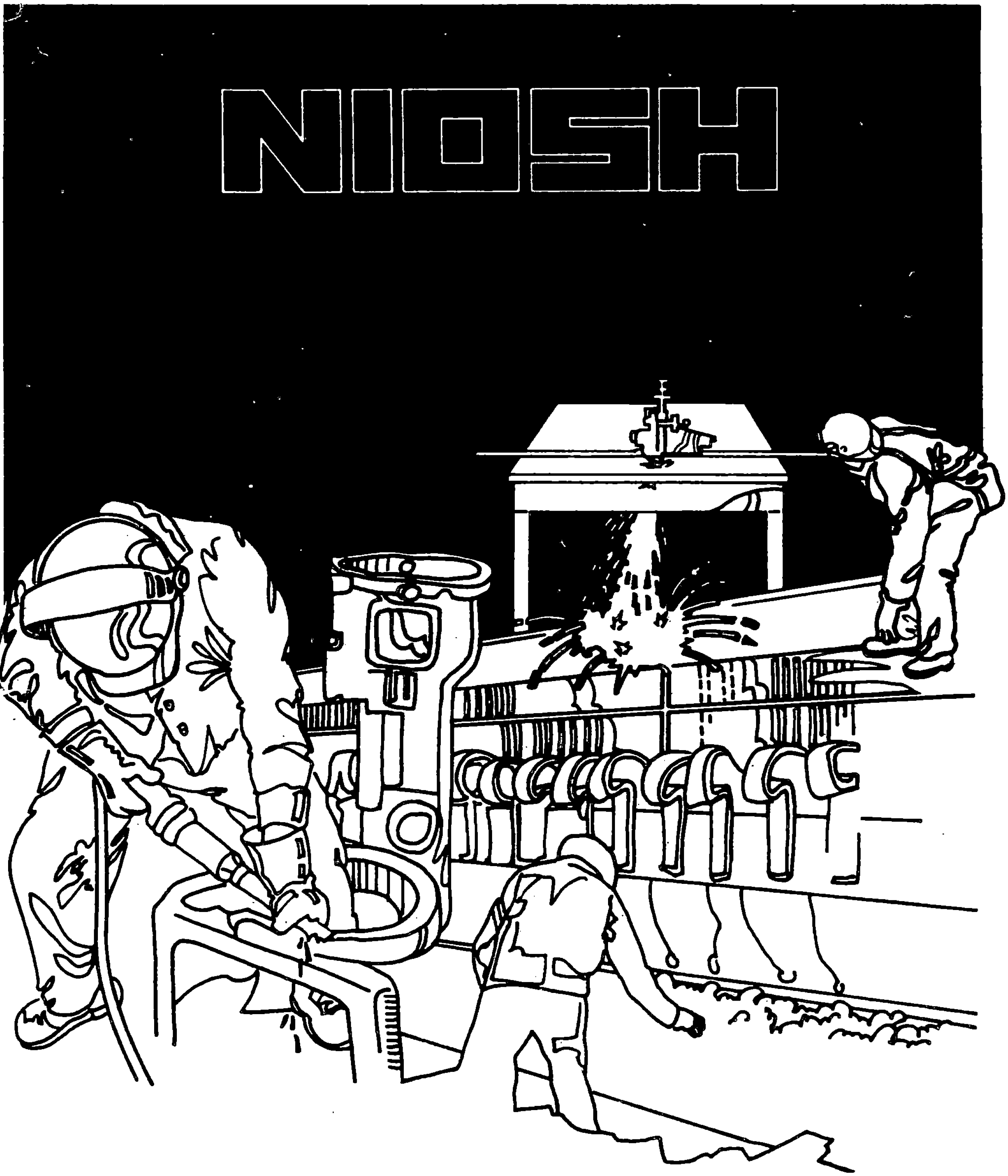
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 78-121-1071
ALLIS-CHALMERS CORPORATION
WEST ALLIS, WISCONSIN

PREFACE

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

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

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ALLIS-CHALMERS CORPORATION
WEST ALLIS, WISCONSIN

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I. SUMMARY

On August 7, 1978, NIOSH received a Health Hazard Evaluation request from the United Auto Workers (UAW) Union, Local 248, to investigate exposures to air contaminants at the Allis-Chalmers Corporation Foundry, West Allis, Wisconsin. The foundry produces grey and ductile iron castings for assembly into farm implements and tractors. NIOSH conducted an initial survey on September 13, 1978, and environmental evaluations on October 24-26, 1978, and June 18-21, 1979. Medical evaluations were conducted on October 1, 1980 and February 9-12, 1981.

Personal and/or area air samples were collected for measurement of exposure to carbon monoxide, formaldehyde, ammonia, methylene bisphenyl isocyanate (MDI), xylene, hexamethylene tetramine, iron oxide fume, total dust, phenol, inorganic metals, particulate oil mist, dimethylethylamine, methyl chloroform and Particulate Polycyclic Organic Material (PPOM). Total and respirable dust samples were taken and analyzed for percent free crystalline silica by X-ray diffraction.

A confidential medical questionnaire was administered to 64 current and 3 retired foundry employees. Pulmonary function tests were performed on these 67 workers, with pre- and post-shift tests performed on 10 core-room employees. Company medical records were obtained and chest X-rays performed by the company were read by two independent "B" readers using the ILO U/C classification system for pneumoconioses.

Airborne exposures were found to exceed NIOSH recommended standards for respirable-crystalline silica, nickel and carbon monoxide. The NIOSH recommended standard for silica [50 micrograms/cubic meter (ug/m^3)] was exceeded in sixteen (64%) of 25 samples in the Core and Molding areas (range 50-130 ug/m^3) and in all 12 samples in the Finishing area (range 100-550 ug/m^3). All 12 Finishing area samples also exceeded the OSHA standard.

The NIOSH recommended standard for nickel (15 ug/m^3) was exceeded in four of seven Electric Arc Welder samples in the Finishing area (range 69-159 ug/m^3). The OSHA Nickel standard is 1000 ug/m^3. Short term (30-seconds to one minute) monitoring for Carbon Monoxide (CO) documented air levels up to 300 parts per million (ppm) on the pouring floor; the NIOSH recommended ceiling level for exposure is 200 ppm. Long term monitoring (by Detector Tube) in the area on a later survey indicated that only two employees (one pourer, one craneman) were exposed to CO levels (37-40 ppm) in excess of the NIOSH eight-hour TWA criteria of 35 ppm. However, expired air CO and carboxyhemoglobin (COHb) levels concentrations showed excessive increases (any level greater than NIOSH's recommended standard of five percent COHb) over the work shift in seven of 16 workers in or near the pouring area. None of the other air contaminants sampled exceeded NIOSH recommended limits.

Analysis of chest X-rays and occupational histories of the 67 participating workers revealed six cases (9%) of definite silicosis, including one case of silico-tuberculosis. One case of other pneumoconiosis was found. Symptoms of recent upper respiratory symptoms were found in 50 (75%) of the workers, and symptoms of chronic bronchitis were found in 16 (24%) workers. Nine workers (14%) had abnormal pulmonary function tests on NIOSH examination. Pre- and Post-Shift pulmonary function testing in core room workers revealed that one worker had a 10% decline in FVC over the work shift.

Based on the data obtained in this study and company medical records, including X-rays, NIOSH determined that a serious health hazard exists due to excessive exposures to free crystalline silica in the core making and cleaning departments. Health hazards also existed due to carbon monoxide exposure in the old coke fired cupolas and pouring areas and to nickel in the Finishing area. Recommendations that will help reduce exposures and for medical management of employees are provided in Section VII.

KEY WORDS: SIC 3321, respirable crystalline, silica, carbon monoxide, nickel, silicosis, foundry.

II. INTRODUCTION

On August 7, 1978, NIOSH received a request for a Health Hazard Evaluation from an authorized representative of Local No. 248 of the United Auto Workers (UAW) representing employees of the Allis-Chalmers Corporation, West Allis, WI. The request expressed a concern that employees in the foundry may have suffered lung damage as a result of their work.

On September 13, 1978, NIOSH conducted an opening conference and an initial walkthrough of the plant. Private interviews with twelve workers in the core-making department were conducted revealing no evidence of sensitization to isocyanates. Although NIOSH regulations allow for the review of company-held employee medical records, the company would not allow the NIOSH Medical Officer to do so. Since the review of the records was necessary to determine the need for new or additional medical testing, it was decided that legal actions by NIOSH would be undertaken before medical followup would be performed. Interim report # 1, September 28, 1978, summarized the findings of the initial survey.

The first follow-up environmental survey was conducted on October 24-26, 1978. Air monitoring for free crystalline silica, carbon monoxide, nickel and other potential contaminants of foundry atmospheres was performed. Excessive concentrations of free crystalline silica , carbon monoxide and nickel were found in several areas of the plant. A summary of findings and recommendations from the first followup survey was reported in Interim Report #2, January 30, 1979.

A second follow-up environmental survey was conducted on June 18-21, 1979. Air levels of metal fumes, dimethylethylamine, carbon monoxide, and methylene bisphenyl isocyanate (MDI) were measured. Overexposures were again found to nickel fumes. A summary of findings and recommendations may be found in Interim Report #3, September 1979.

On June 24, 1980, the Eastern District Court of Wisconsin announced its decision supporting NIOSH's access to company-held employee medical records and ordered Allis-Chalmers to comply with the NIOSH supoena.

On October 1, 1980, a NIOSH medical officer met with company and union officials to discuss the medical follow-up survey and review company-held employee medical records. A second walk-through survey was conducted to see areas of the foundry which had been changed since the initial walk-through.

On February 9-12, 1981, NIOSH performed a medical follow-up survey involving pulmonary function testing, medical records review and administration of a confidential questionnaire. As the last step of the medical follow-up survey, company-held chest x-rays were reviewed by two independent "B reader" radiologists for presence of radiographic evidence of pneumoconiosis among foundry workers.

III. BACKGROUND

The Allis-Chalmers foundry has been engaged in the production of gray and ductile iron castings for agricultural tractors since 1903. The employee population is distributed among 4 major departments: Core, Molding, Melting and Cleaning. The employees work in a building having dimensions of approximately 1000 feet long, 250 feet wide and 72 feet high. There are three work shifts: Most of the employees work the first shift from 6 a.m. to 2 p.m.; several maintenance employees work the second shift from 2 p.m. to 10 p.m.; and employees responsible for pouring most of the molds work the third shift from 10 p.m. to 6 a.m. A brief description of the process stages and the associated potential health hazards are described below.

1. Core Making: The sand cores are produced by the shell, no-bake and cold-box processes. The shell cores are prepared from a urea-phenol-formaldehyde-sand mixture by blowing the resin-sand mixture into a metal mold pre-heated to 400 to 450° F, holding for less than a minute to allow the binder to cure, then removing the finished core or core segment from the mold.

The automatic no-bake cores are prepared from a phenolic urethane binder system containing phenol, formaldehyde, MDI, and aromatic hydrocarbons. Core makers feed the sand-resin mixture onto a pattern placed on an automatic (turntable) core making machine. They then place reinforcing rods in the pattern as they pack the mixture in the pattern. Once the pattern is filled, the unit rotates the pattern past a "strike-off" which scrapes the surface of the core and gives a final topping, i.e., smooth surface. Within three minutes, the core is set (hardened). The pattern box is then transferred to the "plate feed line" which puts a steel cover on top. The pattern is automatically clamped, turned upside down, and then released onto conveyor-rollers.

Core makers are exposed to formaldehyde, phenol, and ammonia which are evolved from thermal degradation of the binder system during curing.[1,5] The ammonia results from the decomposition of hexamethylene tetramine (HMTA) which acts as a catalyst for the resin. The core maker's primary exposures occur while removing the finished core from the mold and carrying it to a storage table or rack. The core makers also may be exposed to free crystalline silica.

Core finishers glue all component parts into the main core, smooth the core edges, and finally blow the excess sand off with high pressure air lines. This air line is also used to blow dust off the pattern box before it is recycled onto the turntable. Core finishers may be exposed to crystalline free silica.

