U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 73-27-200

GORSUCH FOUNDRY COMPANY INCORPORATED
JEFFERSONVILLE, INDIANA

JUNE 1975

I. TOXICITY DETERMINATION

An evaluation of employee exposures to air contaminants found in the Aluminum, Brass, and Bronze Shop of the Gorsuch Foundry Company, Inc. in Jeffersonville, Indiana has been conducted. National Institute for Occupational Safety and Health (NIOSH) investigators made visits to the foundry on May 3, 1973, February 5-7, 1974, and June 11, 1974. The following determinations have been made with regard to potential hazards to employee health:

(1) Based on measured breathing zone concentrations/exposures, medical and occupational histories, employee interviews/physical examinations, measured blood levels of copper, nickel, and zinc, criteria for evaluating exposures to measured air contaminants, and information regarding the potential toxicity of measured air contaminants, it has been determined that employee exposures to aluminum oxide, copper fume, manganese, nickel, tin oxide, and zinc oxide are not toxic at the concentrations found during this evaluation.

(2) Based on measured breathing zone concentrations/exposures, medical and occupational histories, physical examination, measured blood lead levels, criteria for evaluating exposures to lead, and on information regarding the potential toxicity of lead, it has been determined that employee exposures to lead are not toxic at the concentrations found during this evaluation.

(3) Based on measured work area concentrations of airborne free crystalline silica, and on recently recommended criteria for evaluating employee exposures to silica, it has been determined that concentrations of silica found during this evaluation may be potentially toxic to employees. Recommendations to reduce employee exposures to silica and to consider the institution of a medical monitoring program have been made in the Discussion and Recommendations section of this report.

Recommendations to reduce reported occurrences of adverse environmental conditions within the shop during cold weather are made in the Discussion and Recommendations section of this report.

II. DISTRIBUTION AND AVAILABILITY OF THE DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

a) Gorsuch Foundry Company, Inc. - Jeffersonville, Indiana
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region V, Chicago, Illinois
d) NIOSH - Region V, Chicago, Illinois

For the purposes of informing the approximately 25 "affected employees", the employer will promptly "post" the Determination Report in prominent places near where affected employees work for a period of thirty (30) calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. (a)(6), authorizes the Secretary of Health, Education, and Welfare, following written request by 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 National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees regarding employee exposures to emissions from the melting and pouring of aluminum, brass, bronze, and nickel bronze in the Aluminum, Brass, and Bronze Shop of the Gorsuch Foundry Company, Inc. in Jeffersonville, Indiana. The request was allegedly precipitated by recurrent symptoms of metal fume fever in employees working in the Aluminum, Brass, and Bronze Shop.

IV. HEALTH HAZARD EVALUATION

A. Evaluation Progress

1. Initial Plant Visit

This plant was initially visited on May 3, 1973 by NIOSH investigators Mr. Robert Vandervort and Steven R. Cohen, M.D. A preliminary conference was held with representatives of labor and management to obtain background information regarding processes, materials, attitudes, and occupational health problems within the plant.

Following the preliminary conference, an initial survey of the Aluminum, Brass, and Bronze Shop was made. Each employee working in the shop was privately interviewed by Dr. Cohen with regard to possible occupationally related health problems. Concurrently, Mr. Vandervort conducted preliminary air sampling to evaluate employee exposure to metal fumes. Since several operations in the shop were noted to produce significant levels of noise, noise measurements were also made.

From medical and environmental data collected during the initial survey it was apparent that alleged symptoms of metal fume fever had subsided with the onset of warm weather. Many employees did report that they had experienced symptoms during cold winter weather when shop windows and doors were closed, but that these symptoms would not be expected to occur again

until the return of cold weather. Preliminary air sampling and work practice evaluation suggested that no serious exposures to metal fumes were occurring so it was decided that a follow-up survey of the shop would be planned during the next winter. Before leaving the plant, representatives of labor and management were advised of the potential hazard to employee hearing presented by the noisy operations conducted in the Aluminum, Brass, and Bronze Shop.

2. Follow-up Evaluation

During February 5-7, 1974 a follow-up evaluation of the Aluminum, Brass, and Bronze Shop was conducted by Mr. Vandervort and Dr. Cohen. A complete medical and work history was obtained from each employee in the shop. Particular attention was given to symptoms present in employees during or following the day of environmental monitoring (February 6, 1974). A blood and urine sample was obtained from each employee. During the workshift of February 6, 1974 each employee in the shop was asked to wear personal air sampling equipment to facilitate measurement of employee exposures to metal fumes and silica. Additionally, area samples for workroom contaminants were obtained. Unfortunately, problems with the analysis of blood, urine, and airborne silica samples were encountered by the NIOSH analytical laboratory in Cincinnati, Ohio. As a result, it was necessary to make a second follow-up visit to the plant.

