U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 78-47-570

AMERICAN CONCRETE DIVISION, UNION METAL COMPANY
Waukegan, Illinois

March, 1979

I. TOXICITY DETERMINATION

A health hazard evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) on March 30, July 5, and October 20, 1978, at the American Concrete Division of the Union Metal Company in Waukegan, Illinois. Breathing zone and general area samples were taken for toluene, mineral spirits, VM&P naptha, methyl isobutyl ketone, total particulates, respirable particulates, respirable free silica, iron oxide fume, chromium, nickel, copper, and aluminum. The airborne concentrations of respirable free silica in three personal samples exceeded the evaluation criteria. The concentrations of respirable free silica as they existed during the time of this evaluation constitute a health hazard to the workers involved. All the other substances sampled for were well below the evaluation criteria. Recommendations have been offered in this report to reduce the exposure of employees to free silica and to reduce peak exposures to contaminants.

II. DISTRIBUTION AND AVAILABILITY

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After ninety (90) days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati, Ohio address.

Copies of this report have been sent to:

a) American Concrete Division, Union Metal Company
b) Authorized Representative for Employees, International Association of Machinists and Aerospace Workers, District 140
c) International Association of Machinists and Aerospace Workers, International Office
d) U. S. Department of Labor - Region V
e) NIOSH - Region V

For the purpose of informing the 60 affected employees, copies of the report shall be posted in a prominent place accessible to the employees for a period of 30 calendar days.

III. INTRODUCTION

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, Education and Welfare, following a 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 received a request from an authorized representative of employees regarding exposure to toxic substances, while mixing concrete, welding, and painting without any type of exhaust ventilation.

IV. HEALTH HAZARD EVALUATION

A. Plant Process

American Concrete Division is basically a job shop type operation, which is capable of producing a multitude of concrete, aluminum, or steel light poles. The poles are made according to customer specification, with a major portion being utilized for street and parking lot lighting, and for traffic lights.

Cement poles are made by injecting cement into a steel mold, lathing the mold to remove H_2O and compact the cement, baking the pole to cure the cement, polishing and grinding the pole, and adding accessories as needed.

Metal poles are made in any size or shape, according to customer specifications. This creates a situation in which many different types of welding and metal alloys are utilized. Completed poles are painted with an iron oxide and zinc chromate paint.

The plant has no ventilation system, either general or local exhaust.

B. Evaluation Design

An initial survey was conducted on March 30, 1978. The NIOSH Regional Industrial Hygienist made a complete walk through of the entire plant, accompanied by management and union representatives. About 20 of the employees were given nondirected interviews to determine if they had experienced health problems as a result of their work place exposure. Those interviewed made complaints such as; "sore throat," "eye and nasal irritation," "bleeding from the nose," "dizziness," "shortness of breath," "itching from dust," etc. Material safety data sheets on the substances used in the plant were obtained from the plant manager.

On July 5-6, and October 23, 1978, an environmental follow-up survey of the plant was conducted by NIOSH Regional Industrial Hygienists to further assess employee exposure to toxic substances. Personal breathing zone and general area atmospheric samples were taken in the pole painting area for toluene, mineral spirits, VM&P naptha, and methyl isobutyl ketone. The welding areas were sampled for iron oxide fume, chromium, nickel, copper, and aluminum. The mixing, polishing, and grinding areas were sampled for total particulates, respirable particulates, and respirable free silica.

C. Evaluation Methods

Breathing zone and general area atmospheric samples for toluene, mineral spirits, VM&P naptha, and methyl isobutyl ketone were collected on organic vapor charcoal sampling tubes using portable battery powered sampling pumps operating at approximately 150 cubic centimeters (cc) per minute. Samples were analyzed by gas chromatography.

Atmospheric samples for iron, chromium, nickel, copper, and aluminum were collected on 37mm diameter polyvinyl chloride copolymer filters attached to battery operated air sampling pumps operating at a flow rate of 1.5 liters per minute. Samples were analyzed by atomic absorption spectrophotometry.

Total particulate samples were collected on 37mm polyvinyl chloride copolymer filters. Personal samples were taken with filters attached to a battery operated air sampling pump operating at a flow rate of 2.0 liters per minute, while the area samples were taken using a nonpulsating high volume sampler equipped with a 9.0 liter per minute critical orifice. The weight of the samples were determined by subtracting the pre-sampling weight from the post sampling weight of the filters.