Core painters (assemblers) then dip the cores in a tank with an iron oxide based paint, trichloroethylene, and 5% isopropyl alcohol which results in better castings and decreased cleaning times. A final application is done with a brush. The core sets are then sent to temporary storage. Core painters may be exposed to the core paint solvent (trichloroethylene), iron oxide dust, and free crystalline silica. There are no local exhaust ventilation systems in the no-bake core making area.

2. Sand Molding: The ferrous castings are produced in "green sand" molds. The term "green sand" implies that the bonding agent in the sand is a form of clay such as bentonite. The clay is plasticized with water. The green sand molds also contain organic additives such as pulverized coal dust (sea coal) which may be present in amounts up to five percent of the weight of the sand. Sea coal is added to provide a reducing atmosphere at the mold-metal interface and cushion the shock of thermal expansion of the sand when the metal is poured into the mold cavity.[6]

The sand molds are constructed by two methods - Spomatic and Osborn. The first is an "automatic" method in which sand molds are prepared by continuously running "jolt squeeze" machines. A pattern changer makes necessary changes and feeds the proper "drag" section of the mold onto the mold line. Core setters place cores into the sand mold section before the cope is set on top and also spray the molds section with the same paint used in core making. The sand mold, encapsulating the sand core, is now ready for the poured metal. Following pouring, the mold is conveyed to the Spomatic shakeout unit equipped with a canopy hood. The metal casting falls through the grating to a conveyor belt which transports the sand to the reclaim or sand muller. The empty molds are then ready to be recycled. The castings proceed along a vibrating grate under a canopy hood to an area where they are removed via a hoist and by two pull off operators.

The Osborn method is a semi-automatic method employing molders, utility helper, shakeout, finisher, and core setters. The molder operates a "jolt squeeze" machine which allows sand to fall onto the mold section. The molder smooths the sand and sprays a mineral oil parting compound (for mold release) onto the mold. The shakeout operator transports the mold to a vibrating grate where the excess sand is removed from the casting. The unit is equipped with a single side draft local exhaust ventilation system to capture silica dust.

All Molding Department employees have potential exposures to free silica dust during both methods.

Reclamation and reconditioning of used sand is accomplished by mixing units called mullers. The reconditioning additives are added to the semi-automatic mullers by the muller operators with a hand scoop. The unit for the Osborn method has a local exhaust ventilation system (lateral exhaust slot) positioned adjacent to the additive entry port to capture excess dust. Both units are in separate rooms off the main foundry floor. These employees may be exposed to free silica dust.

3. Melting and Pouring: The gray or ductile iron allow is prepared in one of three new coreless induction furnaces (replacing two vertical shaft type coke fired cupola furnaces in 1980) with close capture 10,000 - 20,000 Cubic Foot per minute ventilation systems vented to a bag house. Once the molten metal has been heated to the required temperature (about 2600-2900°F) the furnace is tapped and the molten metal flows into a channel induction furnace to maintain the proper temperature. Then the molten metal flows into preheated ladles. The cupola is prepared for a melt by a cupola tender, while iron pourers bring the ladels for refilling. Once pouring begins it continues until all molds have been cast. Also working in this department are skimmers, metal control men, and crane operators.

From the ladles the molten metal is poured into sand molds of the Spomatic, Osborn or manual no-bake methods. The Spomatic method molds are filled with molten iron several feet from the cupola. This pouring/cooling line consists of four parallel tracts, arranged in a zig-zag fashion, which eventually move the molds to the automatic shakeout described above. Approximately the first 20 feet of the line is open to the atmosphere. At this point, the molds enter a canopy exhaust hood for the remainder of this line and the next track. The last two tracks are open to the atmosphere until reaching the automatic shakeout area.

The Osborn pouring line is further away from the furnaces. None of the Osborn line is supplied with local exhaust ventilation.

A third pouring area, adjacent to this area, is used to make castings from no-bake cores.

The melting and pouring personnel are exposed to a variety of potential air contaminants resulting from the thermal decomposition of the organic binders and carbonaceous materials contained in the sand cores and molding sand. The principal gases evolved during pouring of castings include carbon monoxide and low molecular weight hydrocarbons with smaller amounts of ammonia, formaldehyde, and hydrogen cyanide.[4] Recent research provides evidence that the thermal decomposition of green sand molds produces many organic pyrolysis products which include benzo(a)pyrene and benzo(e)pyrene.[15] The pourers are exposed to iron oxide fume (ferric oxide). They are also exposed to airborne silica dust generated from adjacent operations such as shakeout. Isocyanates may also be evolved during pouring, cooling, and shakeout.

4. Cleaning: A casting is "finished" by chipping, grinding, shot blasting, and painting.
Chippers work in small bays with hand-held pneumatic tools to remove imperfections from castings. There are three sets of chipping and grinding bays - east side, north and center each measuring 12 feet long, seven feet wide and eight feet high. The east side bay is

equipped with mechanical supply and exhaust air ventilation. Air is directed onto the chipper from a few feet above his head from grills and exhausted from side exhaust grills near the floor of the bay. In order to capture silica dust generated during chipping, the workers position a casting as close as possible to the side exhaust slots. Each north bay chipper wears a supplied air helmet to keep contaminated air and flying pieces away from the chipper. The compressed air source is monitored for carbon monoxide, with an alarm set at 20 parts of CO per million parts of air. A filtered air supply comes from the north outside end of the building. There is no local exhaust ventilation in the center bays.

Grinding wheel units are operated by a cut off saw operator. Generated dust is contained by enclosing the operation in a three sided booth with exhaust ventilation.

The steel shot blasting operators run spinner blast units, monorail blast units, and wheelabrater units. Each unit is enclosed and fitted with dust collection devices.

All cleaning department employees may be exposed to crystalline free silica.

Painter/Hang casting workers hang and spray paint the castings in a spray booth equipped with a waterfall for collection of excess paint particles and vapors. They may be exposed to solvent vapors, as well as the free crystalline silica dust from the nearby cleaning areas.

If castings need repair, electric arc-welders, work in a welding station nearby with potential exposures to welding fumes, and free crystalline silica.

The foundry has been under abatement with OSHA for elevated silica levels. The company has eliminated several cleaning booths, cut cross-drafts in the cleaning department, and decreased total time required for cleaning.

IV. EVALUATION DESIGN AND METHODS

The flow diagram (Fiqure 1) sequentially presents the medical and environmental events of the health hazard evaluation and significant findings as they occurred.

A. Environmental Methodology

The air sampling and analytical methodology for the different types of samples is shown in the Table 1. Included are, for each substance evaluated, the collection device, the pump flow rates, the range of sample durations, the analysis method, the analytical detection limit, and where applicable, the reference for the detailed sampling and analytical method. The personal air are those for which the subject actually wears the air sampler with the collection device being pinned to the shirt lapel or collar so as to obtain an air sample representative of what the subject is breathing. The area samples are obtained by placing the sampling apparatus either in general work areas or in positions thought to have air quality similar to that to which the subject is exposed. Carbon monoxide was monitored using a portable direct reading instrument and long term colorimetric gas indicator tubes.

1. Survey #1: There was no environmental sampling during this initial survey conducted on September 13, 1978. This visit was used for an opening conference with representatives of management and labor and to conduct a walkthrough where information was collected that would aid in developing future medical and environmental activities.

2. Survey #2: The first follow-up environmental survey was conducted on October 24-26, 1978. Air samples were obtained and analyzed for: formaldehyde, ammonia, MDI, phenol, hexamethylenetetramine, methyl choroform, crystalline free silica, particulate polycyclic organic matter, carbon monoxide, xylene, iron oxide, nickel, total weight and oil mist. Results are presented in Tables 2 to 13 and summarized in section VI. Samples were obtained over periods ranging from 30 seconds (direct reading instrument for CO) to over 7 hours.

3. Survey #3: A second follow-up environmental survey was conducted on June 18-21, 1979. Air sampling was conducted for carbon monoxide in metal pouring areas to further document CO exposures using long term personal breathing zone sampling techniques. CO dosimeters and long term colorimetric gas detector tubes were both utilized to measure exposure and to collect data comparing the two methods of sampling. Both methods generate results in the field and do not require further lab analysis. Carbon monoxide exposures in the crane cab was monitored using a direct reading instrument. Dimethylethylamine was sampled for in the core-making area using a silica gel sampling method.

Exposures to nickel, manganese, copper and iron oxide were determined in the casting repair operation.

B. Medical Evaluation Methodology

1. Survey #2: October 1978. Worker exposure to carbon monoxide was measured by an expired air analysis method using "breath-hold" techniques. The concentration of CO in the expired air is an indicator of the percent of hemoglobin (Hb) bound as carboxyhemoglobin (COHb). In this procedure, the subject exhales completely, fills his lungs rapidly and holds for 20 seconds while

being timed, then exhales a small portion (several hundred milliliters) to the ambient air, and the remainder is admitted to an evacuated bag. The former maneuver is necessary, since the expired air represents unequilibrated gas from the pulmonary dead space. The CO level in the exhaled air was measured, in parts of gas per million parts of contaminated air by volume, with a direct reading CO monitor. The COHB level in percent saturation was calculated using Ringold's equation:[17]

$$\text{COHB\%} = 0.5 + \frac{\text{CO in ppm}}{5.0}$$

Pre- and post-shift breath analysis samples were collected from certain Mold and Melt Department personnel. The employees' smoking habits were recorded. We did not ask the employees to refrain from smoking during the workday because we wanted the sample to be representative of their normal smoking routine.

2. Survey #4: October 1980. Medical records of all foundry employees were reviewed for types of tests performed and quality of x-rays available.

3. Survey #5: February 1981. All 105 current foundry employees and 30 retirees who had worked in the foundry and were known by the Union to be residing in the Milwaukee area were invited to participate in the medical survey.

The medical evaluation included a confidential interview, pulmonary function testing, review of company medical records, and reading of chest X-rays previously performed by the company medical department.

A confidential questionnaire was administered which requested information concerning past medical history of respiratory problems, respiratory symptoms, social history and occupational history.

All workers in the core making department were offered pre- and post-shift pulmonary function tests. Other foundry and retired workers were offered pulmonary function testing during the shift (or during the day for retirees). Copies of medical records were obtained for all workers. Previous pulmonary function tests performed by the company since 1979 were analyzed by NIOSH and were evaluated using the Morris[22] nomogram.
Chest X-rays performed by the company since the early 1940's were reviewed and consensus readings performed by two independent "B readers" for possible pneumoconioses. The earliest adequate quality film was compared with the most recent film available. Films were classified by the ILO/UC classification system.

Frequencies of responses to respiratory questions concerning usual morning cough, phlegm, wheezing and shortness of breath were compared to frequencies generated from HANES (Health and Nutrition Examination Survey)[19].

Data was adjusted for age, sex and smoking status. Significance was evaluated by comparison of two proportions based on two large samples[20] generating two-sided p-values using a computer program.[21]

V. EVALUATION CRITERIA

A. Environmental Criteria

The environmental criteria described below are intended to represent airborne concentrations of substances to which workers may be exposed for eight hours a day, 40 hours per week for a working lifetime without adverse health effects. Because of wide variation in individual susceptability, a small percentage of workers may experience discomfort from some substances at concentrations at or below the permissible limit. The time-weighted average (TWA) exposre refers to the average concentration during a normal 8-hour work day. The Short-term Exposure Limit is the maximum allowable concentration, or ceiling limit, to which workers can be exposed during a period of up to 15 minutes, provided that no more than four excursions per day are permitted, with at least 60 minutes between exposure periods.

