced while working with rare earths. Findings of this study indicate that biologically significant exposures may be occurring in the presence of improper production or work practices. Management should carefully check for these when symptoms are reported.
3. The rare earth silicide should be stored in a properly ventilated location.
4. Local exhaust ventilation should be provided for the ladlemen and helpers. Due to the changing locations of the job and the varied positions of the workers, a portable ventilation system with a flexible duct should be considered. Until local exhaust ventilation can be provided, ladlemen and helpers should wear respiratory protection. Section 1910.134 of OSHA outlines the minimal acceptable program.

VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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IX. REFERENCES

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4. Fowler BA, Weissberg JB: Arsenic Poisoning. N Engl J. Med 291: 1171-1174, 1974.
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X. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this report are currently available upon request from NIOSH, Division of Technical Services, Publications Dissemination, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161.

Copies of this report have been sent to:

- a) Interlake, Incorporated, Beverly, Ohio
- b) United Steelworkers of America, Local 6856
- c) United Steelworkers International
- d) U. S. Department of Labor, Region V
- e) NIOSH, Region V

For the purpose of informing the approximately 40 "affected employees", the employer shall promptly "post" the determination report for a period of 30 days in a prominent place near where exposed employees work.

TABLE 1
PREVALENCE OF SYMPTOMS DURING RARE EARTH CAMPAIGNS

INTERLAKE, INC.
BEVERLY, OHIO

Department	Worked at Furnace #1	Symptomatic Employees/Total Employees (%)		
		December 1977	February-March 1978	May-June 1979
Furnace	Yes	12/18 ^A (67)	13/20 ^B (65)	16/36 ^A (44) [*]
	No	0/27 ^C (0)	0/25 (0)	1/21 ^C (5) [*]
Maintenance	Yes	0/7 (0)	0/7 (0)	2/10 (20)
	No	1/4 (25)	1/4 (25)	1/5 (20)
Shipping	Yes	0/1 (0)	0/1 (0)	0/1 (0)
	No	0/6 ^C (0)	0/6 ^C (0)	0/9 ^C (0)
Ladle	Yes	2/3 (67)	0/3 (0)	1/3 (33)
	No	0/2 (0)	0/2 (0)	0/2 (0)
Yard	Yes	0/0 (-)	0/0 (-)	0/1 (0)
	No	0/4 ^C (0)	1/4 ^C (25)	0/4 ^C (0)
Total	Yes	14/29 (48)	13/31 (42)	19/51 (37) ^{**}
	No	1/43 (2)	2/41 (5)	2/41 (5) ^{**}

A - Excludes 2 persons in which presence of symptoms is uncertain.

B - Excludes 3 persons in which presence of symptoms is uncertain.

C - Excludes 1 persons in which presence of symptoms is uncertain.

* - $\chi^2 = 8.17$, $p < 0.01$

** - $\chi^2 = 11.75$, $p < 0.001$

TABLE 2

CURRENT SYMPTOMS, NOVEMBER 6/7, 1979

INTERLAKE, INC.
BEVERLY, OHIO

Symptoms	Number of Employees and (%) Reporting Symptoms	
	14 Furnace #1 Employees	12 Furnace #6 Employees
Tiredness or fatigue	1 (7)	2 (17)
Lightheadedness	0 (-)	0 (-)
Dizziness	0 (-)	0 (-)
Weakness	0 (-)	0 (-)
Headache	3 (21)	2 (17)
Nervousness	0 (-)	0 (-)
Double vision	0 (-)	0 (-)
Eye irritation	1 (7)	1 (8)
Puffy eyelids	0 (-)	0 (-)
Nose irritation	0 (-)	2 (17)
Congested or runny nose	7 (50) A	4 (33) A
Nosebleed	1 (7)	0 (-)
Dry mouth	1 (7)	2 (17)
Sore throat	0 (-)	0 (-)
Difficulty swallowing	0 (-)	1 (8)
Coughing	0 (-)	1 (8)
Soreness or tightness in your chest	0 (-)	0 (-)
Shortness of breath	2 (14) B	0 (-) B
Decreased appetite	1 (7)	0 (-)
Nausea	0 (-)	0 (-)
Vomiting	0 (-)	0 (-)
Abdominal pains or cramps	0 (-)	0 (-)
Diarrhea	0 (-)	0 (-)
Numbness, tingling, or burning sensations in your hands or feet	1 (7)	0 (-)
Joint pains	2 (14)	1 (8)
Muscle cramps in your legs	1 (7)	0 (-)
Tremors or shaking in your hands	2 (14)	0 (-)
Blood in your urine	0 (-)	0 (-)
Pain in your neck when you urinate	0 (-)	0 (-)
Fever	0 (-)	0 (-)
Chills	0 (-)	0 (-)
Yellow eyes or skin	0 (-)	0 (-)
Loss of hair	0 (-)	0 (-)