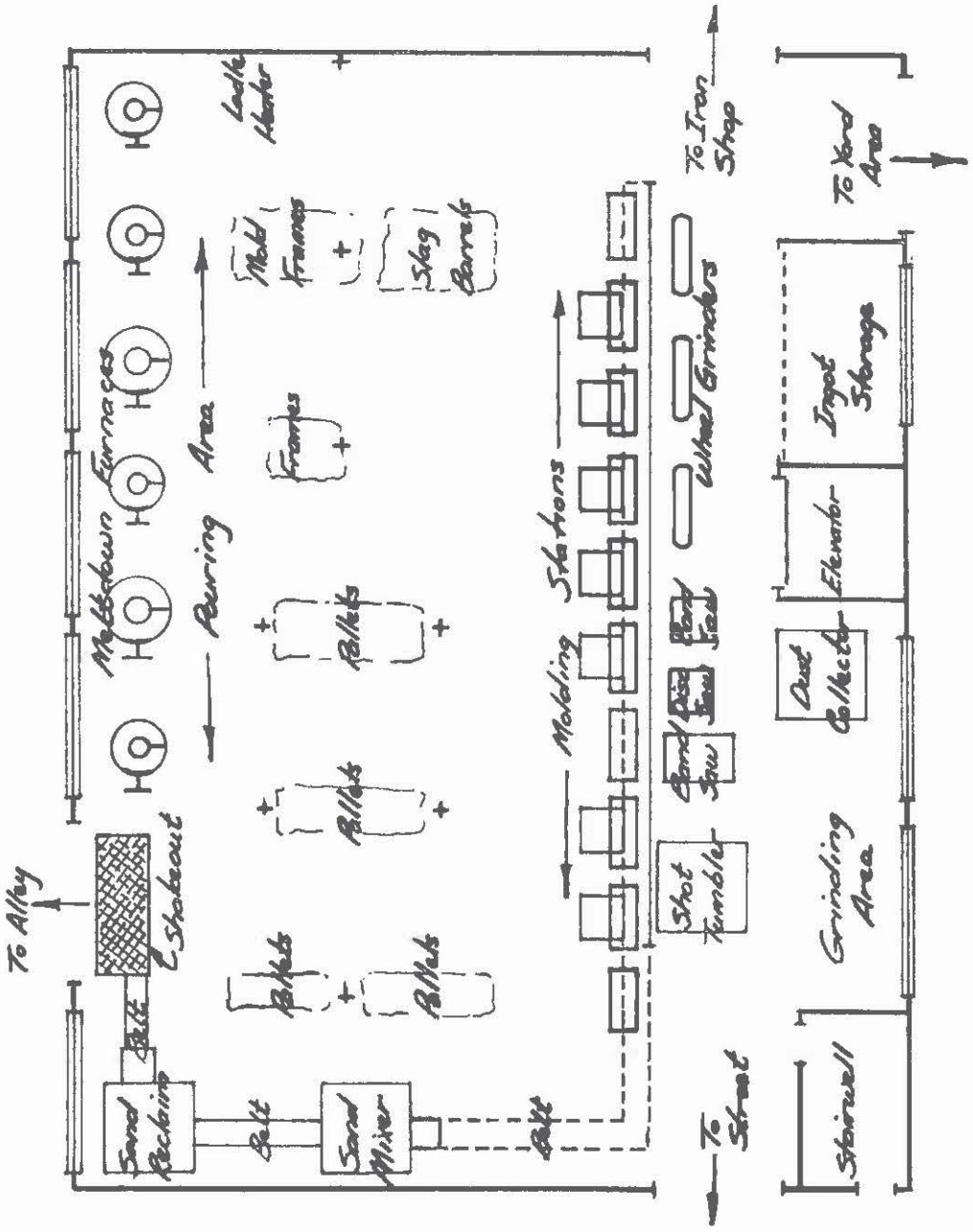
Delays in analysis, mounting request and work load, and scheduling problems prevented a return visit to the plant until June 11, 1974. On that day blood samples were drawn from all Aluminum, Brass, and Bronze Shop employees by Drs. Steven R. Cohen and Theodore W. Thoburn. Work area samples for metal fumes and silica were obtained by Mr. Vandervort.

Employees and their private physicians (or company physician if so authorized) were informed by letter of blood analysis results during the month of September, 1974. Physicians were supplied with the raw analytical results accompanied by data from study controls and established normal populations.

B. Description of Process

The Gorsuch Foundry Company, Inc. is engaged in the production of ferrous and non-ferrous metal castings. This evaluation was confined to those operations conducted in the Aluminum, Brass, and Bronze Shop of the foundry. Approximately 18 to 25 employees work in this small scale shop where virtually all work is accomplished by manual labor. A sketch of the shop is shown in Figure 1. The ceiling height of the shop is roughly 18 feet. Fresh air is not mechanically provided to the shop but enters through doors, windows and other openings in the building. Axial exhaust fans are located in the ceiling above the meltdown furnaces. Emissions elevated to the ceiling fans by thermal currents are partially contained by a hood-like structure associated with the exhaust fans. The fans and hood do not effectively control emissions projected by the furnaces toward the pouring area. Emissions from pouring operations are not effectively captured by the fans and hood. Airborne contamination which does not cleanly enter the hood circulates in the shop until it meanders into the hood and is exhausted.

FIGURE 1: Sketch of Aluminum, Brass and Bronze Shop
(Approximate Scale 1/2" = 6 feet)



Molding: Sand molds are constructed using standard sifting, pneumatic compacting and manual finishing techniques. The molding sands used are natural products containing clay. Only water is added to the molding sand to achieve desired consistency. Finished molds are placed on rolling carts which are arranged in rows behind the pouring line.

Melting and Pouring: Alloys are prepared in small oil fired furnaces. Each melt or heat starts by placing ingots and scrap (pure metals and alloys) into the furnace in proportion to customer specification. Melting time depends on alloy composition and quantity and varies from 1 to 4 hours. Once the molten alloy has been heated to the required temperature the furnace is manually tipped and the molten metal poured into preheated ladles. The ladles are of varying size; some requiring two men and a hoist to handle. From the ladles the molten metal is poured into the sand molds. The shop foreman and pour-off men perform the pouring operation. The shakeout man and shop laborer also spend some of their workday in the pouring area.

Shakeout and Sand Reclaim: After a cooling interval of a few minutes, the poured castings encased in their sand molds are moved to the shakeout grate. Several molds are dumped onto the grating at once and mechanically vibrated. Molding sand falls through the grating to a conveyor belt which transfers the sand to the reclaim system. Sand is mulled and manually wetted before returning via conveyor to the molding stations. It is important to note that any spilled sand must be periodically cleaned up with brooms, shovels, and wheelbarrows and dumped into the sand reclaim system through the shakeout grating. No mechanical exhaust ventilation is provided at the shakeout grating, but dust generation was observed to be minimal. Sweeping and shovelling of sand appeared to generate more airborne dust than the pneumatic shakeout process.

Finishing: From the shakeout area dirty castings are moved to a shot tumbler. Cleaned castings are then processed using bandsaws, disc saws, and abrasive wheel grinders.

C. Evaluation Methods

1. Measurement of Airborne Workroom Contaminants

Employee exposures to metal fumes and dust, and to free crystalline silica were measured using both personal breathing zone and work area sampling techniques.