The primary sources of environmental evaluation criteria considered for this study were:

1. NIOSH criteria documents and recommendations

2. American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's) and

3. The U.S. Department of Labor (OSHA) Federal Occupational Health Standards. The criteria judged most appropriate for this study are as follows:

Air Contaminant	Source* NIOSH	ACGIH (TLV)	OSHA
formaldehyde	1 ppm C	2 ppm	3 ppm
ammonia	50 ppm C	25 ppm	50 ppm
methylene bisphenyl isocyanate	0.05 mg/M3	0.2 mg/M3	0.2 mg/M3
xylene	100 ppm	100 ppm	100 ppm
hexamethylenetetramine	-	-	-
iron oxide fume	-	5 mg/M3	10 mg/M3
nickel	0.015 mg/M3	1 mg/M3	1 mg/M3
copper	-	0.2 mg/M3	0.2 mg/M3
manganese	-	5 mg/M3	5 mg/M3(c)
total nuisance dust	-	10 mg/M3	15 mg/M3
phenol	20 mg/M3	19 mg/M3	19 mg/M3
particulate polycyclic organic hydrocarbons			
-(as benzene solubles)	-	200 ug/M3	-
-(as cyclohexane solubles)	100 ug/M3	-	-
crystalline free silica, respirable fraction (all forms-quartz, cristobalite, etc.)	50 ug/M3	-	-
quartz	-	$\frac{10,000}{\%\ quartz+2}$ ug/M3	$\frac{10,000}{\%\ quartz+2}$ ug/M3
particulate oil mist	-	5 mg/M3	5 mg/M3
carbon monoxide	35 ppm also 200 ppm C	50 ppm	50 ppm
methyl chloroform (1,1,1-trichloroethane)	350 ppm	350 ppm	350 ppm
dimethylethylamine	-	-	-

*Concentrations, in parts of substance per million parts of air (ppm) by volume, or milligrams or micrograms of substance per cubic meter of air (mg/M3 or ug/M3, are based often on an 8-hour time weighted average exposure (TWA). Values with a C (ceiling limit) represent concentrations which should not be exceeded even instantaneously as commonly measured in a 15-minute period.

The NIOSH recommended standards for various substances where they are available are given prominence in this evaluation since they are considered by the Institute to be the most appropriate health criteria. The OSHA Standard is provided as a reference to determine the state of compliance or non-compliance with Federal Regulations. The Federal Standard is enforced by the U.S. Department of Labor, OSHA.

B. Toxicity

The adverse health effects of overexposure to the substances measured are summarized below:

1. Formaldehyde at low levels (0.1-5 ppm.) has been associated with burning of the eyes, tearing, and irritation of the upper respiratory tract. Higher levels may cause cough, tightness of the chest, and palpitations. Extremely high levels may produce pulmonary edema and pneumonitis. Recent reports suggest that formaldehyde is a carcinogen, producing a nasal cancer in rats. (1)

2. Ammonia is a severe irritant of the eyes, respiratory system and skin. It may cause burning of the eyes, runny nose, cough, chest pain, cessation of breathing and death. High levels may lead to temporary blindness and severe eye damage. Chronic exposures may cause bronchitis or pneumonitis. (2)

3. Methylene bisphenyl isocyanate (MDI) has been associated with irritation of the eyes, respiratory tract, and skin., In severe cases, pulmonary edema, nausea and vomiting and abdominal pain may occur. Sensitization to MDI can occur resulting in an asthma-like reaction with wheezing and cough. (2)

4. Xylene at low concentrations may irritate the eyes, nose and throat. At higher concentrations it may cause loss of appetite, nausea, vomiting, abdominal pain, dizziness, staggering, drowsiness and unconsiousness. Irriversible damage may occur to kidneys and liver. (2)

5. Hexamethylenetetramine (Hexa) may cause skin rash, bladder irritation, hematuria, nausea and vomiting.(2)

6. Iron oxide may cause a benign pneumoconiosis (2).

7. Nickel fumes are respiratory irritants and may cause pneumonitis. Skin contact may cause an allergic skin rash. Nickel fumes have been associated with cancer of the lungs and nasal sinuses (2).

8. Copper fumes may result in irritation of the upper respiratory tract and has been associated with an influenza-like syndrome called "metal fume fever", with chills, muscle aches, nausea, fever, dry throat, cough, weakness and lassitude seen in welders and foundry workers (2).

9. Manganese fumes may also cause "metal fume fever". Long term exposure may cause nervous system effects, including difficulty walking, weakness in the legs, hoarseness, poor memory and emotional difficulties (2).

10. Phenol is a strong corrosive agent when in contact with any tissues. Eye contact may cause blindness. Skin contact may cause severe burns. Long term exposure may cause vomiting, diarrhea, headache, fainting, dizziness, dark urine, mental disturbances and liver damage (2).

12. Particulate polycyclic aromatic hydrocarbons have been associated with increased risk of skin and other forms of cancer (2).

13. Particulate Oil mist may cause irritation to the lungs and dermatitis of the skin (2).

14. Carbon Monoxide exposure decreases the ability of the blood to carry oxygen to the tissues, leading to symptoms of headache, nausea, dizziness, weakness, unconsciousness and death. Aggravation of pre-existing heart and vascular disease may occur (2).

15. Methyl chloroform exposure may cause headache, dizziness, drowsiness, irregular heartbeat and death. Liquid splashes in the eyes may cause irritation. Reproductive abnormalities have been seen in animals exposed to high concentrations. Liver abnormalities and dermatitis of the skin may occur (2).

16. Crystalline Free Silica can cause a form of pulmonary fibrosis called silicosis when fine particles of silica are deposited in the lungs. Symptoms usually develop slowly with cough, shortness of breath, chest pain, weakness and wheezing developing after 10-20 years of exposure to moderate levels of crystalline free silica.. Higher exposure levels may accelerate the development of the disease. Persons with silicosis may be at greater risk of developing a particularly hazardous form of tuberculosis called silico-tuberculosis (18).

VI. RESULTS AND DISCUSSION

A. Environmental

The following table summarizes the results of the environmental sampling effort. Tables of results for each set of samples are presented in Table 2 through Table 16.

1. Visit #1: No Sampling

2. Visit #2: Tables 2-13

a. Core Area

	range	NIOSH Criteria Exceeded?	Table No.
(1) Formaldehyde	0.2 - 0.3 ppm	No	2
(2) Ammonia	1.0 - 23.0 ppm	No	3
(3) MDI	See note (a)		
(4) Phenol	N.D.- 2.8 mg/m^3	No	4
(5) Hexamethylene tetramine	N.D.- 0.09	No criteria	4
(6) Methyl chloroform	40.0 -154.0 ppm	No	5
(7) Crystalline silica (Respirable)	N.D.-130 ug/m^3	Yes	8,9

b. Sand Molding

	range	NIOSH Criteria Exceeded?	Table No.
(1) Crystalline silica (Respirable)	N.D.-160 ug/m^3	Yes	8,9
(2) Oil Mist	0.9 mg/m^3	No	7
(3) Total Dust	6.0 mg/m^3	No	7
(4) Iron oxide	0.3 mg/m^3	No	7

c. Melt and Pour Area

	range	NIOSH Criteria Exceeded?	Table No.
(1). PPOM			
(a) Benzene solubles	N.D.-100 ug/m^3	No	13
(b) Benzo (a) pyrene	0.1 - 1.9 ug/m^3	See note (b)	13
(c) Benzo (e) pyrene	0.2 - 2.0 ug/m^3	"	13
(d) Benzo (a) anthrocene	0.1 - 2.0 ug/m^3	"	13
(e) Chrysene	N.D.- 1.2 ug/m^3	"	13
(f) Pyrene	N.D.- 0.3 ug/m^3	"	13
(g) Fluoranthene	0.03- 0.3 ug/m^3	"	13
(2) Carbon Monoxide (30 sec. readings) pouring floor	20-300 ppm	Yes	6,10
(3) Carbon Monoxide (crane cab) (30 sec. readings)	2-102 ppm	No	12
(4) Total dust	4.0 mg/m^3	No	7
(5) Iron oxide	0.3 mg/m^3	No	7

d. Cleaning Area

(1) Crystalline silica (respirable)	100-550 ug/m^3	Yes	8
(2) Nickel	0.1 mg/m^3	Yes	7
(3) Total dust	3.0 mg/m^3	No	7
(4) Xylene	7.0 ppm	No	7
(5) Iron Oxide	0.9 mg/m^3	No	7
3. Visit #3: Tables 14-16			
a. Core area			
(1) DMEA	N.D.-9.09 ppm	No criteria	14
b. Sand Molding: No sampling			
c. Metal Pouring Area			
(1) Carbon Monoxide (long term)			
dosimeter results	7 - 32 ppm	No	
Long term detector tubes	21 - 40 ppm	Yes	16
(2) Carbon Monoxide (30 min reading inside cab)	10 -100+	Note (c)	15
d. Cleaning Area			
(1) Nickel	9 -159 ug/m^3	Yes	14
(2) Manganese	N.D.- 0.02 mg/m^3	No	14
(3) Copper	N.D.	No	14
(4) Iron Oxide	0.1 - 0.9 mg/m^3	No	14

(a) Results not able to be used due to excessive build up of particulates on the surface of the tape.

(b) Even though there are no criteria for these substances, exposure should be minimized due to the association of these types of compounds with cancer.

(c) Thirty percent (30%) of readings were off scale or greater than 100 ppm.

B. Discussion of Environmental Results

1. Core area: Personal samples ranged from non-detectable to 130 micrograms of free silica per cubic meter of air (ug/M^3); nine of 11 samples were above the NIOSH recommended standard of 50 ug/M^3 (Table 9). All were below the OSHA legal standard. These samples represent exposures of core makers of all the different core making techniques.

In the core making area, the iso-cure operator was exposed to air levels of dimethylethylamine (DMEA) ranging from non-detectable to 0.09 ppm (Table 14). Area samples taken near the work table were similar (0.05 ppm). However, there are no environmental standards for DMEA with which to compare these concentrations. Two other fairly similar amines - methylamine and triethylamine - have for their TLV's 10 and 25 ppm, respectively. If the toxicity of DMEA would be found to be similar to these, the exposure levels would not be expected to cause health effects.

Other exposures were all well below the applicable environmental criteria.

2. Molding/Shakeout: Except for silica exposures, the result of air sampling in this area indicated that air concentrations of the various contaminants were all below applicable criteria. Seven of 14 silica samples exceeded the NIOSH 50 ug/m^3 criteria. Results ranged from N.D. - 70 ug/M^3 (Table 8). All samples were below the OSHA standard.

3. Melt and Pouring Areas: The results of air sampling of the iron pourers and cupola tenders for particulate polycyclic organic matter (PPOM) are illustrated in Table 13. Three iron pourers and one cupola tender were exposed to time weighted average concentrations of PPOM (Benzene Solubles) of 100 micrograms of substance per cubic meter of air (ug/M^3), benzene soluble fraction. These concentrations are the highest recommended by NIOSH for coal tar products - 100 ug/M^3.

Six specific polynuclear aromatic hydrocarbons (PNA) were also determined. The highest concentration found was benzo(e)pyrene at 2.0 ug/m^3. An iron pourer was also exposed to air concentrations 0.3 mg/M^3 of iron oxide and 4 mg/M^3 total particulate weight, neither of which exceeded the evaluation criteria (Table 7).

In the Spo-line iron pouring area (Melt Department), samples ranged from 10-100 parts of CO per million parts of air by volume (ppm) during the October, 1978 study; area samples inside the charging crane ranged from 2-200 ppm, and samples near the entry door into the inside crane ranged from 10-80 ppm. Area samples in the no-bake mold pouring area ranged from 50-300 ppm, while samples on the Osborn pouring line ranged from 20-25 ppm. The recommended NIOSH standard is 35 ppm based on an

8-hour time weighted average concentration and 200 ppm based on a 15 minute ceiling concentration. There results were based on 30 sec - one minute sampling times and taken using a direct reading instrument (CO Ecolyzer).

In the iron pouring areas during the June, 1979 study, personal exposures to carbon monoxide (CO) were evaluated using long term colorimetric gas detector tubes (LTGDT) and CO dosimeters. On certain employees both methods were used simultaneously. Table 10 and 16 illustrates the long term CO sampling results. Concentrations derived from the gas detector tubes ranged from 21 to 40 ppm. Two samples the No-Bake wheel iron pourer (37 ppm) and the inside cranemen (40 ppm) exceeded the NIOSH recommended CO standard of 35 ppm on one day each. During the other two sampling days neither employees's exposure exceeded the standard. Personal air samples collected with the CO dosimeters ranged from 6 to 32 ppm, in most cases less than the respective gas tube results.

