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AN INDUSTRIAL HYGIENE SURVEY

OF THE

AMERICAN FOUNDRY AND MACHINE COMPANY

AT

SALT LAKE CITY, UTAH

JANUARY 24 - FEBRUARY 3, 1964

BY

OCCUPATIONAL HEALTH FIELD STATION
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16. Abstract (Limit: 200 words)

Worker exposure to free silica (7631869) was determined at the American Foundry and Machine Company (SIC-3362) in Salt Lake City, Utah, on January 9, 1969. The survey was part of a NIOSH health study of the foundry industry in Utah, and was requested by the Utah State Industrial Commission. Personal respirable mass samples of silica dust ranged from 1.3 to 10.7 milligrams per cubic meter (mg/cu m), with free silica percentages ranging from 3 to 45 percent. The corresponding threshold limit values ranged from 1.1 to 2.0mg/cu m. The author recommends that an extensive survey be conducted at this facility at a later date, that local exhaust ventilation be provided for scarfing stations and at welding locations, and that an air supplied hood be furnished to the sand blast operator.

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SURVEY OF AMERICAN FOUNDRY AND MACHINE COMPANY

This survey of the American Foundry and Machine Company plant in Salt Lake City, Utah was conducted by the Occupational Health Field Station at the request of Mr. Muench, Regional Director, Bureau of Labor Standards, San Francisco, California, who had received complaints concerning exposures to toxic dusts, smokes, and gases. The industrial hygiene investigation, conducted during the period January 24 - February 3, 1964, and this report do not include safety hazard evaluations. Mr. Casper Nelson, Safety Commissioner of the Industrial Commission of Utah, and Dr. Grant S. Winn, Chief, Industrial Hygiene Section, Sanitation Division of the Utah State Department of Health, were informed of the plans for the survey and invited to accompany our personnel on any of the plant visits. The results of the survey and recommendations for improvements are given in the following sections. Appreciation is expressed to Mr. Jack Carter, Manager, and Mr. Cecil McCarty, Plant Engineer, for their assistance.

SUMMARY AND RECOMMENDATIONS

The results of the workroom air samples and observations made during the survey showed there were several areas where the atmospheric concentrations of dust, smokes, and gases should be reduced. Both engineering controls and improved operating procedures will be needed to achieve a satisfactory improvement in conditions. Reference should be made to such publications as "Michigan's Occupational Health"[1] and "Manual of Industrial Ventilation"[2] for general comments on controlling exposures to toxic materials in foundries and specific suggestions for typical operations. The specific recommendations are:

1. Institute a program of good plant housekeeping to minimize the redispersion of dust into the workroom air.

2. Provide an improved local exhaust system at the core baking operations.

3. Improve the general ventilation in the core building by operating all eight roof fans.

4. Install mechanical fans in the roof of the foundry building and maintain in good operating condition.

5. Install improved local exhaust ventilation for the shakeout operation.

6. Reduce the atmospheric concentrations of dust at the slinger sand preparation operation.

7. Provide local exhaust ventilation at the metal scarfing stations.

8. Improve exhaust ventilation controls on the two furnaces.

Discussions of these recommendations and suggestions, together with the atmospheric samples on which they are based, are given in the appropriate sections of the report.

THRESHOLD LIMIT VALUES

The term "Threshold Limit" refers to the maximum average concentration of contaminant to which workers may be exposed repeatedly for an 8-hour work day without injury to health. These values, based on the best data obtainable are not fixed, but are reviewed annually for changes or revisions as new information becomes available. They are not and should not be regarded as absolute lines of demarkation between safe and dangerous levels. The figures refer to average concentration in an 8-hour working shift, rather than an absolute maximum which is not to be exceeded even momentarily. The amount by which these figures may be exceeded for short periods during the work day depends upon a number of factors such as the nature of the contaminant, whether very high concentrations even for short periods produce acute poisoning, whether results are cumulative, the frequency with which high values occur and for what period of time. All must be taken into consideration in arriving at a decision as to whether a hazardous situation is deemed to exist.