Breathing zone samples were obtained through the use of personal air sampling equipment. Airborne fumes and other particulate were collected on cellulose ester (0.8 µm pore size) and polyvinyl chloride (2.0 µm pore size) filters held in open face plastic cassettes. Filter cassettes were positioned near the breathing zones of monitored employees. Workroom air was drawn through the filters at flow rates of 1.5 to 1.7 liters per minute by battery powered, MSA Model G personal sampling pumps. When samples for only the respirable mass fraction of airborne particulate were collected, 10 mm Dorr-Oliver cyclone presamplers preceded the filter cassettes. All personal breathing zone, respirable mass samples were collected at a flow rate of 1.7 liters per minute.

Work area air samples were collected at several locations within the shop. Stationary sampling equipment consisting of vacuum-pressure pumps, ring stands, 9-liter per minute critical flow orifices, cassettes and filters similar to those utilized in breathing zone sampling, and 9-liter per minute stainless steel cyclone presamplers was used. Both total and respirable mass samples were collected. In almost all cases, two samples were collected at each location simultaneously.

Air contaminants collected on filter media were analyzed by gravimetric, spectophotometric, and colorimetric methods at NIOSH's Cincinnati Laboratories. Total particulate was determined gravimetrically. Metals were determined by wet ashing the filters in acid and analyzing by atomic absorption spectrophotometry. Free crystalline silica was determined by the colorimetric method of Hyslop and Talvitie[1] after digestion with phosphoric acid.

2. Measurement of Workroom Noise

A General Radio Company Model 1565B Sound Level Meter was used to measure sound pressure levels at several work stations. Measurements were recorded on the A-weighting network. The meter was calibrated directly before and after use in the shop.

3. Medical Evaluation Methods

During the initial visit each Aluminum, Brass, and Bronze Shop employee was privately interviewed by Dr. Cohen to elicit past and present occupationally related health problems.

During the second visit each shop employee was (1) briefly examined, (2) questioned with regard to current health complaints, medications, etc., (3) administered a medical and work history questionnaire, (4) asked for a sample of urine and blood, and (5) questioned about symptoms which may have occurred during or following the monitored shift.

Difficulties encountered during analyses of urine samples rendered the data uninterpretable. Blood lead data were valid, but due to the small quantity of blood available for lead analysis the desired level of detail in blood lead values was not obtained. Blood levels of copper, nickel and zinc were not affected by analytical problems. The above mentioned problems necessitated a third visit to the plant to recollect blood samples for lead analysis. These blood samples were analyzed by atomic absorption spectrophotometry for lead. Blood samples were collected in lead-free vacutainers.

D. Evaluation Criteria

1. Criteria for Assessing Workroom Concentrations of Air Contaminants.

The three primary sources of criteria used to assess workroom concentrations of air contaminants in this evaluation are: (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 (1974); and (3) occupational health standards as promulgated by the U.S. Department of Labor (Federal Register, June 27, 1974, Title 29, Chapter XVII, Subpart G, Tables G-1, G-2, and G-3).

In the following tabulation of criteria, the most appropriate value (in the opinion of the authors) is presented with its reference and other information footnoted.

Substance	Permissible Exposure 8-hour Time-Weighted-Average	
[1]Alundum (Al_2O_3) (Nuisance Particulate)	10	mg/M^3 [a]
[2]Carbon Monoxide	35	ppm [b]
[3]Copper Fume	0.1	mg/M^3
[4]Copper, Dusts and Mists	1	mg/M^3
[5]Lead and Its Inorganic Compounds	0.15	mg/M^3
[6]Manganese and Compounds as Mn	5	mg/M^3
[7]Nickel, Metal and Soluble Compounds as Ni	1	mg/M^3
[8]Tin Oxide (Nuisance Particulate)	10	mg/M^3
[9]Zinc Oxide Fume	5	mg/M^3

[a] mg/M^3 = approximate milligrams of substance per cubic meter of air.
[b] ppm = parts of gas per million parts of contaminated air.

[1]Reference: ACGIH TLV (1974). The ACGIH classified this material as nuisance particulate. The 8-hour time-weighted-average Federal occupational health exposure standard for nuisance particulate is presently 15 mg/M^3 for total airborne particulate and 5 mg/M^3 for respirable airborne mass.

[2]Reference: NIOSH Criteria Document (1972). The Federal occupational health standard and ACGIH TLV (1974) for carbon monoxide are presently 50 ppm for 8-hour time-weighted-average exposure. NIOSH additionally recommends that no exposure should occur to concentrations in excess of 200 ppm.

[3]Reference: Federal occupational health standard (1974). The ACGIH (1974) has proposed that employee exposures to copper fume be controlled to 0.2 mg/M^3 on an 8-hour time-weighted-average basis.

[4]Reference: Federal occupational health standard (1974) and ACGIH TLV (1974).

[5]Reference: NIOSH Criteria Document (1972) and ACGIH TLV (1974). The Federal occupational health standard for lead is presently 0.2 mg/M^3 for 8-hour time-weighted-average exposure.
[6]Reference: Federal occupational health standard (1974) and ACGIH TLV (1974).
[7]Reference: Federal occupational health standard (1974) and ACGIH TLV (1974).
[8]Reference: ACGIH TLV (1974). The ACGIH classified this material as nuisance particulate. The 8-hour time-weighted-average Federal occupational health exposure standard for nuisance particulate is presently 15 mg/M^3 for total airborne particulate and 5 mg/M^3 for respirable airborne mass.
[9]Reference: Federal occupational health standard (1974) and ACGIH TLV (1974).

Employee exposures to free crystalline silica have been controlled by limiting employee exposure to airborne particulate based on its free silica content. The ACGIH has recommended that employee exposures to silica containing dust be controlled to a limit calculated by the following equations:

$$\text{8-hour time-weighted-average exposure to total airborne particulate.} = \frac{30 \text{ mg/M}^3}{\%SiO_2 + 3}$$

$$\text{8-hour time-weighted-average exposure to respirable airborne particulate.} = \frac{10 \text{ mg/M}^3}{\%\text{ respirable } SiO_2 + 2}$$

The current federal occupational health standard for controlling employee exposures to both total and respirable particulate containing silica are calculated from the same equations as above except that the denominator of the equation for total airborne particulate containing silica is "$\%SiO_2 + 2$". A recent NIOSH Criteria Document (Criteria for a recommended standard.... Occupational Exposure to Crystalline Silica, 1974) has recommended that employee exposures to silica be controlled to 50 micrograms of pure respirable silica per cubic meter of air on an 8-hour time-weighted-average basis.