The melting area has been remodeled since the final environmental survey was conducted and electric induction furnaces have replaced the coke-fired cupolas. This most likely has changed the the quantity and quality of present airborne emissions from the furnaces.

Personal air sampling for MDI was conducted in the Spomatic, Osborn, and No-Bake Wheel pouring operations, and in the Osborn shakeout operation. Tape sampling devices were used for MDI because; 1) they were specific for diisocyanates, unlike the Marcali Method which also detects primary amines, and 2) they do not involve the use of a liquid solution, which could possibly spill out onto a mold and splatter hot metal on an employee; also, the hot environment would evaporate the solution to greater degree than during other sampling situations, and require constant attention. Unfortunately, results were not interpretable due to excessive building of particulates on the surface of the tape.

d. <u>Cleaning/Casting Repair</u>: The results of air sampling of chippers and grinders for free crystalline silica are illustrated in Table 8. Twelve air samples ranged from 100-550 ug/M^3, with all being above the NIOSH recommended standard of 50 ug/M^3. All 12 samples were also above the calculated OSHA standard. The East Side Bay Chippers received the highest exposures of all employees monitored, along with the highest range of free silica per centages per sample (24-35%). The ranges for the core making and molding/shakeout personnel were 6-25% and 4-15%, respectively.

During the October, 1978 study, in the casting repair area of the Cleaning Department, and electric arc welder was exposed to a nickel metal concentration of 100 ug/m^3 during welding using nickel coated rods (Table 7). During the June, 1979 study, and electric arc welder was exposed to nickel metal concentrations ranging from approximately

70-160 ug/m^3 during three workshifts (Table 14). Nickel coated rods were used during the welding, and lesser amounts of manganese, copper, and iron are usually present in this type rod. These concentrations exceeded the NIOSH recommended standard of 15 ug/M^3 which is set at the lowest most reliably detectable concentration since it is considered by NIOSH to be suspected carcinogen of the nasal cavity and lungs. Concentrations of the other metals were below their environmental criteria.

e. Ventilation Results: Approximately 150,000 cubic feet of air (CFM) was mechanically supplied to the foundry through gas fired and steam heating units during the survey. Approximately 1/2 of this amount is supplied to the cleaning department near the east side chipping bays. Approximately 560,000 CFM is mechanically exhausted from the foundry through various ceiling fans and local exhaust ventilation fans. Most of the air cleaning devices, such as bag houses, and wet scrubbers, are located on the eastern exterior side of the foundry.

Two iso-cure machines were equipped with local exhaust ventilation in the core making department. Each had an exhaust slot behind and below the die to capture emissions. Unit #1 had a capture velocity of approximately 200-250 feet of air per minute (fpm) at the die and unit #2 had one of approximately 375 fpm. Ventilation measurements were taken in the east side chipping bays of the cleaning department. The average slot velocities for the side exhaust grills ranged from 2200-2450 fpm for bays 1, 2, 3 and 5. At two feet from the bays, the average velocities ranged from 100-200 fpm, and in the middle of each bay (about three feet from the slot), the velocities decreased to 10-50 fpm. Velocities needed to capture silica dust from grinding operations have been recommended in the range of 500-2000 fpm[31] which would be possible in the east side bays only if work on the castings was done very close to the exhaust slots. However, it was observed that many employees positioned the castings in the middle of the bay, where the influence of the exhaust system was reduced to the velocities mentioned above. Ventilation measurements were also taken of the cut off (grinding) machines. The capture velocities of the exhaust booth #1 ranged from 90-125 fpm, at a point outside the enclosure where the grinding wheel strikes the casting. The velocities at the face of the hood ranged from 100-150 fpm. For exhaust booth #2, the capture velocities ranged from 140-200 fpm, and for the unnumbered booth, the capture velocities ranged from 100-200 fpm.

C. Medical Results

1. Survey #3: October 1978. Expired air Carbon Monoxide and Carboxyhemoglobin concentration results are shown in Table 11.

The results of the expired carbon monoxide and carboxyhemoglobin measurements indicate post-shift elevations greater than NIOSH criteria (5% increase over shift) in all six iron pourers, and one of four Spo-line pull-off operators.

2. Survey #4: October 1980. A sample of Chest X-rays reviewed by the NIOSH medical officer were of adequate quality to enable the final part of the survey to proceed without requiring NIOSH to perform additional X-rays.

3. Survey #5: February 1981. A total of 67 individuals were able to participate.

a. Questionnaire Data Results: Demographic characteristics are shown in Table 17. Occupational histories of the participants revealed that 39 (58%) of the workers had worked for 20 or more years in the foundry (Table 20).

Analysis of the social history of the participants revealed that 32 (48%) of the workers were current smokers, 19 (28%) were previous smokers, and 16 (24%) had never smoked (Table 21).

Upper respiratory symptoms were found in many workers, with 19 (28%) reporting hayfever or allergic rhinitis symptoms, and 50 (75%) reporting having had an upper respiratory infection within the previous 4 months (Table 22).

Past history of respiratory diseases revealed 8 (12%) with a history of chronic bronchitis and 14 (21%) with a history of pneumonia (Table 23).

Symptoms of lower respiratory tract disease were prevalent (Table 24). Symptoms consistent with chronic bronchitis were found in 16 (24%) of participants. Fourteen of these were current or former smokers. Wheezing symptoms were reported by 26 (40%), and shortness of breath on exertion (Class 1-4) by 36 (54%).

When these data are compared to answers obtained from similar questions asked to working people in the HANES survey (adjusted for age, sex and smoking status), significant excesses over expected value are seen in Allis Chalmers foundry workers for phlegm production, wheezing and shortness of breath (Table 24a).

b. Pulmonary Function Tests (PFT's) performed by NIOSH revealed abnormalities among nine (15%) of those tested, with one (2%) with changes suggestive of restrictive disease, and 8 (13%) showing evidence of obstructive changes alone (Table 25). NIOSH review of company medical records showed a total of 43 foundry workers had previously had an abnormal pulmonary function test result, including all nine workers with abnormal results found by NIOSH testing.

c. Pre- and post-shift pulmonary function tests were performed on 10 of 16 workers in the core making department. One worker showed a 10% drop in Forced Vital Capacity (FVC) over the workshift, with a 7% drop in Forced Expiratory Volume in one second (FEV_1). The remainder of the workers tested from the core-making department had non-significant changes in pulmonary function tests (less than 10% changes over the work shift).

d. Chest X-ray reading for pneumoconiosis. Chest X-rays performed by the company and read by two independent "B readers" revealed 6 cases with chest X-ray and occupational history consistent with a diagnosis of silicosis. One additional case of pneumoconiosis was found with irregular opacities possibly consistent with other pneumconiosis such as pneumconiosis due to asbestos exposure. All seven workers with pneumoconiosis had X-rays which had been previously read as normal by company physicians.

Ages of the cases with definite silicosis ranged from 44-63, with a mean age of 52. Three of the cases were white, and three were black. Total years in the foundry ranged from 10 to 36. Three workers had histories of employment in other foundries totalling 6-11 years each. Characteristics of cases are shown in Table 18. Five were cases of simple silicosis, and one case was complicated by evidence of silicotuberculosis.

Further analysis of the pneumoconiosis cases compared with all other workers studied showed that workers in the cleaning department had a significantly higher risk of developing pneumoconiosis compared with workers in other departments (Table 19). Occupational histories of the cases revealed that three had worked in the cleaning department as chippers and grinders, one was a crane operator, one worked hanging castings and painting castings, and one was a core finisher.

The three cleaning department workers developed pneumoconiosis despite reportedly wearing respiratory protection during the most recent period of their employment. The three non-cleaning department workers reported never wearing respiratory protection on the job.

D. Discussion of Medical Results

1. Silica: Hazardous levels of exposure to free crystalline silica were demonstrated in the Allis-Chalmers foundry during this investigation. Despite changes in ventilation, exposures to silica in all areas measured continued to exceed NIOSH recommended criteria. The highest risk appears in the Cleaning Department, however, with measured levels up to 10 times the NIOSH standard (Table 26). The prevalence of pneumoconiosis was also significantly greater in the cleaning department compared with the other departments (Table 27).

Two of the cases of pneumoconiosis were symptomatic, both with shortness of breath on exertion. One case had abnormal pulmonary function testing on NIOSH evaluation, and 5 of the 6 had abnormal pulmonary function tests at some time by company test. One case had evidence of silico-tuberculosis, a known complication of silicosis exposure.

Four of the seven employees identified by NIOSH AS having pneumoconiosis voluntarily reported to the Allis-Chalmers Medical Service and were referred for evaluation by pulmonary medical specialists. Results of these follow-up evaluations have not yet been obtained by NIOSH, but preliminary reports from the Allis-Chalmers Medical Service indicate that all four of the workers had findings suggestive of silicosis on re-evaluation.

The results of NIOSH's review of company X-rays in this study demonstrates the value of standardized and consensus readings by trained B-readers of chest X-rays taken for the purpose of surveillance for silicosis.

The large number of employees with abnormal pulmonary function found on NIOSH review of prior company testing is of concern. The much smaller number os abnormalities detected by NIOSH testing may be results of:

a. Differences in equipment

b. Differences in procedures used to motivate and elicit cooperation of employees

c. Real changes in lung function over time

2. MDI: One worker in the core-making department had evidence of possible acute reaction of the lungs to the work environment over the work shift. MDI, a possible lung irritant commonly found in core making processes, was not able to be detected due to technical problems during NIOSH environmental sampling.

3. Carbon Monoxide: Carbon monoxide exposure in the former coke-fired cupolas were shown to be excessive on NIOSH environmental evaluation, with corresponding excesses found in expired air concentrations and carboxyhemoglobin concentrations among workers exposed. These cupolas have been since replaced by electric arc induction furnaces. No measurements of current carbon monoxide exposures have been made by NIOSH.

4. Nickel: Overexposures to nickel were demonstrated among arc-welders. This may present a hazard of increased risk of lung and nasal cancer among these workers.

VII. RECOMMENDATIONS

Several publications exist that discuss the control of emissions in ferrous foundries in various ways.[12,16] Certain methods will be mentioned here that might he considered for this foundry.

1. Silica exposures should be reduced by adequate engineering controls to levels not exceeding NIOSH's recommended standard of 50 ug/M^3 over a 10 hour/day, 40 hour week.

2. Downdraft benches may be considered for chipping and grinding castings with pneumatic portable tools. These may be best for internal grinding. The piece should be positioned on a fitted turntable for manageability.

3. Low Volume-High Velocity (LVHV) tools could be considered for external work on pieces, preferably supported by hoists. In doing so, larger exhaust hoses could be used and the operator would then only have guide and apply pressure to the tool.

4. The air supply to the foundry is currently being increased, an improvement to allow local exhaust systems to work more efficiently and to reduce cross-contamination of areas.

5. Exhausted contaminated air should be handled so as not to be readmitted into the foundry, through proper maintenance of air cleaners and well designed stack heights.

6. To reduce dust emissions from sand conveyor systems, it is suggested that water be added. The proper addition can be based on the sand flow, temperature, and moisture content.

7. The practice of blowing off core boxes with pressure high air before they are recycled (observed in the automatic no-bake area) should be eliminated as a source of airborne silica. It may be possible to enclose the operation, though, within a locally vented hood if it can contain the blown dust.

8. In the casting repair area, the electric arc welding operation should be equipped with a local exhaust ventilation system.

9. Environmental sampling for carbon monoxide should be conducted in the melting department since the rennovation has been completed. The substitution of an electric furnace for the cupolas and a more automated pouring line should reduce emissions from this area but air concentrations should be documented.

10. The process of modifying engineering controls and ventilation should be continued and carefully monitored to insure that workers are not continuing to be exposed to levels of respirable crystalline silica exceeding NIOSH's recommended standard of 50 micrograms/m^3 over a 10 hour/day, 40 hour work week. Substitution of foundry sands with lower percentage of free crystalline silica may be needed to reduce levels adequately.