POTENTIAL HAZARDS

Silica Dust

Toxicity of air-borne dust depends on the particle size, percentage of free silica in the dust, concentration which is expressed in the number of millions of particles per cubic foot of air, and duration of exposure. Inhalation of respirable sizes of free silica particles and retention of these particles will develop fibrotic tissue in the lung. The extent of the fibrotic lesion and the consequent effect upon the function of the lung is dependent both on the dust concentration and the duration of the exposure. Development of the usual chronic type of silicosis takes many months or years. The effects of repeated inhalation of silica dust are cumulative and progressive.

The recommended threshold limit values for air-borne silica dust is calculated from the formula $\frac{250}{\%\ SiO_2 + 5}$ based on the percentage of crystalline free silica determined from air-borne samples (as recommended by the American Conference of Governmental Industrial Hygienists, Threshold Limit Values for 1963).

Irritant Gases

Irritant gases common to the foundry environment are those produced when materials such as oils, glycerol and fats are decomposed by heating to high temperatures. Human exposure to these irritant gases results primarily in lacrymation and also inflammation of contacted tissues. This consists of edema, cellular infiltration and may progress to necrosis. This reaction is common to all irritant gases, but the degree of inflammation varies widely. High concentrations of these gases are so irritating to the upper respiratory system and to eyes that individuals avoid toxic concentrations. Acute intoxication is consequently rare. However, continuous exposure to low, barely tolerable levels of irritants may be responsible for decreased efficiency, morale and comfort of the workmen.

Smoke

Smoke consists of small, air-borne particulates mainly resulting from incomplete combustion and high temperature decomposition of organic materials. Some of these substances are tars and polynuclear hydrocarbons having carcenogenic properties.

Carbon Monoxide

Carbon monoxide is a colorless, tasteless, odorless, insidious gas, originating from the incomplete combustion of carbonaceous material. The more common sources in foundries are electric furnaces, metal treating and mold curing ovens, welding and metal scarfing operations and from the mold pouring operation.

Inhaled carbon monoxide is quickly absorbed through the lung tissue. As carbon monoxide enters the blood stream it rapidly combines with the hemoglobin to form carboxyhemoglobin. This compound is 300 times more stable than oxyhemoglobin and consequently the hemoglobin becomes relatively much less available for oxygen transport. At toxic concentrations of the gas asphyxiation results. If 500 ppm of carbon monoxide are inhaled until equilibrium is practically attained, 50% of the hemoglobin will be combined with the carbon monoxide. This means the oxygen-carrying capacity of the blood is reduced by one-half causing slight confusion and possible fainting or collapse upon exertion. Continued exposures to concentrations of the order of 100 ppm may cause severe headaches but ordinarily no permanent injury. (See Elkins: The Chemistry of Industrial Toxicology, page 92.)

SAMPLING PROCEDURES

Silica Dust

Air-borne dust concentrations, reported as millions of particles per cubic foot of air, were determined by use of the midget impinger dust sampling apparatus and the standard light-field microscopic dust counting technique.[3]

A high-volume (20 CFM) sample of the air-borne dust was collected on microsorban filter for laboratory analysis of the percentage of free silica.[4]

Irritant Gases

Air samples were collected for aldehyde determination using 10 ml. of one percent sodium bisulfite in midget fritted-glass bubblers. The absorbed aldehydes were then released from the bisulfite and the liberated bisulfite was titrated with standard iodine solution.[5]

Smoke

Smoke samples were collected on a glass fiber filter by a high volume sampler. The filter weight before and after sampling was determined and the sample on the filter was extracted with benzene in a soxhlet extraction apparatus for 24 hours. This separated the organic material from the sample and permitted the determination of the percent of organic material.

