U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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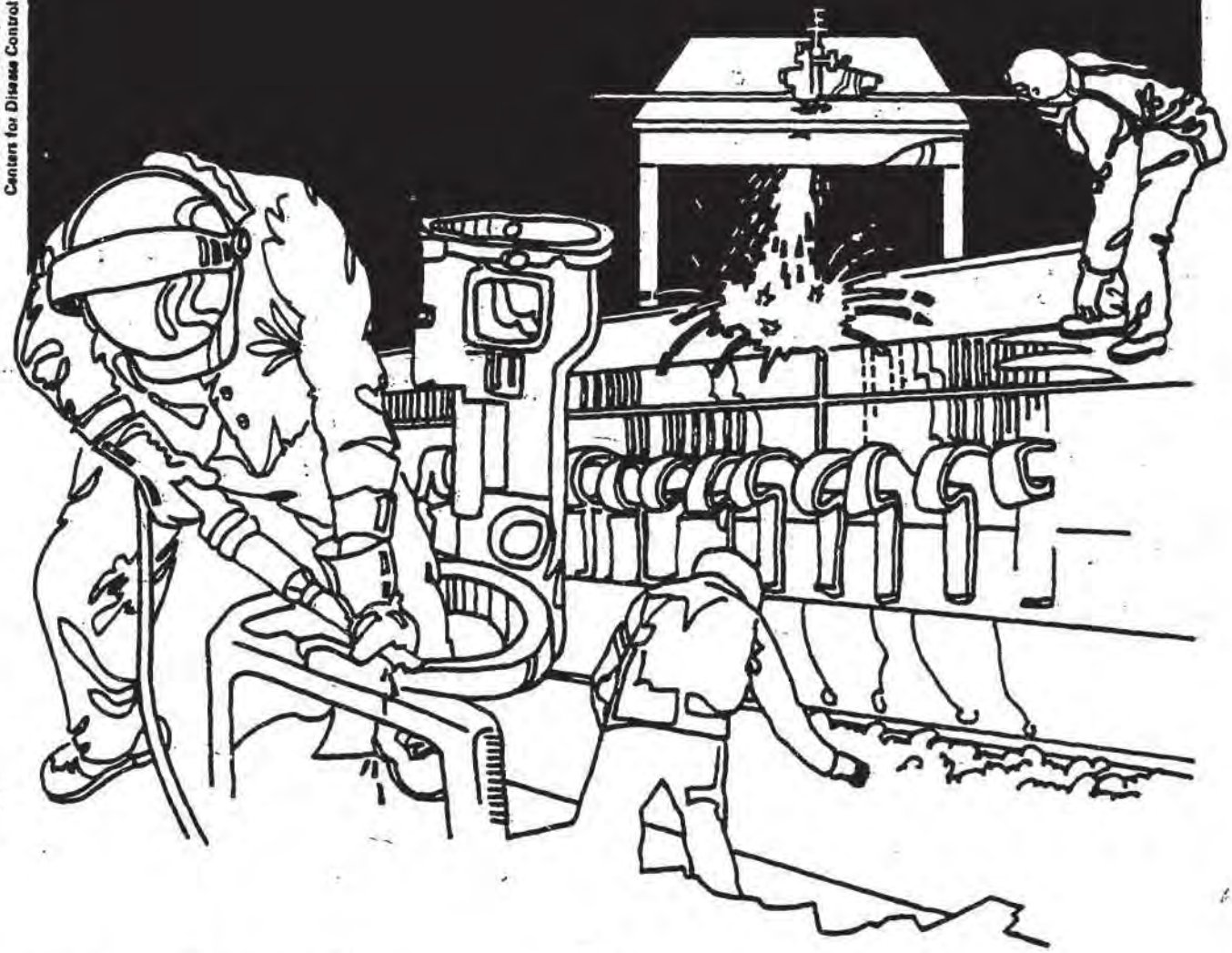

Health Hazard Evaluation Report

HETA 83-174-1718
COOPER ENERGY SERVICES CORPORATION
GROVE CITY, PENNSYLVANIA

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.