2. Criteria for Assessing Employee Exposure to Lead and Its Inorganic Compounds - Biologic Threshold Limit

Assessment of employee exposure to lead is greatly facilitated by determining concentrations of lead in samples of whole blood. This procedure reflects total exposure via inhalation and ingestion. Unacceptable absorption of lead posing a risk of lead poisoning is demonstrated at levels of 80 micrograms of lead per 100 grams of whole blood or greater.[2]

3. Criteria for Assessing Employee Exposure to Noise

Permissible Noise Exposures as promulgated by the U.S. Department of Labor (Federal Register, June 27, 1974, Title 29, Chapter XVII, Subpart G, Table G-16); Daily Occupational Noise Exposure as recommended in the NIOSH Criteria Document for Occupational Exposure to Noise; and Threshold Limit

Values for occupational exposure to noise as proposed by the American Conference of Governmental Industrial Hygienists (ACGIH) are presented in the table to follow. The NIOSH recommended and ACGIH proposed limits are identical although the NIOSH limits are presented in graphical form.

Duration per Day Hours	U.S. Dept. of Labor Sound Level dBA[a]	NIOSH recommended ACGIH proposed Sound Level dBA[a]
16	--	80
8	90	85
6	92	--
4	95	90
3	97	--
2	100	95
1-1/2	102	--
1	105	100
1/2	110	105
1/4 or less	115[b]	--
1/4	--	110
1/8	--	115[b]

[a]Sound level in decibels (re: 2×10^{-5} N/M^2) as measured on a sound level meter conforming to ANSI-S1.4(1971) Type S^2A, set on the A-weighted network with slow meter response.
[b]No exposure to continuous or intermittent noise in excess of 115 dBA.

The basic difference between the promulgated Permissible Noise Exposures and the NIOSH/ACGIH limits is a 5 dBA lower limit at 8 hours of exposure and 5 dBA lower for each halving of exposure duration; the NIOSH/ACGIH limits being the more restrictive.

E. Evaluation Results

1. Environmental Evaluation

a. Employee Exposure to Airborne Contaminants

Air sampling to determine employee exposures to airborne contaminants was conducted on May 3, 1973; February 6, 1974; and June 11, 1974.

Samples collected during the initial survey (May 3, 1973) were breathing zone samples collected on molders, pour-off men, and the shop foreman. These air samples were analyzed for aluminum, copper, lead, manganese, nickel, tin, and zinc. The results of this sampling are shown in Table I below.

Table I: Breathing Zone Concentrations of Metal Particulate
(Samples Collected May 3, 1973)

Employee Job Title	Sampling Time Minutes	Contaminant Concentration in mg/M³						
		Alum. Oxide	Copper	Lead	Mangan-ese	Nickel	Tin Oxide	Zinc Oxide
Molder	218	0.35	0.10	0.10	<0.001	0.019	<0.10	0.37
Molder	228	0.24	0.05	0.09	<0.001	0.038	<0.10	0.41
Pour-Off Man	254	0.28	0.19	0.46	<0.001	0.012	<0.10	4.5
Pour-Off Man	251	0.26	0.05	0.17	<0.001	0.035	<0.10	2.4
Foreman	249	0.29	0.04	0.09	<0.001	0.056	<0.10	0.57
Permissible Exposure Criteria, 8-hour time-weighted-average concentration		10	0.1	0.15	5	1	10	5

As can be seen from the data in Table I, airborne concentrations of aluminum oxide, manganese, nickel, and tin oxide were found to be insignificant. (Subsequent air samples were not analyzed for these substances.) Exposures to copper fume, lead, and zinc oxide, as crudely approximated by these measurements, were found to require further sampling for interpretation.

During the initial survey, cursory measurements for carbon monoxide were performed using gas detector tubes. None of the twelve measurements showed carbon monoxide concentrations in excess of 20 ppm. The federal 8-hour TWA occupational health standard for carbon monoxide is 50 ppm. NIOSH has recommended that exposures be controlled to 35 ppm on an 8-hour TWA basis. Using either criteria, carbon monoxide concentrations in the shop appeared to be well within acceptable limits.

Also during the initial survey, sand handling techniques were carefully observed. Although it did not appear likely that excessive exposure to free silica was occurring, it was decided to sample for free silica during the follow-up visit.

During the second visit to the foundry (February 2, 1974), total mass breathing zone samples were collected on all 18 men working in the Aluminum, Brass, and Bronze Shop. Thirteen of the men spent their entire workshift in the shop. Five of the men worked from 7:00 A.M. to approximately 1:30 P.M. in the Aluminum, Brass, and Bronze Shop and then spent the remainder of their work day in the gray iron or ferrous shop of the foundry. These five men were not monitored during their work in the gray iron shop.

All men sampled were fitted with sampling equipment near the start of the shift and were monitored almost continuously during their work duties in the shop that day. Three of the men wore respirable mass sampling equipment in addition to total mass sampling equipment.

Filter samples were analyzed for copper, lead, and zinc. Samples from employees who were thought to have highest exposures to sand and dust were analyzed for free silica. Unfortunately, an error was made during the analysis of these silica samples and the results are of no value.

Table II presents the air sampling data obtained on February 6, 1974, from breathing zone sampling. Each employee is numbered and the location where the employee spent most of his workday is indicated in Figure 2 by the position of the employee identification number on the figure. Employee Nos. 4 and 6 roamed throughout the shop as indicated by the arrows.

The data in Table II indicate that breathing zone concentrations of copper and zinc oxide fume were well below limits designed to protect employee health. Lead concentrations were generally below 0.15 mg/M3 with five individual samples showing short term concentrations in excess of 0.15 mg/M^3. Comparison of total and respirable mass contaminant concentrations for the three men who wore both types of sampling equipment indicates that a significant portion of the total airborne mass of copper, lead, and zinc was respirable as defined by the design characteristics of the Dorr-Oliver cyclone. In this case, final evaluation of employee exposures to lead rests with the results of analyses of blood samples obtained from exposed employees.