Carbon Monoxide

Air samples are drawn by means of a calibrated hand pump through sampling tubes containing a specially prepared gel. The carbon monoxide in the air reacts with the indicating gel to produce a color change. The carbon monoxide concentrations were determined by comparison of the color change of the gel in the tube with known color standards.

EVALUATION OF RESULTS

Silica Dust

Air-borne dust is more apparent in the main foundry; the primary sources are the shakeout, slinger sand mixing, and furnace "blowing" operations.

The dust counts from samples collected near the shakeout operation indicate that the atmospheric concentrations of dust were below the TLV.

However, considerable amounts of visible dust are released into the general foundry air when the hot molds are vibrated. This contributes to the general level of dustiness. Management's proposal to install a new dust collection system at the shakeout should improve the overall dust levels in the plant.

On the slinger sand mixing platform dust levels (refer to sample summary) are greatly in excess of the threshold limit values. The overall dust level is the result of the sand mixing operation; the method of adding chemical components to the sand; the close proximity to the shakeout operation and general poor housekeeping. Control methods should be incorporated in the operational procedures to reduce this high dust exposure. Until this is done respirator protection should be provided and worn, particularly during periods of maximum dustiness.

Dust samples were collected in the general air of the main foundry and indicate dust levels which could be reduced by more efficient removal of dust and smoke created in blowing the carbon from the furnace.

Air-borne dust samples were collected in the core room in the sand mixing and core molding areas. A plot of time versus dust concentration as determined from sequential samples in the core molding area is shown in Graph 1. The exposure to silica dust is in excess of the permissible level for two hours in the morning. However, the time weighted average workman exposure is within acceptable limits.

Air-borne dust samples collected in the cleaning department were found to be highest near the metal scarfing operations. Local exhaust ventilation would greatly reduce the dust as well as the iron oxide dust associated with the burning process.

Good housekeeping is one of the most important phases of a dust control program. Floors and aisles should be cleaned regularly. Vacuuming should be done throughout the day whenever needed. Raw material and accessory equipment should be properly stored. Through an active and effective housekeeping program overall dust concentrations are reduced, local exhaust ventilation is more effective, and worker attitudes and production improve. Several studies conducted among groups of foundries have indicated that good dust control appears to go hand in hand with good housekeeping. Dust concentrations were determined by the quality of housekeeping regardless of the amount of activity in the plant. The results of the studies indicated the dirtier the plant, the higher the dust levels. The best possible housekeeping program should be enforced at all times. Good housekeeping is an indication of good supervision.

Irritants

The principle sources of irritants are the oils and other organic material added to the molding sand and decomposed by heat and released in the core baking ovens and the main foundry especially during the period near the end of the shift when the floor is full of smoking molds. Although the most persistent exposure to these irritants occurs in the core sand preparation section, at times there is scarcely a location in the foundry where the workmen are not subjected to irritating concentrations of these materials. Analyzed samples indicate the presence of aldehydes. The concentrations, calculated as formaldehyde, ranged from 1.4 - 8.3 parts per million. To control the irritant problem the following items are indicated:

1. Improve the exhaust ventilation controls on the core baking oven.

2. Provide additional hood area for collection of smoke and fume from the cooling molds as they are removed from the oven.

3. Repair, properly maintain, and operate the eight roof fans already installed in the core room.

4. Control smoke sources in the main foundry. This can be accomplished by the installation of mechanical roof fans in the roof of the foundry building with provision to admit outside air at floor level and block air intake at higher levels.

5. If these measures fail to eliminate irritant gases from the foundry atmosphere, it may then be necessary to separate, by partition, the core room from the main foundry.

Smoke

The air in the main foundry was sampled for smoke with a high volume sampler to determine the amount of organic material present. The benzene soluble (organic) portion in the sample was 1.96 milligrams per cubic meter, or 30% of the total sample. The effects on health of such amounts of these compounds are, at present, uncertain. Air pollution investigators are studying this factor because of the association of the organic fraction of air pollutants and upper respiratory ailments. The level found in the foundry environment is considerably higher than that found in the air of large cities.