11. Since there is a potential for exposure to MDI in the core-making areas and NIOSH was not able to sucessfully measure employee exposures due to technical problems during sampling, it is recommended the MDI exposures be monitored. A more reliable method is now available and has been successfully used during recent surveys.

12. Adequate personal protective equipment should be provided while engineering controls are being installed. They should be as confortable as possible, and should be provided in areas with potential excessive exposure, particularly among crane operators and core-making workers, in addition to the present practice of respiratory protection in the cleaning department.

13. A more effective medical monitoring process to detect cases of silicosis should be instituted by the Allis-Chalmers medical department, including independent consensus "B reading" of all past and future chest X-rays performed by the company. The company pulmonary function testing program should be evaluated for adequacy of training and certification. Some means of standardizing the results by comparing simultaneous tests with local hospital pulmonary function laboratories would be useful as a method of insuring quality control.

14. Medical management of workers who have evidence of chest X-ray, pulmonary function, or symptoms of respiratory impairment should include evaluation by a physician qualified to advise the worker whether he or she should continue work in a dusty environment. If evidence of silicosis is noted, workers should be evaluated fully by a pulmonary medical specialist.

15. Any workers with simple or complicated silicosis should be notified of this finding and warned of hazards of further exposure. In addition, they should be removed from further exposure to free crystalline silica. If no pulmonary function impairment is noted, this may be accomplished by a combination of environmental dust control, reduced exposure time, and adequate respiratory protective equipment.

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X. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

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

Copies of this report have been sent to:

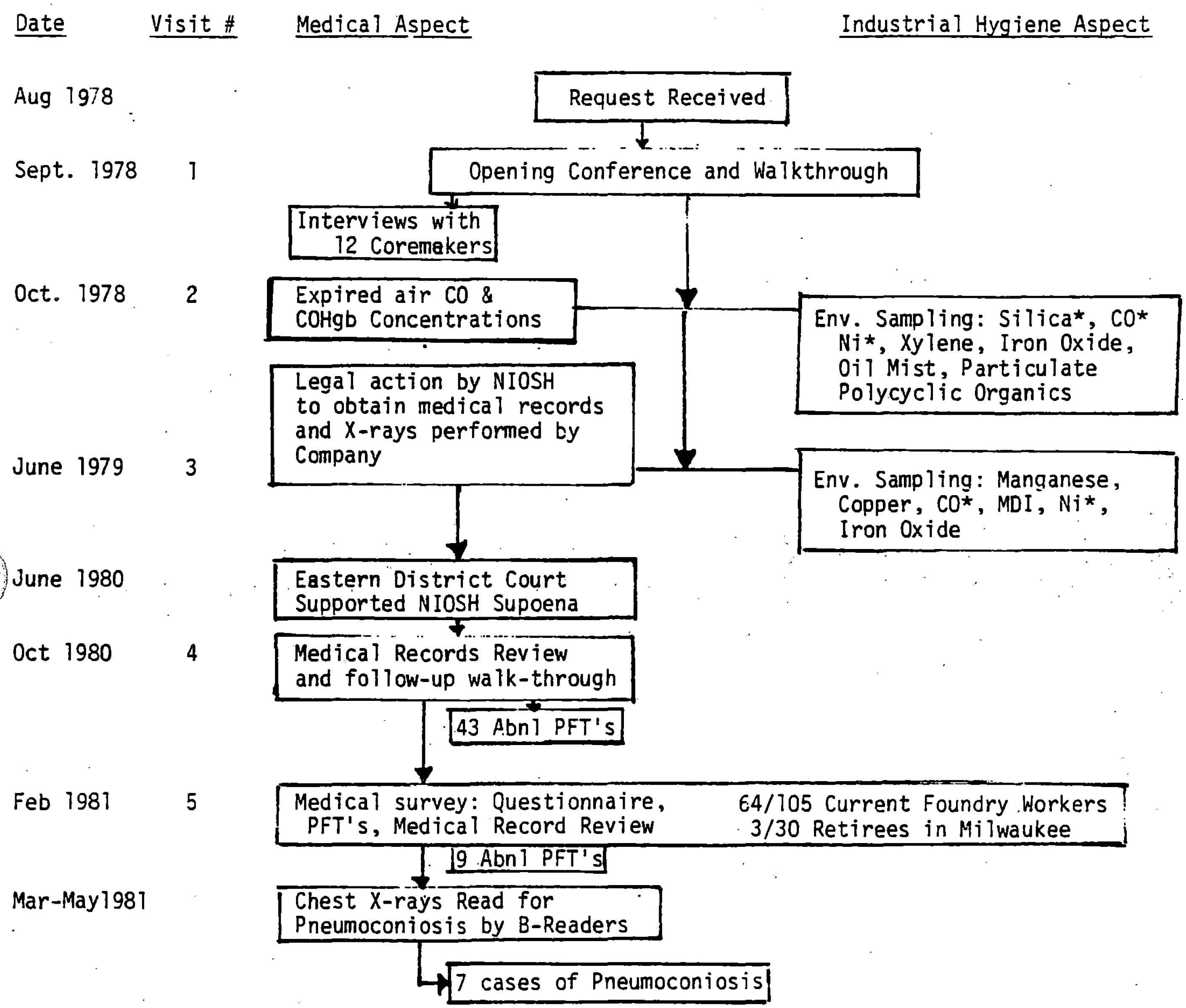
1. Allis-Chambers, W. Allis, Wisconsin
2. Authorized Representative of Employees - United Auto Workers of America, Local 248, W. Allis, Wisconsin
3. U.S. Department of Labor - Region V
4. United Auto Workers of America - Region X, Milwaukee, Wisconsin and Agricultural Implement Department, Social Security Department, Detroit Michigan.

For the purpose of informing the approximately 150 "affected employees" the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) near where exposed employees work.

Figure 1

HETA 78-121 Allis-Chalmers Corporation

Flow Diagram of study



* Environmental measurements exceeding NIOSH criteria

Table 1
Industrial Hygiene Collection and Analytical Methods
Allis-Chalmers Corporation
W. Allis, Wisconsin

Substance	Collection Device	Flow Rate	Duration	Analysis	Detection Limit	Reference
formaldehyde	impregnated charcoal tube	1.0 LPM	0-5 hours	ion chromatography	0.8 ug	6
ammonia	impinger-0.01N H_2SO_4	1.0 LPM	3-4 hours	colorimetry	4 ug	7
MDI	impinger-marcarli soln.	1.0 LPM	3-4 hours	colorimetry	2 ug	8
xylene	charcoal tube	0.2 LPM	3-4 hours	gas chromatography	0.05 mg	9
hexa	impinger-water with prefilter	1.0 LPM	3-4 hours	spectrophotometry	0.01 mg	10
iron oxide fume	filter with acyrlonitrile/poly-vinyl chloride copolymer	1.5 LPM	7-8 hours	atomic absorption	3 ug	11
total nuisance dust	" " "	1.5 LPM	7-8 hours	tared weight determination	0.01 mg	-
phenol	impinger-0.1N Na OH	1.0 LPM	3-4 hours	gas chromatography	0.02 ug	12
inorganic metals	filter with acyrlonitrile/poly-vinyl chloride copolymer	1.5 LPM	7-8 hours	atomic absorption	4 ug	13
crystalline free silica	10mm-cyclone pre-filter polyvinyl chloride filter	1.7 LPM	7-8 hours	X-ray diffraction	0.03 mg	14
particulate oil mist	membrane filter	1.5 LPM	7-8 hours	infrared analysis	.12 ug	15
dimethylethylamine	silica gel tube	0.05 LPM	7-8 hours	gas chromatography	0.01 mg	10
methyl chloroform	charcoal tube	0.05 LPM	7-8 hours	gas chromatography	0.01 mg	17
P.P.O.M.	silver membrane/glass fiber filter	2.0 LPM	7-8 hours	high pressure liquid chromatography	0.02 mg	18

Table 2
Survey #2
Results of Personal Air Sampling for Formaldehyde

Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin

October 24-26, 1978

Date	Job Title	Sample #	Sampling Times	Concentration (ppm)[1]
10/24	shell core (hot box) opr.	F1	0750-0820	0.3
	"	F2	0930-1000	0.2
	"	F3	1215-1250	0.2
10/26	"	F4	0800-0830	0.2
	"	F5	0830-0900	0.3
	"	F6	0900-0930	0.3
	"	F7	0930-1000	0.3
	shell core (hot box) operator	F8	1230-1300	0.3

1 PPM = Parts of vapor per million parts of air

Environmental criteria[2]:

NIOSH - 1 ppm
OSHA - 5 ppm
ACGIH (TLV) - 2 ppm

2 ceiling values which should NOT be exceeded even instantaneously

Table 3
Survey #2
Results of Personal Air Sampling for Ammonia and
Methylene Bisphenyl Isocyanate (MDI)

Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin

October 24-26, 1978

Date	Job Title	Sample #	Sampling Times	Concentration (ppm)[1] Ammonia	MDI
10/24	shell core (hot box) opr.	A1	0750-1100	1	
		A2	1100-1425	5	
10/25	" "	A3	0750-1150	16	
		A4	1150-1335	23	
10/24	Iso-cure	M-1	0805-1150		See note (2)
	Operator	M-2	1105-1425		See note (2)
10/25	"	M-10	0800-1130		See note (2)
	"	M-11	1130-1350		See note (2)
10/26	"	M-20	0725-0905		See note (2)
10/24	Automatic No-bake Core Maker	M-6	0730-1130		See note (2)
	"	M-7	1130-1425		See note (2)
	"	M-12	0720-1145		See note (2)
	"	M-13	1145-1330		See note (2)
	"	M-22	0715-1400		See note (2)
10/24	Spo line pull off operator	M-23	0710-1300		See note (2)

1 ppm = Parts of vapor or gas per million parts of air
2 Results not interpretable due to excessive particulate load on the surface of the sampling tape.

Environmental criteria:	Ammonia	MDI
NIOSH -	(50)[3]	0.05
OSHA -	50	(0.2)
ACGIH (TLV) -	25	(0.2)

3 - ceiling values which should not be exceeded even instantaneously

Table 4
Survey # 2
Results of Personal Air Sampling for Phenol and
Hexamethylenetetramine (hexa)

Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin

October 24-26, 1978

Date	Job Title	Sample #	Sampling Times	Concentration (Mg/M3)[1] Phenol	Hexa
10/24	Shell Core Operator	H-1	0750-1105		N.D.[2]
		H-2	1105-1425		0.05
10/26	Shell Core Operator	H-3	0750-1330		0.09
10/24	Shell Core Operator	P-4	0750-1100	0.4	
		P-2	1100-1425	1.3	
10/24	Iso-cure Operator	P-3	0805-1110	0.4	
		P-7	1110-1425	N.D.	
10/25	Iso-cure	P-10	0800-1130	0.2	
		P-11	1130-1350	0.6	
10/24	Automatic No-bake Core Maker	P-5	0730-1130	1.4	
		P-6	1130-1425	1.0	
10/25	Automatic No-bake Core Maker	P-12	0720-1150	1.7	
		P-13	1150-1330	2.8	

1. mg/M3 = milligrams of substance per cubic meter of air
2. N.D. = Non-detectable

Environmental Criteria:	Phenol	Hexa
NIOSH	20	-
OSHA	19	-
ACGIH (TLV)	19	-

Table 5
Survey # 2
Results of Personal Air Sampling for 1,1,1,-Trichloroethane (Methyl Chloroform)

Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin

October 24-26, 1978

Date	Job Title	Sample #	Sampling Times	Concentration (ppm)[1]
10/24	automatic No-bake core wash sprayer	CT-1	0810-1410	60
10/24	automatic No-bake core wash sprayer	CT-3	0900-1410	40
10/25	automatic No-bake core wash sprayer	CT-5	0810-1440	154
10/25	automatic No-bake core wash sprayer	CT-6	0810-1440	140
10/25	manual No-bake core wash sprayer	CT-7	0945-1500	80
10/26	manual No-bake core wash sprayer	CT-8	0725-1430	100
10/24	Osborn line core washer	KT-01	0605-1320	75
10/25	Osborn line core washer	KT-04	0600-1005	60
10/25	Osborn line core washer	KT-07	1010-1315	100
10/25	spo-line core setter	KT-05	0620-1340	50
10/26	spo-line core setter	KT-08	1045-1445	40

1. ppm = parts of vapor per million parts of air

Environmental Criteria	
NIOSH	(350)[2]
OSHA	350
ACGIH (TLV)	350

2. ceiling value

Table 6
Survey # 2
Results of General Air Sampling for Carbon Monoxide

Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin

October 25, 1978

Location	Time	Concentration (ppm)[1]
Pouring Line Catwalk	1030	50-75
Pouring Line Catwalk	1055	50-75
Pouring Line Catwalk	1100	50-75
In Front of Holding Furnance during Tap	1104	50-75
Heat Ladle Area	1108	50-60
Heat Ladle Area	1114	50-70
In Front of Holding Furnance during Tap	1117	50-75
Foreman's Work Station	1125	25-35
In Front of Holding Furnace during Tap	1130	50-75
Slaging Area Cypola Platform	1134	15-25
Ground Level Area behind Cupola	1138	10-20
Pouring Platform	1235	60
Farthest end of Pouring Catwalk-near exhaust hood	1240	100

1 - Concentrations (in ppm - parts of CO per million parts of air by volume) were determined from continuous 30 second readings of a portable analyzer.