A - $\chi^2 = 0.21$, $p > 0.5$ B - $p = 0.28$, Fisher's exact test

TABLE 3

BLOOD TEST RESULTS

INTERLAKE, INC.
BEVERLY, OHIO

November 1979

Test	12 ^{A,B} Furnace #1 Employees	11 ^A Furnace #6 Employees
Haptoglobin		
Range	85-240 mg/dl	42-215 mg/dl
Mean	144 \pm 14 ^C	150 \pm 17
Red blood cell count		
Range	4.17 - 5.50 million/u1	4.62 - 5.45 million/u1
Mean	4.92 \pm 0.11	4.91 \pm 0.08
Hemoglobin		
Range	14.0-16.9 gm/dl	14.4 - 16.6 gm/dl
Mean	15.4 \pm 0.2	15.2 \pm 0.2
Hematocrit		
Range	42.0 - 49.0 %	42.0 - 47.4 %
Mean	45.3 \pm 0.6	44.5 \pm 0.5
Mean Corpuscular Volume		
Range	81.0 - 103.3 μ m ³	84.1 - 94.9 μ m ³
Mean	92.4 \pm 1.7	90.8 \pm 1.0
Mean Corpuscular Hemoglobin		
Range	27.8 - 34.6 μ ug	29.0 - 32.3 μ ug
Mean	31.5 \pm 0.6	31.1 \pm 0.3
Mean Corpuscular Hemoglobin Concentration		
Range	33.3 - 35.0 %	33.4 - 35.7 %
Mean	34.1 \pm 0.2	34.3 \pm 0.2

A - Excludes 1 employee who had not been working continuously on this furnace.

B - Excludes 1 employee who did not have the blood tests.

C - Standard error of the mean.

TABLE 4
ARSINE CONCENTRATIONS
INTERLAKE, INC.
BEVERLY, OHIO

<u>Sample Location</u>	<u>Sample Description</u>	<u>Sampling Time</u>	<u>Sample Volume (liters)</u>	<u>Arsine (ppm)</u>
November 6, 1979				
Furnace 1	Mixer	1653 - 2238	7.2	0.002
Furnace 1	Tapper	1727 - 2247	6.7	0.001
Furnace 1	Helper	1650 - 2232	6.9	0.001
Furnace 6	Tapper	1740 - 2246	8.2	0.002
Furnace 6	Helper	1707 - 2244	7.0	N.D.*
November 7, 1979				
Furnace 1	Tapper	0747 - 1450	10.0	0.001
Furnace 1	Helper	0750 - 1447	8.4	0.002
Furnace 6	Tapper	0900 - 1524	5.0	0.002
	Slag Truck Driver	0831 - 1412	7.4	.002
* N.D. - Not Detected				
Recommended Permissible Exposure Limit				0.05