In view of the concern given this problem by air pollution investigators, smoke concentrations in the working environment should be kept as low as possible. The measures recommended for the control of irritant gases will also reduce the atmospheric concentration of smoke. Additionally, improvement of the local exhaust systems on the furnaces will reduce the release of smoke.

Carbon Monoxide

Carbon monoxide levels ranged from only a trace to 150 ppm. The maximum levels were found in the main foundry during mold pouring operations. The maximum allowable concentration for an 8-hour exposure is 100 ppm. Based on the results of samples collected during the survey there is little likelihood of acute or chronic carbon monoxide toxicity if the ventilation recommendations are adopted.

* * *

REFERENCES:

1. Michigan's Occupational Health, Vol. 9, No. 1, Fall, 1963. Michigan Department of Public Health.

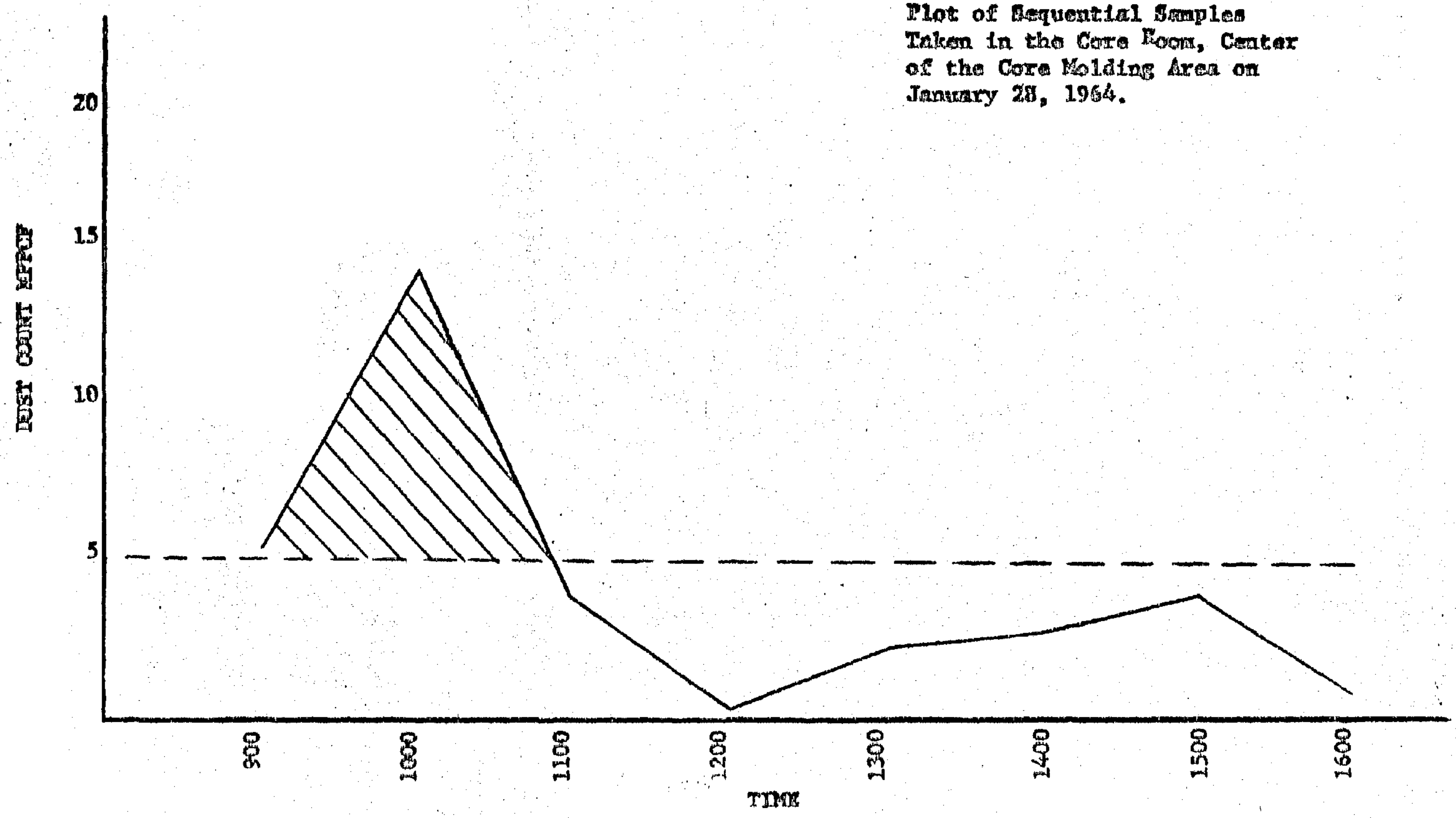
2. Industrial Ventilation; 7th Edition - American Conference of Governmental Industrial Hygienists, P. O. Box 453, Lansing, Michigan.