Respirable particulate and respirable free silica were collected on a 37mm low ashing type of polyvinyl chloride filter. The personal sampling train consisted of a filter, 10 millimeter nylon cyclone size selective sampler, and a battery powered air sampling pump operating at 1.7 liters per minute. Area samples were taken with a sampling train consisting of a filter, one-half inch metal cyclone, critical orifice to restrict airflow to 9.0 liters per minute, and a nonpulsating flow pump. The weight of the samples were determined by subtracting the tare weight from the total weight. Analysis for free silica was performed using X-ray diffraction.

D. Evaluation Criteria

In order that workers may better understand the potential health hazards associated with the chemical substances evaluated during this study, the following discussion is provided.

Toluene -- the major problem of toluene is its narcotic effects on workers. Symptoms and signs of these narcotic effects are experienced in the form of muscular weakness, incoordination, and mental confusion. NIOSH recommends that no worker be exposed to a concentration greater than 100 ppm determined as a time-weighted average (TWA) exposure for up to a 8 hour workday, 40 hour workweek and a 200 ppm ceiling (10 minute sample).(1) The OSHA standard is 200 ppm. (2) The use of exposure limits designated TWA hereafter in this report refers to an 8 to 10 hour workday, 40-hour workweek.exposure.

Mineral Spirits -- overexposure may cause vertigo, headache, and anesthetic stupor. In extreme cases of acute exposure rapid central nervous system depression may occur resulting in deep coma and death. Prolonged skin exposure may cause drying and cracking of the skin. NIOSH recommends an exposure limit of 350 milligrams per cubic meter (TWA). (3) There is no OSHA standard for mineral spirits.

VM&P Naptha -- exposure may cause throat and eye irritation, hyperactivity, and cyanosis if concentrations are high. NIOSH recommends an exposure limit of 350 mg/cubic meter (TWA). (3) There is no OSHA standard.

Methyl Isobutyl Ketone -- exposure to concentrations of 200 ppm have been known to cause eye and respiratory passage irritation, headache, dizziness or nausea. (4) NIOSH recommends an exposure limit of 100 ppm (TWA). (5) The OSHA standard is the same.

Iron -- inhalation of iron oxide fume or dust gives rise to apparently benign pneumoconiosis termed siderosis. Prolonged excessive exposure over a period of 6 to 10 years is usually required before changes recognizable by x-ray can occur. The iron deposition in the lungs gives x-ray shadows which may be indistinguishable from fibrotic pneumoconiosis. (6) The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that no worker be exposed to a concentration greater than the Threshold Limit Value (TLV) of 5 milligrams per cubic meter determined as a TWA exposure for normal 8-hour workday or 40-hour workweek. (7) The OSHA standard is 10 mg per cubic meter.(2)

Chromium -- under environmental conditions where oxygen is present, chromium exists in 3 principal forms: elemental chromium or chromium metal; trivalent chromium or chromium (III) including chromite and soluble chromous and chromic salts; and hexavalent chromium or chromium (VI) compounds as chromates, dichromates or chromic acid anhydride (CrO_3). Chromium metal and its insoluble salts are considered to be relatively non-toxic. (8) The soluble chromic and chromous salts have no established toxicity although sensitization dermatitis may occur. (9) Chromium (VI) compounds are known to cause penetrating sores of the skin, ulceration and perforation of the nasal septum, inflammation of the mucous membrane, and may cause kitney or liver damage, tooth erosion and discoloration, and perforated eardrums. Some forms of chromium (VI) may cause lung cancer. (10) NIOSH recommends an exposure limit of 25 micrograms per cubic meter (TWA) for noncarcinogenic

hexavalent chromium (monochromates and dichromates of hydrogen, lithium, sodium, potassium, rubidium, cesium, ammonium, and chromic acid anhydride), and also recommends an exposure limit of 1 microgram per cubic meter for carcinogenic hexavalent chromium (any other chromium (VI) material such as lead, zinc, and calcium chromates). (10) The OSHA standard is 0.1 milligrams per cubic meter. (2) The ACGIH recommends a TLV of 0.5 milligrams per cubic meter for Trivalent chromium compounds and 1.0 milligrams per cubic meter for Chromium metal and insoluble salts. (7) The OSHA standard is the same.