Environmental Criteria:

NIOSH	35/200 ceiling
OSHA	50
ACGIH (TLV)	50

Table 7
Survey #2
Results of Personal Air Sampling for Miscellaneous Contaminants

Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin

October 24-26, 1978

Date	Job Title	Sample #	Sampling Times	Concentration Xylene (ppm)[1]	Iron Oxide	Nickel (ug/M3)	Total Weight	Oil Mist
10/24	Spray Painter - Finishing Area	KT-02	0620-1415	7				
10/25	Electric Arc Welder - Finishing Area	1896	0530-1320		0.9	100	3.0	
10/25	Osborn Line Molder	AA-01	0605-1315					0.9
10/26	Osborn Line Core Washer	1881	0610-1320		0.3		6.0	
10/26	Iron Pourer	1887	0615-1330		0.3		4.0	
Environmental criteria								
	NIOSH			100	-	15	-	-
	OSHA			100	10	1000	15	5
	ACGIH(TLV)			100	5	1000	10	5

1. ppm - Parts of vapor per million parts of air
   mg/M^3 = Milligrams of substance per cubic meter of air
2. sample collected under welding hood

Table 8
Survey #2
Results of Personal Air Sampling for Crystalline Free Silica
Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin
October 24-26, 1978

Date	Job Title	Sampling Times	Free Silica ug	Free Silica %	Concentration (ug/M3)[1] Respirable Free Silica (quartz)[2]	Concentration (ug/M3) Total Respirable Dust	OSHA or ACGIH Silica (quartz) Standard
10/24	Spo-line Mueller	0530-1445	40	4	40	1000	1700
10/25	Spo-line Mueller	0645-1445	60	5	70	1200	1400
10/24	Osborne Line Mueller	0615-1310	110	10	160	1100	800
10/25	Osborne Line Mueller	0615-1320	50	9	70	556	900
10/25	Spo-line Core Setter	0620-1340	30	6	40	500	1250
10/26	Spo-line Core Setter	0610-1445	40	6	45	667	1250
10/26	Spo-line Pattern Changer	0550-1445	N.D.[3]	-	N.D.	-	-
10/24	Spo-line Pull Off Operator	0655-1400	40	8	55	500	1000
10/25	Spo-line Pull Off Operator	0630-1440	50	-	N.D.	-	-
10/24	Osborn Molder	0610-1110	N.D.	-	N.D.	-	-
10/24	Osborn Molder	1110-1310	N.D.	-	N.D.	-	-
10/26	Osborn Molder	0615-1320	50	8	70	625	1000
10/24	Osborn Shakeout Operator	0730-1310	40	15	70	267	600
10/26	Osborn Shakeout Operator	0600-1305	40	11	60	363	800
10/24	Cut Off Saw Operator	0520-1300	80	3	100	2667	2000
10/24	East Side Chipper-Bay 2	0510-1335	440	31	500	1467	300
10/24	East Side Chipper-Bay 4	0515-1305	330	31	400	1064	300
10/24	East Side Chipper-Bay 6	0515-1320	280	32	300	875	300
10/25	East Side Chipper	0515-1245	220	29	300	759	300
10/25	East Side Chipper	0515-1250	180	24	200	750	400
10/26	East Side Chipper	0530-1310	440	35	550	1257	300
10/24	Spinner Blast Operator	0505-1325	120	16	140	750	550
10/24	Wheelabrater Operator	0520-1330	90	11	100	818	800
10/24	Monorail Operator	0510-1320	220	15	250	1467	600
10/25	Monorail Operator	0525-1315	130	15	160	867	600
10/26	North Side Chipper	0520-1315	-	-	-	-	-
10/26	Center Bay Chipper	0515-1125	120	28	200	428	300

1 - ug/M3 = micrograms of respirable free silica per cubic meter of air (for comparison with NIOSH criteria)
2 - Quartz was the only polymorph of free silica found
3 - N.D. = Non-detectible
4 - sample lost

Environmental Criteria:
NIOSH - 50 ug/M3
OSHA - $\frac{10,000}{\%\ \text{quartz}+2}$ ug/M3 (calculated in last column, for comparison with total respirable dust)

Table 9
Survey #2
Results of Personal Air Sampling for Crystalline Free Silica
Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin
October 24-26, 1978

Date	Job Title	Sampling Times	Free Silica ug	Free Silica %	Concentration (ug/M³)[1] Respirable Free Silica (quartz)[2]	Concentration (ug/M³) Total Respirable Dust	OSHA or ACGIH Silica (quartz) Standard
10/24	Automatic No-bake Core Finisher	0715-1425	-[3]	-	-	-	-
10/25	Shell Core Operator	0750-1335	60	11	100	546	750
10/26	Shell Core Operator	0750-1330	30	6	50	500	1250
10/25	Iso-cure Operator	0800-1500	N.D.	-	N.D.	-	-
10/26	Iso-cure Operator	0725-1400	80	17	100	471	500
10/26	Iso-cure Operator	0725-1300	40	12	70	333	700
10/25	Automatic No-bake Core Finisher	0725-1330	40	8	65	500	1000
10/26	Automatic No-bake Core Finisher	0715-1400	60	14	85	429	600
10/25	Automatic No-bake Core Preparation (set-up) Operator	0725-1330	60	11	100	545	800
10/26	Automatic No-bake Core Preparation (set-up) Operator	0715-1140	90	20	130	450	450
10/26	Manual No-bake Core Maker	0730-1315	60	25	100	240	350
10/26	Manual No-bake Core Maker	0730-1400	50	10	75	500	800

1 - ug/M³ = micrograms of free silica per cubic meter of air (for comparison with NIOSH criteria)
2 - Quartz was the only polymorph of free silica found
3 - sample lost
4 - N.D. = Non-detectible

Environmental Criteria:
NIOSH - 50 ug/M³
OSHA/TLV - $\frac{10,000}{\%\ quartz+2}$ ug/M³ (calculated in last column, for comparison with total respirable dust)

Table 10
Survey #2
Results of Personal Air Sampling for Carbon Monoxide
Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin
October 26, 1978

Charging Crane Area [1]

Time	Concentration	Time	Concentration
1200	60[3]	1221	31
1201	72	1222	39
1202	61	1223	38
1203	66	1224	34
1204	59	1225	35
1205	82	1226	38
1206	80	1227	44
1207	71	1228	38
1208	54	1229	31
1209	54	1230	28
1210	59		
1211	57	1240	15[4]
1212	40	1241	14
1213	48	1242	13
		1243	12
1216	49[3]	1244	15
1217	48	1245	10
1218	42	1246	11
1219	33	1247	14
1220	31	1248	14
		1249	11
		1250	11
1405	18[4]		
1406	24		
1407	25		
1408	27		
1409	23		
1410	30		

Spo-line Casting Pull Off Area

1255-1300	36" floor Fan Operating	20-25

No-bake Mold Pouring Area

1307-1335	In Aisle during Pouring	100-300
	2-3 Feet from Pourer°s Head	100
	After Pouring in General Area near different molds	50-200

Osborn Mold Pouring Area

1255-1300	On Platform	20-25

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1 - samples collected near door to "inside" crane and exit door either closed or open, windows open, and roof fan on.
2 - average concentrations (in ppm - parts of CO per million parts of air by volume) were determined from continuous readings four times per minute of a portable analyzer.
3 - crane room doors open in this block of numbers
4 - crane room doors closed in this block of numbers

Environmental Criteria:

NIOSH	35/200 ceiling
OSHA	50
ACGIH (TLV)	50

Table 11
Survey #2
Expired Air Carbon Monoxide (CO) and Carboxyhemoglobin (CoHB) Concentrations
Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin
October 24-26, 1978

				Pre-Exposure			Post-Exposure			Cigarette Smoking Habits[4]	
Date	Job Title	S[1]	N.S.[2]	Approx.Time	Air Level(ppm)[3]	%CoHB	Approx. Time	Air Level(ppm)	%CoHB	Pre-exposure	Post-exposure
10/24	Iron Pourer		X	0625	9.7	2.4	1450	47.5	10.0		
10/25	Iron Pourer		X	0612	12.5	3.0	1350	40	8.5		
10/26	Iron Pourer		X	0615	16	3.7	1335	43	9.1		
10/24	Iron Pourer	X		0610	37	7.4	1545	71	14.7	2	16
10/25	Iron Pourer	X		0620	45.5	9.6	1445	72.5	15.0	3	14
10/26	Iron Pourer	X		0625	47	9.9	1450	78	16.1	4	10
10/25	Cupola Tender		X	-	-	-	1455	34	7.3		
10/26	Cupola Tender		X	0616	27	5.9	1600	29	6.3		
10/24	Osborn Shake-out Oper.		X	0730	10.5	2.6	1410	24	5.3		
10/25	Osborn Shake-out Oper.		X	0600	14.5	3.4	1306	24	5.3		
10/26	Iron Pourer No-bake		X	0612	15	3.5	1320	30.5	6.6		
10/24	Spo-line Pull off Oper.		X	0655	8	2.1	1355	22	4.9		
10/25	Spo-line Pull off Oper.		X	0655	13	3.1	1423	25	5.5		
10/24	Spo-line Pull off Oper.	X		0705	26	5.7	1330	54	11.3	3	6
10/25	Spo-line Pull off Oper.	X		0625	-	-	1438	52	10.9	2	6
10/24	Osborn Molder	X		0735	50	10.5	1400	52	10.9	4	4
Environmental Criteria - NIOSH						5% CoHB			10% CoHB		

1 - smoker
2 - non-smoker
3 - ppm = parts of gas per million parts of air by volume
4 - No. cigarettes smoked before pre-exposure sample was taken or No. smoked after the pre-exposure sample but before the post exposure sample

Table 12
Survey #2
Results of General Air Sampling for Carbon Monoxide
Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin
October 25, 1978

Charging Crane Cab

Time	Operation[1]	Concentration[2] (ppm)	Time	Operation	Concentration (ppm)	Time	Operation	Concentration (ppm)
1158	L.B.	60	1209	L.B.	70	1220	L.B.	68
1159	L.B.	59	1210	L.B.	90	1221	C.F.	50
1200	C.F.	40-50	1211	L.B.	90	1222	L.B.	81
1201	L.B.	74	1211	C.F.	60	1223	L.B.	69
1202	L.B.	80	1213	L.B.	92	1224	L.B.	60
1203	C.F.	60	1214	L.B.	80	1225	C.F.	58
1204	C.F.	65	1215	L.B.	90	1226	L.B.	65
1205	L.B.	60	1216	L.B.	95	1227	L.B.	60
1206	L.B.	73	1217	C.F.	60	1228	L.B.	63
1207	C.F.	55	1218	L.B.	85	1229	L.B.	55
1208	L.B.	92	1219	L.B.	78	1230	C.F.	39