3. Industrial Dust; Drinker, P. and Hatch, T. F., McGraw-Hill Book Company, Inc., 2nd Edition, New York (1954).

4. Determination of Quartz in Presence of Silicates Using Phosphoric Acid, N. A. Talvitie, Anal. Chem. 23:623 (1951).

5. The Chemistry of Industrial Toxicology, Harvey B. Elkins, John Wiley and Sons (1959).

Graph 1.



Plot of Sequential Samples
Taken in the Core Room, Center
of the Core Molding Area on
January 28, 1964.

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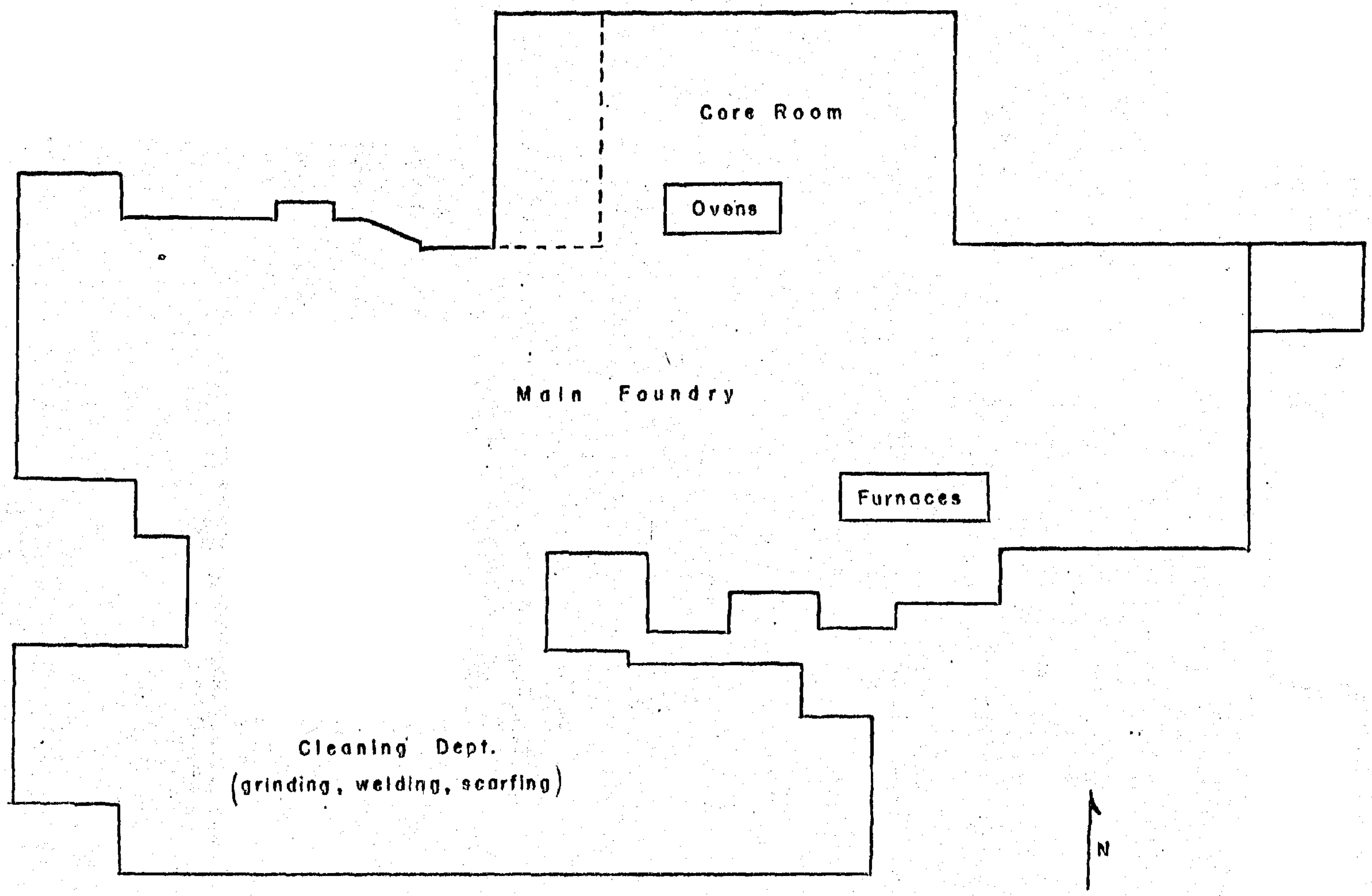