Inorganic Nickel -- lung cancer and nasal cancer can result from inhalation of nickel. Nickel can also cause dermatitis (nickel itch) if there is appreciable skin contact. NIOSH recommends an exposure limit of 15 micrograms per cubic meter (TWA). (11) The OSHA standard is 1.0 milligrams per cubic meter (2)

Copper -- health effects from exposure to the fumes consist of irritation of the upper respiratory tract, metallic or sweet taste,nnausea, metal fume fever, and in some instances discoloration of the skin and hair. (4) The ACGIH recommends a TLV for copper fume of 0.1 milligrams per cubic meter. (7)

Aluminum -- exposure to aluminum oxide produces Shaver's disease. The role of aluminum oxide in producing this disease is still not completely understood. The ACGIH recommends a TLV for aluminum oxide of 10 milligrams per cubic meter. (4)

Crystalline Silica -- The primary health effects associated with inhalation of free silica is a form of pneumoconiosis (dusty lung) termed silicosis. As the silicon dioxide is deposited into the lungs, the silica stimulates production of fibrotic nodules. The nodules in turn compress the alveoli (air sacs) thereby decreasing the lung function and producing restrictive type pulmonary disease. NIOSH recommends an exposure limit of 50 micrograms per cubic meter (TWA) (12) The OSHA standard is derived by dividing 10 mg/M^3 by the % Quartz + 2. (2)

Respirable Particulate -- The ACGIH recommends a TLV of 5 milligrams per cubic meter. (7) The OSHA standard is the same. (2)

Total Particulate -- The ACGIH recommends a TLV of 10 milligrams per cubic meter. (7) The OSHA standard is 15 milligrams per cubic meter.(2)

E. Evaluation Results

Results from the personal breathing zone and area samples collected are shown in Tables 1-4.

Three of eight personal samples taken in the mixing area (Table 3) on July 5, 1978,

exceeded the NIOSH evaluation criteria for crystalline silica of 50 micrograms per cubic meter. All the other samples taken were well below the evaluation criteria.

Although the long-term environmental samples did not show average concentrations of air contaminants which could explain the health effects reported by the workers, the substances involved would cause the reported irritation if peak concentrations, even for very brief periods, considerably exceeded the levels found on this survey. This appears very likely because: 1. with no ventilation system the individual operator is very likely to get a high exposure to the fumes or dust at the time it is generated before it has a chance to dissipate; 2. the complaint of the dust clogging the nose or causing production of dark sputum strongly suggest that dust particles larger than "respirable" are involved (these would also tend to settle faster) and 3. cement dust, at least, is not completely inert and could be expected to cause irritation to moist body surfaces in which it might come in contact. The low level of overall contamination suggests that some attention to peak concentrations should considerably improve the working conditions.

F. Recommendations

1) Employee exposure to crystalline silica should be reduced to a level below the NIOSH evaluation criteria. This should be accomplished by utilizing engineering controls (ventilation, enclosure, etc.) or administrative controls in the areas where employees are exposed to crystalline silica.

2) A respiratory protection program, utilizing NIOSH approved respirators, should be implemented to reduce employee exposure to crystalline silica until other suitable methods are put into effect. Employees should be instructed in how to use respirators, clean respirators, and leak test respirators if a respiratory protection program is utilized.

3) The mold spinning machines should be enclosed as required by OSHA standard 1910.212a(4). This would eliminate the hazard of objects being thrown from the spinning molds, and would help reduce the noise levels.

4) Peak exposures to air contaminants should be controlled either by installing local exhaust ventilation to carry the contaminants away from the operator, or by supplying appropriate respiratory protection to the worker. The choice of either method, or a combination of the two will depend on the frequency, duration, and mobility required for the particular procedure.

V. REFERENCES

(1) NIOSH Recommended Standard for Occupational Exposure to Toluene, NIOSH, Cincinnati, Ohio (1973)

(2) Federal Register, Volume 39, No. 125, Title 29, Code of Federal Regulations, Part 1910, July 1977.

(3) NIOSH Recommended Standard for Occupational Exposure to Refined Petroleum Solvents, NIOSH, Cincinnati, Ohio (1977)

(4) American Conference of Governmental Industrial Hygienists: Documentation of the Threshold Limit Values for Substances in Workroom Air, third edition, 1971, Page 127.

(5) NIOSH/OSHA Draft Technical Standard, Set A, Hexone.

(6) NIOSH/OSHA Draft Technical Standard, Set O, Iron Oxide Fume.

(7) Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1978, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio (1978).

(8) NIOSH/OSHA Draft Technical Standard, Set O, Chromium metal and insoluble chromium salts.

(9) NIOSH/OSHA Draft Technical Standard, Set O, soluble chromous and chromic salts.

(10) NIOSH Recommended Standard for Occupational Exposure to chromium (VI), NIOSH, Cincinnati, Ohio (1976)

(11) Criteria for a Recommended Standard-Occupational Exposure to Inorganic Nickel, NIOSH, HEW, Washington, D.C., May, 1977.

(12) Criteria for a Recommended Standard-Occupational Exposure to Crystalline Silica, NIOSH, HEW, Washington, D.C., (1974).