In addition to the personal breathing zone sampling conducted on February 6, 1974, two area sampling stations were utilized to provide background contaminant levels and relationships between total and respirable airborne particulate. The locations of the two area sampling stations designated "A" and "B" are indicated in Figure 2. The results of area sampling are presented in Table III. Each filter used in this sampling was cut in half and one half analyzed for silica and the other half analyzed for metals. As previously mentioned, laboratory problems with analyses for silica resulted in the loss of these data. Accordingly, only airborne metal particulate concentrations are reported in Table III.

The data in Table III indicate that work area concentrations of copper and zinc oxide fume were somewhat lower than breathing zone concentrations and well below limits designed to protect employee health. Work area lead concentrations were near or below 0.15 mg/M^3 and favorably agree with breathing zone concentrations measured on employees working in the same general area. In general, the data in Table III demonstrate little difference in total and respirable mass concentrations, i.e. most airborne particulates in the work areas sampled were respirable.

During the third visit to the foundry (June 11, 1974), which was necessitated by problems encountered in the analysis of biological samples and air samples for free silica, limited air sampling was conducted. Three stationary sampling stations were used to measure airborne free silica and metal particulate. Each sampling station collected two filter samples simultaneously. One filter of each set was analyzed for free silica and the other for metal particulate. The locations of the sampling stations are shown in Figure 2 and are designated "A", "C" and "D". The results of this sampling are presented in Tables IV and V.

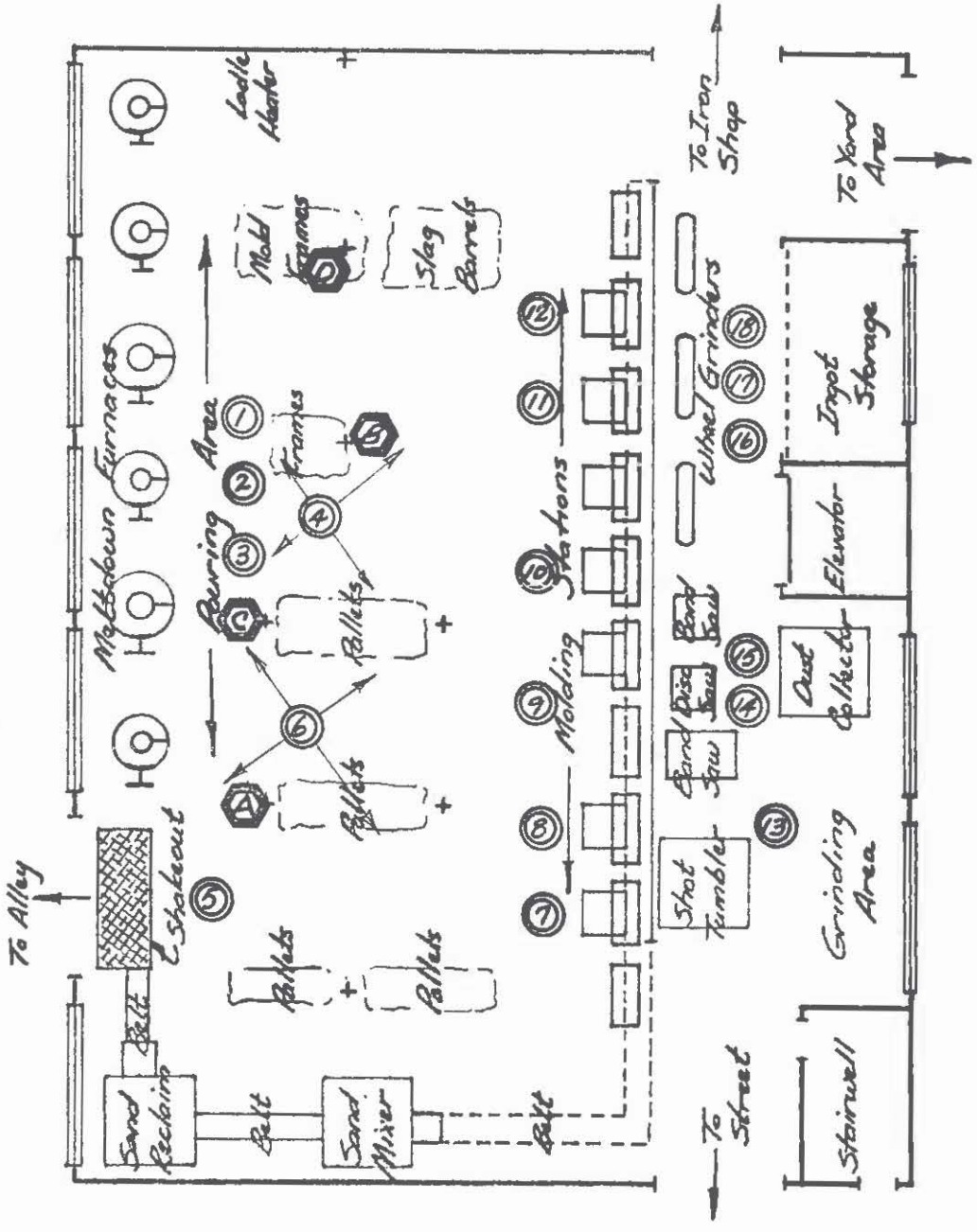
Table II: Breathing Zone Concentrations of Metal Particulate
(Samples collected February 6, 1974)