Elmco Foundry Floor Plan

AMERICAN FOUNDRY AND MACHINE COMPANY

SAMPLE SUMMARY

Sample Number	Date and Time	Sample Location Operation and Comments	Result
		Core Room	Dust Count MPPCF
2	1/24/64 9:40 a.m.	Sand mixing department. BZ Muller	2.6
3	1/24/64 9:50 a.m.	BZ Muller, Sand mixing dept.	1.7
5	1/24/64 11:07 a.m.	Front of oven, washing and painting operation. GA several men working in area.	2.5
14	1/27/64 1:25 p.m.	Sand mixing department. GA	15.8
18	1/27/64 8:20 p.m.	Sand mixing department. GA	12.4
19	1/27/64 8:35 p. m.	Sand molding. Very little activity.	1.1
26	1/28/64 8:55 a.m.	Center core molding area under mez. Sequential samples, normal operation.	5.4
27	1/28/64 9:55 a.m.	Sequential samples, Shop on break.	14.2
28	1/28/64 10:55 a. m.	Center core molding area under mez. Sequential samples. Normal operation.	3.9
29	1/28/64 11:55 a.m.	Sequential samples, lunch period.	0.4
30	1/28/64 12:55 p.m.	Sequential samples, normal operation.	2.1
31	1/28/64 1:55 p.m.	Center core molding area under mez. Sequential samples, one-half sample time, shop on break.	2.7
32	1/28/64 2:55 p.m.	Core room - center core molding area under mez. Sequential samples, one-half sample time, shop on break.	3.9

Sample Number	Date and Time	Sample Location Operation and Comments	Result
		Core Room	Dust Count MPPCF
33	1/28/64 1:35 p.m.	Center core molding area under mez. Sequential samples, one-half sample time, shop on break.	0.8
36	2/3/64 12:50 p.m.	Core sand mixing. Not working 4½ min. of samples.	2.5
40	2/3/64 12:50 p.m.	Core sand mixing. BZ complete cycle of muller operation.	5.5
			Percent Free Silica
HV 3	1/24/64 11:15 a.m.	Core sand mixing near control booth.	45.7
SD 4	1:20 p.m. 1/24/64	Core sand mixing, settled dust from top of control booth.	40.0
			Aldehydes ppm
	1/29/64	Core sand mixing, north of booth.	1.6
	1/29/64	Core sand mixing, north of booth.	1.5
	1/29/64	Core sand mixing, south of booth.	1.4
			Carbon Monoxide ppm
	1/29/64	Core sand mixing	Trace
		Main Foundry	Dust Count MPPCF
1	1/24/64 9:30 a.m.	Shakeout platform	7.2
4	1/24/64 10:10 a.m.	Filling laddle, tapping furnace, 2 men working.	13.7
6	1/24/64 11:10 a.m.	Slinger sand mixing, 2 men working.	90.8