October 26, 1978

Time	Operation	Concentration (ppm)	Time	Operation	Concentration (ppm)
0644	L.B.	51	0806	L.B.	80
0645	L.B., C.F.	49	0807	L.B.	76
0646	C.F.	15	0808	L.B.	76
0647	L.B.	58	0809	L.B.	70
0648	L.B., R.B.	62,63	0810	C.F., L.B.	20,62
0649	R.B.	100	0811	L.B.	74
0650	C.F.	200			
0651	D.B., L.B.	102,75	1032	L.B.	49
0652	L.B., C.F.	62,68	1033	L.B.	51
0653	C.F.	10	1034	L.B., C.F.	45
0654	L.B.	28	1035	C.F., L.B.	10,41
0655	L.B.	24	1036	L.B., L.B.	50,43
0656	L.B.	38	1037	L.B.	36
0657	L.B.	56	1038	L.B.	30
0658	L.B.	73	1039	L.B.	25
0659	C.F.	100	1040	L.B.	19
0700	C.F.	7	1041	L.B.	17
0701	C.F.	7	1042	C.F.	6
			1043	C.F.	3
0755	-[3]	34	1044	C.F.	2
0756	-	40	1045	C.F., L.B.	2,16
0757	-	46	1046	L.B.	16
0758	-	53	1047	L.B.	24
0759	-	57	1048	L.B.	34
0800	C.F.	55	1049	L.B.	40
0801	L.B.	68	1050	L.B.	42
0802	L.B.	77			
0803	L.B.	76			
0804	L.B.	87			
0805	C.F., L.B.	22,60			

1 - L.B. = Loading Charging bucket
C.F. = Charging the furnace
R.B. = Raising the bucket
D.B. = Droping the bucket

2 - Average concentrations (in ppm - parts of CO per million parts of air by volume) were determined from readings every 30 seconds an/or 1 minute intervals from a portable analyzer. Air samples were collected in the crane cab

3 - Cupola full, no harging; air samples collected near craneman.

Environmental Crieria

NIOSH	35/200 ceiling
OSHA	50
ACGIH (TLV)	50

Table 13
Survey #2
Results of Personal Air Sampling for Particulate Polycyclic Organic Matter

Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin

October 24-26, 1978

Date	Job Title	Sample #	Sampling Times	Concentration (ug/M^3) Particulate Polycyclic Matter (Benzene Soluble)	B(a)P[2]	B(e)P	B(a)A	Chrysene	Pyrene	Fluoranthene
10/24	Iron Pourer #1	GF/AG-01	0625-1450	100	0.7	0.6	0.5	0.4	N.D.[3]	0.1
10/24	Iron Pourer #2	GF/AG-02	0615-1545	100	1.9	2.0	2.0	1.2	0.3	0.3
10/25	Iron Pourer #3	GF/AG-03	0625-1450	100	0.2	0.2	0.4	0.2	N.D.	0.1
10/25	Iron Pourer #2	GF/AG-04	0615-1350	N.D.	0.2	0.2	0.2	0.1	N.D.	0.04
10/25	Cupola Tender	GF/AG-05	0715-1455	100	0.8	1.2	1.2	0.9	0.1	0.2
10/26	Iron Pourer #1	GF/AG-06	0615-1335	50	0.1	0.2	0.1	N.D.	N.D.	0.03
10/26	Iron Pourer #2	GF/AG-07	0625-1445	100	0.2	0.3	0.2	0.1	N.D.	0.04

1 - ug/M^3 = miocrograms of substance per cubic meter of air

2 - B(a)P = benzo(a)pyrene
B(e)P = benzo(e)pyrene
B(a)A = benzo(a)anthracene
(All polynuclear aromatic hydrocarbons)

3 - N.D. = non-detectible

Environmental Criteria:

NIOSH	100 ug/M^3
ACGIH(TLV)	200 ug/M^3
OSHA	-

Table 14
Survey #3
Results of Personal Air Sampling for Dimethylethylamine (DMEA)
and Welding Emissions

Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin

June 19-21, 1979

Date	Job Title	Sampling[1] Type	Sampling Time	Sample Number	CONCENTRATION[2,3] DMEA (ppm)	Nickel ug/M^3	Manganese mg/M^3	copper mg/m^3	iron oxide mg/M^3
6/19	isocure operator	P	0605-1345	SG-1	N.D.	-	-	-	-
6/19	on worktable to left of unit	A	0605-1345	SG-2	0.05	-	-	-	-
6/20	isocure operator	P	0605-1330	SG-4	0.07	-	-	-	-
6/20	on worktable	A	0605-1330	SG-3	invalid sample		-	-	-
6/21	isocure operator	P	0610-1345	SG-5	9.09	-	-	-	-
6/21	on worktable to left of unit	A	0610-1345	SG-6	0.05	-	-	-	-
6/19	electric arc welder-casting repair	P	0650-1335	AA-10	-	159	0.01	N.D.	1.1
6/20	electric arc welder-casting repair	P	0635-1345	AA-6	-	145	0.02	N.D.	0.9
6/21	electric arc welder-casting repair	P	0545-1400	AA-1	-	69	0.01	N.D.	0.4
6/19	above arc welding unit	A	0650-1335	AA-4	-	13	N.D.	N.D.	0.1
6/20	above are welding unit	A	0635-1345	AA-5	-	14	N.D.	N.D.	0.1
6/21	above arc welding unit	A	0545-1400	AA-9	-	9	N.D.	N.D.	0.1
Evaluation Criteria:									
	NIOSH				-	15	-	-	-
	OSHA				-	1000	5(c)	0.2	10
	ACGIH				-	1000	5(c)	0.2	5

1 - P = personal sample, A = area sample
2 - ppm = parts of DMEA per million parts of air, by volume
3 - mg/M^3 - milligrams or micrograms of substance per cubic meter of air

Table 15
Survey # 2
Results of General Air Sampling for Carbon Monoxide in Crane Cabs
Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin
June 19-21, 1979

Date	Location	Time	Range of Concentrations(CO) ppm[2]
6/20	"inside" crane[1]	0700-0730	10
6/20	"inside" crane	0730-0800	10-20
6/20	"inside" crane	0800-0830	10-80
6/20	"inside" crane	0830-0900	10-70
6/20	"inside" crane	0900-0930	10-40
6/20	"inside" crane	0930-1000	15-95
6/20	"inside" crane	1000-1030	15-95
6/20	"inside" crane	1030-1100	15-80
6/20	"inside" crane	1100-1130	20-90
6/20	"inside" crane	1130-1200	20-100+[3]
6/20	"inside" crane	1200-1230	20-100
6/20	"inside" crane	1230-1300	20-70
6/20	"inside" crane	1300-1330	20-95
6/20	"inside" crane	1330-1400	20-40
6/20	"inside" crane	1400-1430	20-50
6/20	"inside" crane	1430-1500	20-70
			8 hr TWA conc.
6/21	"charge" crane[1]	0630-0700	20-40
6/21	"charge" crane	0700-0730	20-100+
6/21	"charge" crane	0730-0800	40-100+
6/21	"charge" crane	0800-0830	40-100+
6/21	"charge" crane	0830-0900	25-100+
6/21	"charge" crane	0900-0930	20-100+
6/21	"charge" crane	0930-1000	40-100
6/21	"charge" crane	1000-1030	10-90
6/21	"charge" crane	1030-1100	15-40
6/21	"charge" crane	1100-1130	10-20
6/21	"charge" crane	1130-1200	10-40
6/21	"charge" crane	1200-1230	20-100+
6/21	"charge" crane	1230-1300	50-100+
			8 hr TWA conc.

Evaluation Criteria (for personal, 8-hour samples)	
NIOSH	35
OSHA	50
ACGIH	50

1 - range of concentrations were determined from a strip chart recorder attached to a continuously running portable CO analyzer; The instrument was positioned inside each cab and as close to the operator°s breathing zone as possible.
2 - ppm = parts of CO per million parts of air, by volume.
3 - the instrument was set on the 0-100 ppm range and certain concentrations were above this range.

Table 16
Survey #3
Results of General Air Sampling for Carbon Monoxide
Foundry - Agricultural Tractor Division
Allis-Chalmers Corporation
W. Allis, Wisconsin
June 19-21, 1979

Date	Job Title	Sampling Time	Sampling Volume (liters)	Concentration (ppm)[1] L.T.G.D.T.[2]	Dosimeter[3]
6/19	cupola tender	0700-1400	6.9	21	-
6/19	iron pourer[4] - no bake wheels	0645-1345	6.8/25.3	29	24
6/19	charge bucket craneman[5]	0630-1440	6.7/29.5	22	27
6/19	iron pourer-spoline	0610-1335	7.2/26.8	28	14
6/19	iron pourer-spoline	0610-1350	27.6	-	15
6/19	inside craneman	0710-1410	8.2	21	-
6/19	iron pourer-osborn line	0635-1410	27.4	-	6
6/20	iron pourer-no bake wheels	0640-1545	5.3	37	-
6/20	iron pourer-osborn line	0655-1530	30.9	-	7
6/20	skimmer-spoline	0620-1535	8.5	29	-
6/20	iron pourer-spoline	0610-1345	27.3	-	16
6/20	iron pourer-spoline	0615-1340	6.6/26.7	30	23
6/20	charge bucket craneman	0625-1455	7.7/30.8	32	32
6/20	inside craneman	0640-1555	7.9/33.1	25	16
6/21	iron pourer[6]-no bake wheels	0545-1530	8.0	25	-
6/21	skimmer-spoline	0550-1540	5.2	29	invalid sample
6/21	iron pourer-osborn line	0620-1450	7.3/30.6	24	8
6/21	charge bucket craneman	0555-1440	8.4	27	invalid sample
6/21	inside crane[7]	0630-1600	9.1/34.2	40	32

Evaluation Criteria:
NIOSH - 35 ppm
OSHA - 50 ppm
ACGIH - 50 ppm

1 - ppm = parts of CO per million parts of air by volume
2 - L.T.C.I.T. = long-term colorimetric indicator tube, as used with a low flow (20 cc/minute) sampling pump; the tube is not certified by NIOSH.
3 - a self-contained instrument that records CO dosage via a hydrated solid polymer electrolyte sensor.
4 - became iron pourer in spoline from 1345-1700
5 - actual working hours are 0300-1500
6 - sampling pump was of 1012-1021
7 - area samples in crane, since employee did not wish to wear sampling pump.