Employee Number	Job Description	Sample Number	Sampling Interval	Sample Type[a]	Contaminant Concentration Copper mg/M^3	Lead mg/M^3	Zinc Oxide mg/M^3
1	Pour-Off Man	10	0803-1139	Total	0.014	0.17	1.3
1	"	33	1139-1630	Total	0.010	0.054	0.21
1	"	59R	0846-1630	Resp.	0.010	0.13	0.74
2	Pour-Off Man	11	0806-1136	Total	0.016	0.22	1.5
2	"	30	1136-1625	Total	0.014	0.12	1.2
3	Pour-Off Man	08	0753-1149	Total	0.012	0.16	1.2
3	"	36	1308-1627	Total	0.011	0.067	0.22
3	"	56R	0757-1149	Resp.	0.008	0.061	0.37
4	Foreman	07	0751-1137	Total	0.010	0.12	0.92
4	"	31	1137-1626	Total	0.011	0.055	0.15
5	Shake-out	04	0750-1138	Total	0.015	0.12	0.90
5	"	32	1138-1623	Total	*	*	*
5	"	57R	0840-1623	Resp.	0.010	0.10	0.57
6	Laborer	16	0830-1144	Total	0.030	0.045	0.17
6	"	35	1144-1536	Total	*	*	*
7	Molder	03	0738-1127	Total	0.0006	0.10	0.97
7	"	25	1127-1520	Total	*	*	*
8	Molder	02	0737-1128	Total	*	*	*
8	"	26	1128-1521	Total	0.008	0.046	0.14
9	Molder	01	0735-1151	Total	0.007	0.12	0.78
9	"	37	1301-1519	Total	*	*	*
10	Molder	09	0740-1131	Total	*	*	*
10	"	27	1132-1521	Total	0.011	0.041	0.06
11	Molder	06	0744-1133	Total	0.007	0.17	1.2
11	"	28	1133-1521	Total	*	*	*
12	Molder	05	0747-1134	Total	*	*	*
12	"	29	1135-1325	Total	0.011	0.030	0.05
13	Tumbler Oper.	13	0818-1337	Total	0.040	0.11	0.72
14	Saw Oper.	14	0850-1335	Total	0.011	0.11	0.61
15	Saw Oper.	12	0813-1142	Total	0.017	0.11	0.83
15	Saw Oper.	34	1142-1538	Total	0.021	0.042	0.11
16	Grinder	18	0835-1145	Total	0.026	0.17	0.87
17	Grinder	17	0833-1330	Total	0.029	0.092	0.56
18	Grinder	15	0820-1334	Total	0.014	0.081	0.35
Permissible Exposure Criteria, 8-hour time-weighted-average concentration					0.1	0.15	5

[a]Total = total airborne mass; Resp. - respirable airborne mass. (Respirable airborne mass samples were collected to confirm presence of a large percentage of small particles. Respirable airborne mass concentrations are not to be compared with the total mass Permissible Exposure Criteria contained in the table.)

*Sample lost during analysis for free silica.

FIGURE 2: Approximate work stations of workmen sampled on February 6, 1974 and location of area sampling stations



Designates employee number and approximate work station on February 6, 1974.

Designates location of area sampling station.

Table III: Work Area Concentrations of Airborne Metal Particulate - Respirable and Total Mass (Samples Collected February 6, 1974)

Sample No.	Flow Rate LPM[a]	Sampling Interval	Sample Type[b]	Contaminant Concentration		
				Copper mg/M^3	Lead mg/M^3	Zinc Oxide mg/M^3
Sampling Station "A" ---------- Sampling Station "A"						
20	9.0	0754-1002	Total	0.004	0.14	0.28
53	9.0	0754-1002	Resp.	0.006	0.16	0.28
23	9.0	1006-1321	Total	0.008	0.10	0.62
52	9.0	1006-1321	Resp.	0.004	0.034	0.08
47	9.0	1323-1457	Total	0.013	0.058	0.13
48	9.0	1323-1457	Resp.	0.011	0.067	0.18
43	9.0	1459-1616	Total	0.022	0.13	0.10
45	9.0	1459-1616	Resp.	0.019	0.11	0.23
Sampling Station "B" ---------- Sampling Station "B"						
19	8.9	0754-1007	Total	0.007	0.15	0.37
54	9.1	0754-1007	Resp.	0.005	0.15	0.35
24	8.9	1010-1325	Total	0.013	0.11	0.60
51	9.1	1010-1325	Resp.	0.008	0.11	0.84
49	8.9	1332-1453	Total	0.013	0.053	0.19
50	9.1	1332-1453	Resp.	0.009	0.053	0.19
21	8.9	1456-1615	Total	0.012	0.067	0.14
38	9.1	1456-1615	Resp.	0.015	0.092	0.18
Permissible Exposure Criteria, 8-hour time-weighted-average concentration				0.1	0.15	5

[a]LPM = Liters per Minute

[b]Total = total airborne mass; Resp. = respirable mass. (Respirable airborne mass samples were collected to confirm presence of a large percentage of small particles. Respirable airborne mass concentrations are not to be compared with the total mass Permissible Exposure Criteria contained in the table.)

Table IV contains results of airborne metal particulate sampling. All levels are low when compared to permissible exposure levels and also are lower than levels measured by area samplers on February 6, 1974. These lower levels are probably the result of increased natural ventilation present during summer weather.

Table IV: Work Area Concentrations of Airborne Metal Particulate - Total Mass (Samples collected June 11, 1974)

Sample No.	Flow Rate LPM[a]	Sampling Interval	Contaminant Concentration			
			Total Part.[b] mg/M3	Copper mg/M3	Lead mg/M3	Zinc Oxide mg/M3
Sampling Station "A" ---------- Sampling Station "A"						
38	9.0	0947-1041	2.5	0.014	0.024	0.25
50	9.0	1043-1143	1.4	0.002	0.026	0.18
Sampling Station "C" ---------- Sampling Station "C"						
40	8.9	0953-1045	2.0	0.021	0.032	0.31
46	8.9	1048-1145	0.8	0.002	0.011	0.04
Sampling Station "D" ---------- Sampling Station "D"						
42	8.9	1000-1053	3.0	0.006	0.032	0.36
48	8.95	1055-1148	2.9	0.001	0.014	0.05
Permissible Exposure Criteria, 8-hour, time-weighted-average concentration				0.1	0.15	5

[a]LPM = Liters per Minute
[b]Total Part. = Total airborne particulate concentration

Table V contains results of air sampling for free silica performed on June 11, 1974. Comparison of total airborne particulate concentrations with calculated TLV's using the ACGIH formula for control of exposures to silica containing airborne particulate, suggests that airborne silica, as determined by work area sampling, is not a serious problem. Using the recently recommended criteria for evaluating exposures to silica, a somewhat different conclusion regarding exposure to silica is drawn.

The data in Table V indicate total mass, work area concentrations of airborne silica. It has been previously demonstrated that breathing zone concentrations of airborne particulate were higher than work area concentrations and that most of the airborne particulate is respirable. It therefore appears probable that breathing zone concentrations of respirable silica may exceed the recently recommended level of 50 $\mu g/M^3$.

Most of the potential employee exposures to airborne silica can be significantly reduced by modifying work practices as will be discussed in the Discussion and Recommendations section of this report.