Sample Number	Date and Time	Sample Location Operation and Comments	Result
		Main Foundry	**Dust Count MPPCF**
10	1/27/64 1:25 p. m.	Slinger sand mixing.	99.03
12	1/27/64 2:20 p.m.	GA in mold filling area.	1.3
15	1/27/64 1:55 p. m.	Slingersand mixing.	20.8
20	1/27/64 8:50 p. m.	Slinger sand mixing. Operator stirs up dust with activities.	32.4
21	1/27/64 9:10 p.m.	Shakeout.	3.1
22	1/27/64 9:25 p. m.	Slinger sand molding, BZ	4.3
23	1/27/64 9:50 p. m.	Tapping furnace	2.9
34	2/3/64 11:20 a. m.	Shakeout platform.	7.8
35	2/3/64 11:30 a. m.	Between furnaces, GA, No visible dust.	6.9
38	2/3/64 1:50 p. m.	Shakeout - all around. Not very dusty.	2.3
39	2/3/64 11:45 a. m.	Lunch break after 3 minutes sampling. Shakeout between slinger sand dumper and hood.	5.6
42	2/3/64 1:45 p. m.	Shakeout - all around. Shaker not operating for most of sample.	3.0
		Main Foundry	**% Free Silica**
HV 1	1/24/64 9:30 a. m.	Near shakeout.	43.4
HV 2	1/24/64 10:25 a. m.	Near shakeout.	43.8
HV 7	1/27/64 9:00 p. m.	Slinger sand mixing.	24.9
			Aldehyde ppm.
	1/29/64	Near slinger sand molding.	8.3

Sample Number	Date and Time	Sample Location Operation and Comments	Result
		Main Foundry	Mg/m^3 Organic Material
	2/3/64 11:00 a. m.	Near No. 3 slinger sand molding.	1.96
			Dust Count MPPCF
11	1/27/64 1:25 p. m.	Slinger sand mixing, Sta. No. 3.	3.9
			Carbon Monoxide ppm
	1/29/64 1:30 p. m.	Near tapping furnaces.	125
	1/29/64 2:00 p. m.	Near tapping furnaces.	100

Sample Number	Date and Time	Sample Location Operation and Comments	Results
		Cleaning Dept.	Dust Count MPPCF
7	1/24/64 11:27 a. m.	Grinder operation, BZ	9.8
8	1/24/64 11:34 a. m.	Gen. Air, walking sample.	3.5
9	1/24/64 11:40 a. m.	Metal scarfing operation.	9.8
13	1/27/64 2:40 p. m.	Metal scarfing operation.	5.3
16	1/27/64 2:25 p. m.	Grinding operation, BZ	5.4
17	1/27/64 2:30 p. m.	Gen. Air, walking sample.	2.4
24	1/27/64 10:10 p. m.	Gen. Air, walking sample.	1.0
25	1/27/64 10:25 p. m.	Gen. Air, near grinding operation.	1.5
37	2/3/64 1:20 p. m.	Metal scarfing operation.	6.1
41	2/3/64 1:15 p. m.	Metal scarfing operation.	12.3

		Cleaning Dept.	Carbon Monoxide ppm
	1/29/64 1:05 p. m.	Grinding operation	Trace
	1/29/64 1:20 p. m.	Welding operation.	Trace
	1/29/64 1:35 p. m.	Metal scarfing operation.	Trace