Table 17
Survey #5
Demographic Characteristics of Participants
Allis-Chalmers Corp.
HE 78-121

	# of Employees
Total Participants:	67
a. Race:	
Black	36
White	31
b. Job Status:	
Currently Employed	64
Retired	3
c. Sex:	
Male	66
Female	1

Age (yrs):

Mean 48
Range 25-64

Table 18

HETA 78-121

Allis-Chalmers Corporation

Characteristics of cases of pneumoconiosis

Case#	X-ray#1 NIOSH	X-ray#1 COMPANY	X-ray #2 NIOSH	X-ray #2 COMPANY	PFT NIOSH	PFT CO	DEMOGRAPHICS Age	DEMOGRAPHICS PMH	SYMPTOMS COUGH	SYMPTOMS PHLEGM	SYMPTOMS CB	SYMPTOMS W	SYMPTOMS DOE	SMOKING	PREV.OCC	OCCUPATION CURRENT	OCCUPATION FORMER
1	nl	nl	p1/0	nl	nl	nl	40	none	no	no	-	-	0	never	Chipper-6yr	Chipper	Welder
2	p0/1 t2/1	nl	q2/1	nl	nl	nl	50	TB 1972	no	no	-	+	1	current 25 packyrs	none	CraneOP	Handyman
3	nl	nl	p1/1	nl	obst	rest obst	60	none	+	+	-	-	0	current 40 packyrs	none	Painter	
4	nl	nl	p1/0	nl	nl	nl	60	none	no	no	-	-	0	current 20 packyrs	Muller-11 yr	Chipper	
5	nl	nl	p1/1	nl	nl	obst	60	Pneu°68	no	yes	-	+	1	never		Shakeout	Chipper
6	p1/1	nl	p1/1	nl	nl	obst	50	Bronch°80 Pneu°60	no	no	-	+	0	current 15 packyrs		Core Finisher	
7	nl	nl	s1/0		nl	obst	60	none	+	no	-	-	1	previous	Chipper 6mo	Painter	

Table 18a

HETA 78-121

Allis-Chalmers Corporation

Characteristics of cases of pneumoconiosis

Case#	X-ray#1		X-ray #2		PFT		DEMOGRAPHICS		SYMPTOMS					SMOKING	PREV.OCC	OCCUPATION	
	NIOSH	COMPANY	NIOSH	COMPANY	NIOSH	CO	Age	PMH	COUGH	PHLEGM	CB	W	DOE			CURRENT	FORMER
1	nl	nl	p1/0	nl	nl	nl	40	none	no	no	-	-	0	never	Chipper-6yr	Chipper	Welder
2	p0/1 t2/1	nl	q2/1	nl	nl	nl	50	TB 1972	no	no	-	+	1	current 25 packyrs	none	CraneOP	Handyman
3	nl	nl	p1/1	nl	obst	rest obst	60	none	+	+	-	-	0	current 40 packyrs	none	Painter	
4	nl	nl	p1/0	nl	nl	nl	60	none	no	no	-	-	0	current 20 packyrs	Muller-11 yr	Chipper	
5	nl	nl	p1/1	nl	nl	obst	60	Pneu°68	no	yes	-	+	1	never		Shakeout	Chipper
6	p1/1	nl	p1/1	nl	nl	obst	50	Bronch°80 Pneu°60	no	no	-	+	0	current 15 packyrs		Core Finisher	
7	nl	nl	s1/0		nl	obst	60	none	+	no	-	-	1	previous	Chipper 6mo	Painter	

TABLE 19
Location of employment and risk of silicosis

	SILICOSIS	NO SILICOSIS
● CLEANING DEPT	4	13
● MOLDING/CORE MAKING	2	48

P<.05

Table 20
Years employed in Foundry

Cumulative years:	#	%
0-10	14	21
10-19	21	31
20-29	16	24
30-39	12	18
40-49	1	1

Range 5-40 yrs.
Mean 20 yrs.

TABLE 21
Cigarette Smoking Status

	#	%
Current smokers	32	48
Previous smokers	19	28
Never smoked	16	24

TABLE 22
PREVALENCE OF UPPER RESPIRATORY SYMPTOMS

	#	%
Hay fever or allergy	19	28
"Cold" symptoms		
in past months	34	51
in past 4 months	50	75

TABLE 23
HISTORY OF RESPIRATORY DISEASE

Has a physician ever told you that you had:

	#	%
Pneumonia	14	21
Chronic Bronchitis	8	12
Emphysema	1	2
Asthma	3	5
Tuberculosis	2	3
Histoplasmosis	1	2

TABLE 24

SYMPTOMS OF LOWER RESPIRATORY TRACT DISEASE

	Yes #	% (N-67)
Do you usually cough in a.m.?	16	24
Cough other times	31	47
Cough more than 3 mo/yr	20	30
Cough more than 2 years	16	24
Do you usually bring up phlegm in a.m.	27	42
Phlegm more than 3 mo/yr	23	34
Phlegm more than 2 years	14	21
Do you have cough and phlegm more than three months/yr for 2 or more years? (chronic bronchitis)	16	25
Does your chest ever sound wheezy	26	40
Do you have shortness of breath		
Grade I: when hurrying on level ground or up a sligh hill?	23	35
II: with others of same age on level ground?	9	14
III: when walking at own pace on level ground?	0	
IV: When dressing or walking about the house?	4	6
Grade I or greater	36	54

Table 25
Pulmonary Function Data

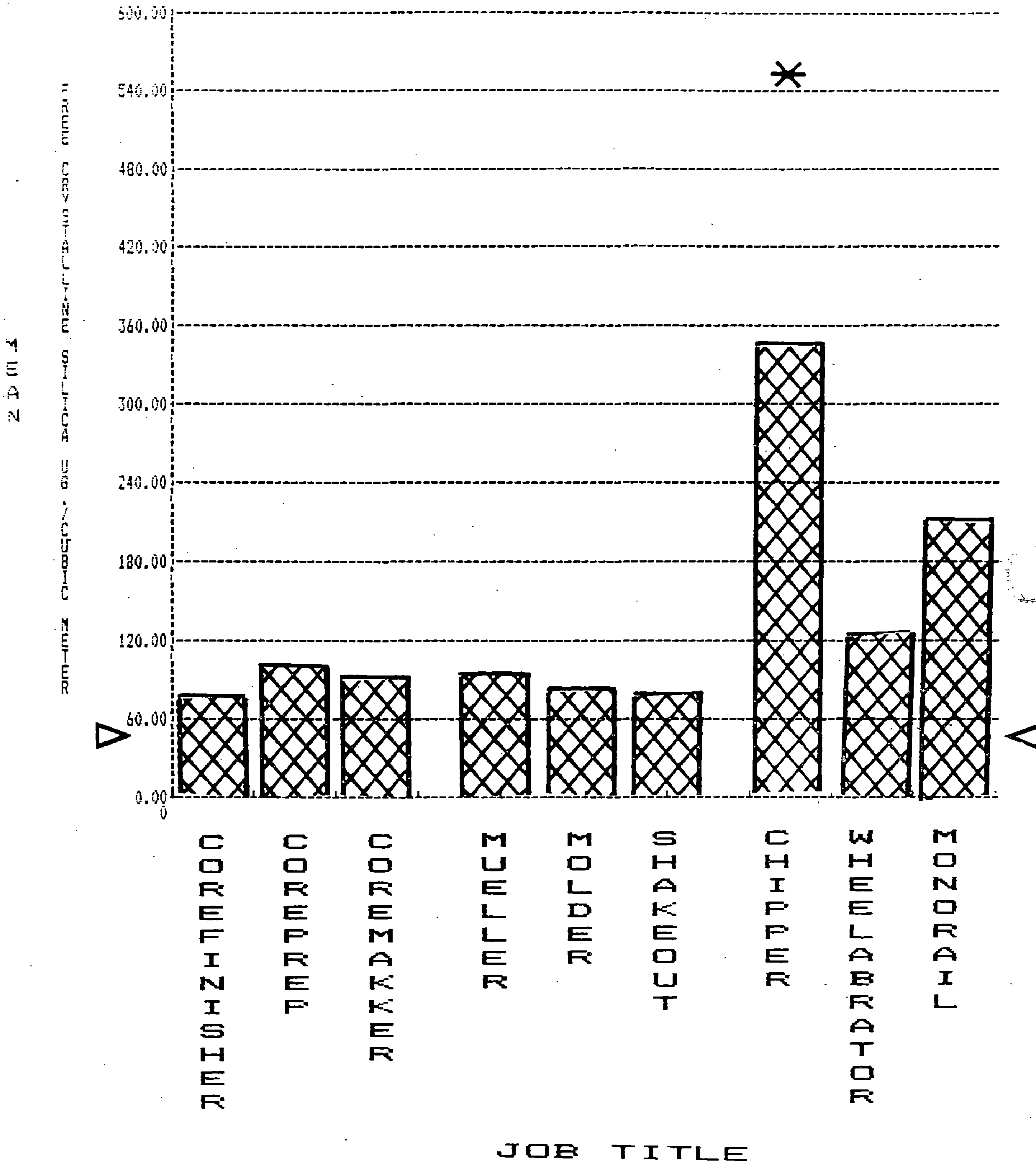
	#	%
● NORMAL	55	82
● OBSTRUCTIVE: FEV1<80% OR FEV1/FVC<70%	8	13
● RESTRICTIVE: FVC<80%	0	0
● COMBINED OBST. AND RESTRICT.	1	1
● NOT PERFORMED	3	5

Table 26

SILICA EXPOSURES

vs.

Job Category



CURRENT NIOSH RECOMMENDED STANDARD

(50 MICROGRAMS/CUBIC METER)

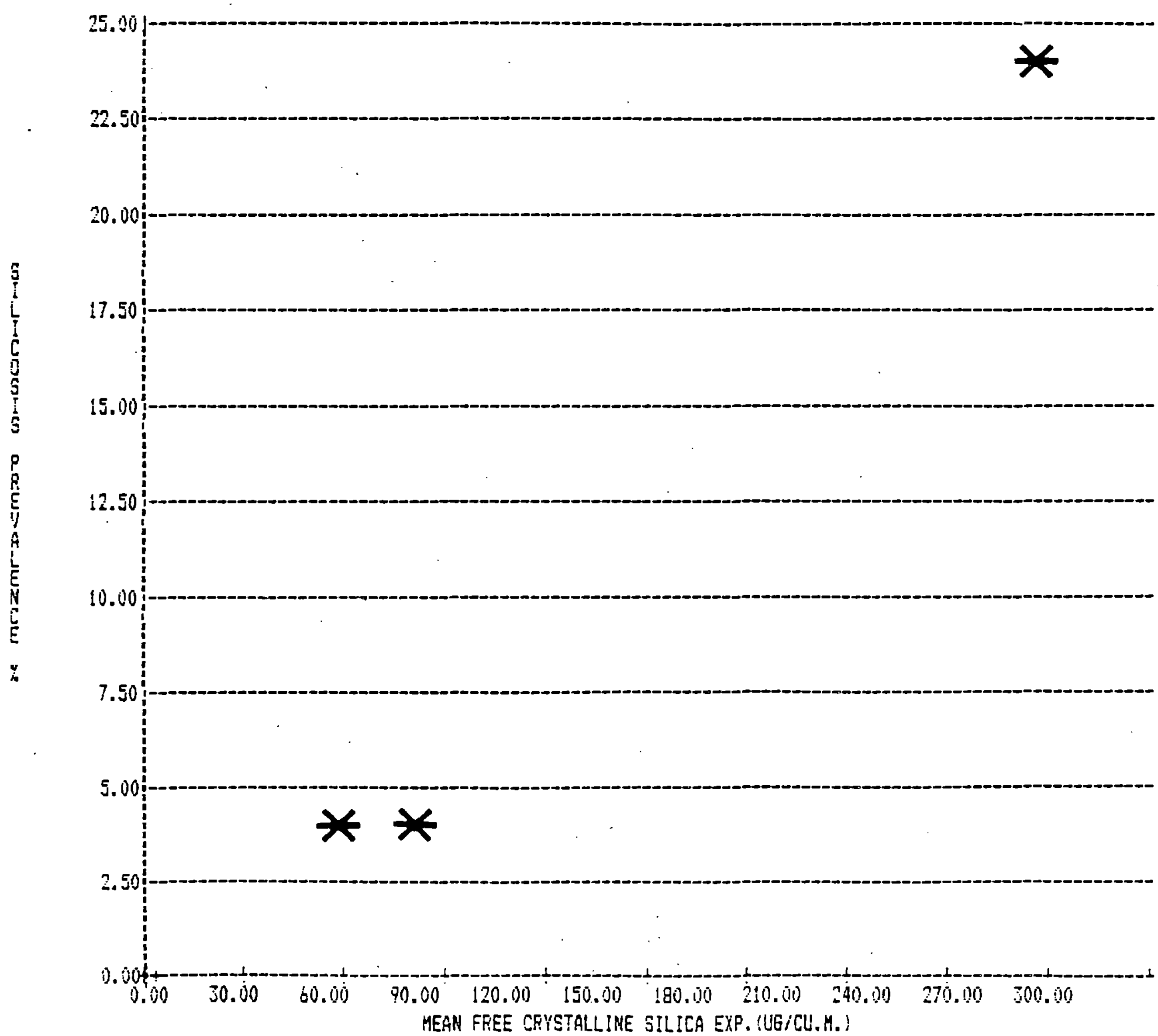
MAXIMUM VALUE OF STUDY

Table 27

Mean Free Crystalline Silica Exposure

vs.

Silicosis Prevalence



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PUBLIC HEALTH SERVICE
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