Table V: Work Area Concentrations of Silica Containing Airborne Particulate, Silica, and Calculated TLV's for Control of Exposures to Silica (Samples Collected June 11, 1974)

Sample No.	Flow Rate LPM[a]	Sampling Interval	Part. mg/Fil[b]	Silica µg/Fil[c]	Total Part[d] mg/M3	TLV[e] mg/M3	Total Silica µg/M3 [f]
Sampling Station "A" ---------- Sampling Station "A"							
37	9.0	0947-1041	0.97	46	2.0	3.9	94
51	9.0	1043-1143	1.0	73	1.9	2.9	140
Sampling Station "C" ---------- Sampling Station "C"							
39	9.1	0953-1045	1.3	30	2.8	5.7	64
45	9.1	1048--145	1.1	ND[g]	2.0	10	--
Sampling Station "D" ---------- Sampling Station "D"							
41	8.9	1000=1053	0.95	79	2.0	2.7	170
47	8.9	1055-1148	1.38	122	2.9	2.5	260

[a]LPM = Liters per Minute.
[b]Part mg/Fil = Milligrams of particulate found on the filter by laboratory analysis.
[c]Silica µg/Fil = Micrograms of silica found on the filter by laboratory analysis.
[d]Total Part. = Total airborne particulate concentration.
[e]TLV = ACGIH recommended control level calculated from: TLV = (30)/(%Silica + 3).
[f]Total Silica µg/M3 = Total airborne silica concentration.
[g]ND = None Detected: Means that no silica was detected in the sample after an average blank value was subtracted from the analytical result.

b. Employee Exposure to Noise

During the first visit to the foundry (May 3, 1973) cursory sound level measurements were made to determine employee risk to noise induced hearing loss. Table VI shows the results of these measurements. As previously mentioned, employee and employer representatives were advised of the potential hazard to employee hearing presented by the sound levels measured.

Table VI: Sound Levels Measured May 3, 1974

Location and Operation	Sound Level dBA*
At melting furnace during heating	93-96
Center of Shop (background level)	90
At shakeout grating during vibration	91-92
At pouring ladle heater during heating	102-104
At molding line	91-95
At disc saw during sawing	100-107
At wheel grinders during grinding	90-93

*Sound level in decibels as measured on a sound level meter, conforming to the requirements of the American National Standard Specification for Sound Level Meters, S1.4(1971) Type S2A, and set to use the A-weighted network with slow meter response.

2. Medical Evaluation

a. Introduction

During the first follow-up visit 18 foundry shop employees were interviewed, given physical examinations, and asked for blood and urine specimens by Dr. Steven Cohen. The attached questionnaire was used to facilitate the collection information in employee interviews. The interviews, physical examinations, and specimen collections were performed in the wash room area which was located on the second story above the foundry area. Blood specimens were obtained in heparinized lead free tubes and urines were collected in plastic bottles, preserved in thymol, and analyzed. Analytical difficulties rendered the data from urine analysis uninterpretable and also necessitated the recollection of blood samples for lead analysis. Repeat blood specimens were drawn by Drs. Cohen and Thoburn. Repeat blood specimens were collected in unheparinized lead free tubes. As no control group could be identified at the plant, control bloods and urines were obtained from NIOSH personnel in Cincinnati.

Table VII contains a characterization of the work force interviewed. All 18 workers were white males with an average age of 41.3 years and an average length of service of 10.8 years.

TABLE VII
DEMOGRAPHIC CHARACTERISTICS OF SAMPLE

		AGE		LENGTH OF EMPLOYMENT		CURRENT SMOKING STATUS		
POSITION	No.	Ave.	Range	Ave.	Range	Non-Smokers	1 pkg. cig. or less/ day or cigars only	More than 1 pkg of cig./day
Molders	6	38.2	29-48	14.8	1-26	2	1	3
Pour Off	3	45.3	25-63	12.0	1-26			
General Laborers	3	36.3	19-49	2.1	5m-5y			
Shakeout	1	25		8m				
Foreman	1	51		22				
	8	40.1	19-63	8.1	5m-26y	1	4	3
Grinders	2	41.5	29-54	1.6y	8.5m-2.5y			
Saw Operators	2	55.5	48-63	18.5	11-26			
	4	48.5	29-63	10.1	8.5m-26y	3	0	1
Total	18	41.3	19-63	10.8y	5m-26y	6	5	7

b. Results and Discussion

Blood Metals

Analysis of the first set of blood samples which were collected in association with personnel breathing zone air sampling (February 6, 1974) was only partially successful. Blood copper, nickel, and zinc levels were determined with sufficient detail and are reported in the tabulation to follow. Blood lead levels could only be reported as not exceeding 40 micrograms of lead per 100 grams of blood, thus precluding careful correlation of measured airborne exposures with blood lead levels. To obtain better detail in blood lead determinations, a second set of blood samples were collected on June 11, 1974, and the results of their analyses are reported in the tabulation to follow. All values contained in the tabulation are reported in terms of micrograms of metal per 100 grams of whole blood.

	WORKERS			CONTROLS	
	No.	Mean Value	Range	No.	Mean Value
Lead	17	42.1	32-55	4	24.0 ± 7.2
Copper	18	114	73-221	8	151.5 ± 87.4
Nickel	18	20.8	10-33	8	25.4 ± 7.9
Zinc	18	715	560-860	8	798 ± 76

The average blood levels of copper, nickel and zinc for the workers did not exceed the control levels, nor were any individual levels significantly different from the mean control level.

The average blood level of lead (from samples collected June 11, 1974) for all the workers was significantly higher than control levels. (Likelihood of this difference being due to chance is only 0.02% utilizing the t test.) The generally accepted normal level for blood lead is up to 40 micrograms per 100 grams. However, levels up to 80 micrograms per 100 grams are considered safe.[2] The lead levels found here suggest that the workers are exposed to, and absorb lead, but that the exposure is not excessive and no health problems should be anticipated. No individuals levels were excessively high.

Employee Symptomatology

Eight of the 18 workers reported at least one past episode of symptomatology suggesting metal fume (or brass) fever. The sawyers and grinders did not complain of this. Five of the 6 molders reported having metal fume fever; the one exception only having been in the plant for a year. Two of these molders reported having experienced this condition more than 3 times a year. The other 3 reported only one or a few episodes. Of the 8 men working closer to the pouring, one Pour Off man reported that episodes occur more frequently than 3 times per year. Two other workers in the area reported only one or a few episodes.