TABLE 5
FLUORIDE CONCENTRATIONS
INTERLAKE, INC.
BEVERLY, OHIO

<u>Sample Location</u>	<u>Sample Number</u>	<u>Sampling Time</u>	<u>Sample Volume (liters)</u>	<u>Fluoride (Filter) (mg/M3)</u>	<u>Fluoride (dmpinger) (mg/M3)</u>	<u>Total Fluoride (mg/M3)</u>
November 6, 1979						
Furnace 1 (Pouring Area)	9	1800 - 2017	257	N.D. *	0.02	0.02
Furnace 1 (2nd Floor-Behind Furnace)	8	1807 - 2020	253	0.03	0.04	0.07
Furnace 6 (Pouring Area)	10	1810 - 2012	242	N.D.	0.01	0.01
Furnace 6 (2nd Floor-Behind Furnace)	11	1817 - 2015	238	N.D.	N.D.	N.D.
November 7, 1979						
Furnace 1 (Pouring Area)	25	0852 - 1415	323	0.01	N.D.	0.01
Furnace 1 (2nd Floor-Behind Furnace)	24	0850 - 1417	327	0.02	0.02	0.02
Furnace 6 (Pouring Area)	27	0855 - 1414	319	N.D.	0.02	0.02
Furnace 6 (2nd Floor-Behind Furnace)	26	0858 - 1414	316	N.D.	N.D.	N.D.

* N.D. - not detected

Recommended Permissible Exposure Limit

2.5

TABLE 6
IRON OXIDE, LEAD AND RARE EARTH METAL CONCENTRATIONS
INTERLAKE, INC.
BEVERLY, OHIO

Sample Location	Sample Description	Sampling Time	Sample Volume (liters)	Iron Oxide (mg/M ³)	Lead (ug/M ³)	Lanthanum (ug/M ³)	Cerium (ug/M ³)	Praseodymium (ug/M ³)	Neodymium (ug/M ³)
November 6, 1979									
Furnace 1	Operator	1647 - 2243	534	0.05	1.9	34	9.2	16	17
Furnace 1	Helper	1650 - 2232	513	0.25	N.D.	35	7.6	15	16
Furnace 1	Mixer	1652 - 2238	519	0.43	7.9	343	80	168	15
Furnace 1	Crane Operator	1721 - 2232	466	0.34	3.4	82	19	35	2
Furnace 6	Operator	1702 - 2307	547	0.09	1.7	7	N.D.*	7	4
Furnace 6	Helper	2020 - 2244	216	0.11	N.D.	12	N.D.	12	6
Furnace 6	Crane Operator	1709 - 2236	490	0.10	1.2	4	N.D.	4	2
November 7, 1979									
Furnace 1	Operator	1115 - 1504	343	0.30	25	520	923	1590	2100
Furnace 1	Helper	0750 - 1447	625	0.30	1.8	7	9	16	17
Furnace 1	Mixer	0753 - 1450	625	0.51	6.1	178	129	90	101
Furnace 1	Crane Operator	0802 - 1407	547	0.20	2.6	19	5	10	10
Furnace 6	Operator	0914 - 1524	555	0.20	2.5	12	N.D.	13	11
Furnace 6	Helper	0907 - 1524	565	0.20	3.2	15	1	15	10
Furnace 6	Crane Operator	0920 - 1524	364	0.11	N.D.	N.D.	N.D.	2	N.D.
	Ladleman	0817 - 1415	537	0.94	9.9	213	56	137	103
	Ladleman Helper	0819 - 1400	511	0.13	1.0	9	2	5	5

*N.D. - Not Detected

Recommended Permissible Exposure Limits

5

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TABLE 7
TOTAL PARTICULATE CONCENTRATIONS
INTERLAKE, INC.
BEVERLY, OHIO

<u>Sample Description</u>	<u>Sample Number</u>	<u>Sampling Time</u>	<u>Sample Volume</u> (liters)	<u>Total Particulate</u> (mg/M ³)
November 6, 1979				
Ladleman	3425	1740 - 2222	423	5.8
Ladleman-Crane Operator	3422	1738 - 2222	426	21.2
November 7, 1979				
Ladleman	3196	0815 - 1415	537	69.8
Ladleman Helper	3421	0818 - 1210	348	2.2
	3427	1210 - 1400	165	9.4
Recommended Permissible Exposure Limit				10