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TABLE 1
RESULTS OF ENVIRONMENTAL SAMPLING FOR FUMES OF
IRON OXIDE, CHROMIUM, NICKEL, COPPER, AND ALUMINUM

Job/Location	Sample Number	Time of Sample	Fe_2O_3 mg/M3	Cr mg/M3	Ni mg/M3	Cu mg/M3	Al mg/M3	Type of Sample
Welding Area - Center	D-649	10:08-15:35	0.08	*	*	*	*	General Area
Welder - Pole bases	D-635	09:55-14:47	0.4	*	*	*	*	BZ
Welder - Poles	D-630	10:05-14:48	0.75	*	*	*	*	BZ
Welder - Pole bases	D-645	10:02-15:37	0.16	*	*	*	0.35	BZ
	Evaluation Criteria		5	**	0.015	0.2	10	
NIOSH Limit of Detection (ug/sample)			2	3	2	2	3	

mg/M3 = milligrams of substance per cubic meter of air
BZ = breathing zone
* = below the NIOSH limit of detection
** = See the evaluation criteria portion of the report

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TABLE 2
RESULTS OF ENVIRONMENTAL SAMPLING
FOR TOTAL PARTICULATES

Job/Location	Sample Number	Time of Sample	Total Particulates mg/M^3	Type of Sample
Grinding and Polishing	D-641	08:45-15:55	2.9	BZ
Grinding and Polishing	D-632	08:50-15:51	1.8	BZ
Batcher	D-640	08:58-15:45	4.0	BZ
Concrete Pumper	D-631	09:02-15:48	1.4	BZ
Batching Platform	D-646	09:14-15:43	1.5	GA
Spinner	D-639	09:00-15:45	0.8	BZ
Parts in Molds	D-638	09:04-14:10	0.7	BZ
Batching Platform	D-647	08:48-15:41	1.8	GA

Evaluation Criteria	10
NIOSH Accuracy (mg/sample)	0.01

mg/M^3 = milligrams of substance per cubic meter of air
BZ = breathing zone
GA = general area

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TABLE 3
RESULTS OF ENVIRONMENTAL SAMPLING
FOR RESPIRABLE PARTICULATES AND FREE SILICA

Job/Location	Sample Number	Time of Sample	Respirable Particulate (mg/M^3)	Respirable Quartz (mg/M^3)	Cristobalite (mg/M^3)	Type of Sample
Wet Grinding	FWS-2685	08:45 - 15:55	0.92	0.164	*	BZ
Polishing and Grinding	FWS-2688	08:50 - 15:51	0.88	0.167	*	BZ
Batcher	FWS-2696	08:56 - 15:45	0.65	*	*	BZ
Concrete Pumper	FWS-2678	09:02 - 15:48	0.51	0.043	*	BZ
Batching Platform	FWS-2679	09:14 - 15:43	0.91	0.034	*	GA
Batcher	FWS-2676	08:49 - 15:40	0.40	*	*	BZ
Spinner	FWS-2683	09:00 - 15:45	0.35	*	*	BZ
Ports in Molds	FWS-2694	09:04 - 14:10	0.27	0.058	*	BZ
Batching Platform	FWS-2682	08:48 - 15:41	0.57	0.013	*	GA
NIOSH Limit of Detection(mg/sample)			0.01	0.03	0.03	
Evaluation criteria (mg/M^3)			5.0	0.05	0.05	

mg/M^3 = milligrams of substance per cubic meter of air
BZ = breathing zone
GA = general area
* = below the NIOSH limit of detection

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TABLE 4
RESULTS OF ENVIRONMENTAL SAMPLING FOR MINERAL SPIRITS, VM&P NAPHTHA, TOLUENE, METHYL ISOBUTYL KETONE

Job/Location	Sample Number	Time of Sample	Toluene (PPM)	Mineral Spirits and VM & P Naptha (mg/M^3)	Methyl Isobutyl Ketone (PPM)	Type of Sample
Painter	C-1	08:40-1510	0.3	9.7	0.3	BZ
Painter	C-2	08:42-14:11	0.2	6.4	0.2	BZ
Painter	C-3	08:50-15:13	0.7	19.0	0.8	BZ
Painting Area	C-5	08:50-15:13	1.2	28.7	1.3	GA
NIOSH Limit of Detection (mg/sample)			0.01	0.02	0.01	
Evaluation Criteria (mg/M^3)			100	350	100	

mg/M^3 = milligrams of substance per cubic meter of air
BZ = breathing zone
GA = General Area
PPM = Parts of vapor or gas per million parts of contaminated air by volume at $25^{o}C$ and 760 mm Hg pressure