Other complaints such as eye irritation, nasal irritation, throat irritation, shortness of breath, productive cough, skin rashes did not show any clear pattern, nor were they reported in significant numbers. Phlegm production was confined to smokers and shortness of breath was often associated with smoking. A possibly increased antero-posterior diameter of the chest was predominantly found among heavy smokers, and did not seem to relate to any particular job. The non-smokers and moderate smokers were more likely to be free of symptoms and/or findings.

One molder (who happened to be a heavy smoker) did complain of daily eye irritation and frequent nasal and throat irritation which seemed related to his work. He was also bothered by metal fume fever more frequently than by any of the others. It is possible that either this individual's work position; or this person's individual reaction to the environment at work are causing him problems.

Both workers complaining of nosebleeds had high blood pressure.

V. DISCUSSION AND RECOMMENDATIONS

Employee exposures to air contaminants found in the Aluminum, Brass, and Bronze Shop have been evaluated. Workroom air concentrations of aluminum oxide, copper fume, manganese, nickel, tin oxide, and zinc were found to be well below permissible exposure levels. Blood levels of copper, nickel, and zinc were normal. Several employees did report at least one episode of symptomatology suggesting metal fume fever which they related to adverse environmental conditions in the shop. Other health complaints were strongly related to employee smoking habits.

Workroom air concentrations of lead were found to vary substantially. Some short duration measurements suggested that employees may from time to time be exposed to potentially toxic concentrations of lead. Employee blood levels of lead demonstrated that employee exposure to lead had not resulted in an adverse body burden of lead and that a toxic condition was not present.

Using the criteria recently recommended by NIOSH to evaluate workroom concentrations of free silica suggests that employees may be exposed to potentially toxic levels of crystalline silica. Improved sand handling procedures should significantly reduce exposures.

In the interest of improving working conditions in the Aluminum, Brass, and Bronze Shop, and to safeguard employee health, the following recommendations are made:

1. Sand handling procedures should be improved. Sweeping of dry sand should be minimized. During cleanup periods, accumulations of sand should be sprinkled with water, collected into piles using flat point shovels or scrappers, and then shoveled into wheel barrows for return to the sand distribution system.

2. Ventilation in the shop should be improved to more efficiently remove air contaminants. Air should flow from the grinding and sawing side of the shop to the furnace side of the shop and be exhausted above the furnaces.

3. Until improved ventilation of the Aluminum, Brass, and Bronze Shop is operational, melting of copper and zinc containing alloys should be balanced with melting of aluminum alloys to limit airborne concentrations of copper and zinc which are capable of inducing metal fume fever. Control of melting schedules is particularly important during extremely cold weather or conditions of air stagnation. During especially adverse environmental conditions it may be advisable to melt only aluminum alloys.

4. A medical monitoring program, similar to that outlined in Criteria for a recommended standard....Occupational Exposure to Crystalline Silica, should be considered at the Gorsuch Foundry. A copy of this Criteria Document with its medical program has been provided to representatives of management and labor.

VI. REFERENCES

1. Talvitie, N.A.: Determination of free silica -- gravimetric and spectrophotometric procedures applicable to airborne and settled dust. Am. Ind. Hyg. Association J 25:169-78, 1964.

2. Criteria for a recommended standard...Occupational Exposure to Inorganic Lead. U.S. DHEW, NIOSH, (1972).

VII. AUTHORSHIP AND ACKNOWLEDGMENT

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FOUNDRY WORKERS DATA SHEET

Name_____Age_____Sex_____Race_____

Address_____

Duration of Employment at Gorsuch Foundry_____

Present Job: Molder ___
Grinder ___
General labor ___
Other _____

Employment Record:

Company	Department	Date Began	Date Terminated	Chemical(s) Handled

Do you smoke? Yes___ No___

How many cigarettes per day?_____Cigars_____Pipe_____

How many years have you smoked at this level? _____years

Have you consistantly had a morning cough and phlegm production over the past two years? Yes___ No___

Are you more short of breath than other men your age? Yes____ No____

Have you ever had an adverse reaction from any type of chemical? Yes___ No___

Have you ever had a reaction from a chemical used in the foundry process?
Yes___ No___

If yes, answer the following:

	Greater than 5 episodes	3-5 epis.	2 epis.	1 epis.	Check if seen by physician for above symp.
Burning, redness, itching of Eyes					
Burning, redness, itching of Nose					
Burning, redness, itching of Throat					
Burning in chest					
Nosebleeds					
Cough					
Skin rashes or changes in skin color					
Itching without Rash					
Loss of Teeth					
Stomach Cramps					
Tremor, weakness, burning or numbness of legs or arms					
Other(History of Anemia, Cancer, Heart Disease, Kidney Disease, Lung Dis					

PHYSICAL EXAM:

General

Skin(include nails)

Eyes, Nose, Throat, and Mouth(include gums)

Chest

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
518 POST OFFICE BUILDING
CINCINNATI, OHIO 45202

FOUNDRY WORKERS STUDY

CONSENT

I hereby voluntarily agree to participate in a study of "foundry" workers exposed to chemicals used in the smelting process. I agree to answer questions about my health which have a bearing in this study. I agree to permit a brief medical examination and the collection of a blood and a urine sample to determine whether I have had an adverse reaction to any of the chemicals used in the smelting process.

I am aware that medical information will be used for statistical purposes only unless I authorize otherwise. I understand that the information obtained in this study will be considered confidential in accordance with U.S. Public Health Service Regulation (42 CFR Part 1). I am also aware that I may withdraw from the study at any time.

DATE_____ SIGNATURE_____

AUTHORIZATION FOR RELEASE OF MEDICAL INFORMATION

I hereby request that the Public Health Service inform my personal physician

Dr. _____

Street_____City_____

and the company physician of

Company Name:_____City_____

DATE_____ SIGNATURE_____

Note: Strike out the words "and the company physician of Company Name:_____ City____," if the worker prefers that the significant medical findings from this study be sent only to his personal physician.

MSB 1/31/74