HETA 83-174-1718
JULY 1986
COOPER ENERGY SERVICES CORPORATION
GROVE CITY, PENNSYLVANIA

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I. SUMMARY

On March 5, 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from the Cooper Energy Services Corporation plant in Grove City, Pennsylvania. The purpose of this evaluation was to study the prevalence of respiratory disease in a population of foundry workers in the plant. Cooper Energy Services initiated a medical screening program in 1982, which examined 181 foundry workers exposed to silica for the presence of pneumoconiosis. Chest x-rays and pulmonary function tests were administered to these 181 employees; 25 of these were referred to a private physician for more detailed examinations. NIOSH investigators reviewed the medical records of these 25 employees and a sampling of the remaining 157, checking for accuracy of diagnosis (using ILO criteria) and completeness and adequacy of the screening protocol.

Environmental data provided by both the Occupational Safety and Health Administration (OSHA) and Cooper Energy Services concerning exposures to crystalline silica, heavy metals, coal tar pich volatiles, methylene bisphenyl isocyanate, formaldehyde, and asbestos were also reviewed. Of the personal air samples collected from 1979 to 1982, only exposures to crystalline silica were in excess of OSHA standards. Of 81 personal samples collected for crystalline silica, 18 were above the OSHA standard. Fifteen of these 18 employees were in cleaning operations; notably chipping and grinding.

Results of this evaluation indicated that there were 10 cases (5.5%) of unequivical pneumoconiosis and 6 cases (3.3%) of possible pneumoconiosis. The pneumoconiotics had a higher average age (59 years) than did the possible pneumoconiotics (52.8 years). Work as a chipper between 1951 and 1970 appeared to be associated with increased risk of silicosis. The environmental sampling data support this, since cleaning operation employees (chippers and grinders) seemed to consistently have the greatest exposures to respirable crystalline silica.

Based on the data collected during this evaluation, NIOSH investigators found that there are definite cases of pneumoconiosis, which indicate overexposure to silica for these diagnosed employees sometime in the past. Recommendations are made to increase the number of employees participating in the existing medical screening program and to continue the company's environmental surveillance program to ensure compliance with OSHA requirements for crystalline silica exposure.

KEYWORDS: SIC 3320 (Iron and Steel Foundries), silica, silicosis, pneumoconiosis, pulmonary function testing, medical screening program.

II. INTRODUCTION

On March 5, 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from an authorized representative of employees at Cooper Energy Services in Grove City, Pennsylvania. NIOSH was asked to evaluate the prevalence of work-related lung disease and identify toxic substances in the foundry operations.

On August 11, 1983, NIOSH personnel conducted an initial investigation. For the medical portion of this investigation, the medical records of foundry employees were reviewed. Of the 181 employees who underwent chest X-ray and pulmonary function examinations by Cooper Energy Services, medical records of 48 were partially reviewed. For the environmental portion, a walkaround tour of the foundry was made to characterize the process, identify potentially toxic materials, and observe existing conditions, work practices and controls. A letter describing NIOSH's activities during this initial investigation was forwarded to Cooper Energy Services on September 26, 1983.

On February 1, 1984, NIOSH personnel conducted a follow-up investigation to collect more detailed work history information to accurately identify the jobs most strongly associated with the development of pneumoconiosis. A letter describing NIOSH's activities during this follow-up investigation was forwarded to Cooper Energy Services on March 6, 1984.

III. BACKGROUND

The Cooper Energy Services plant in Grove City, Pennsylvania, manufactures reciprocating integral gas engine-compressors in several sizes for a wide range of applications. The foundry at the plant primarily makes grey inductile iron castings although a variety of other alloys can also be made at times. At the time of the investigation, about 100 production employees were working in the foundry which operated on a single shift.

The foundry at Cooper Energy Services is typical of other ferrous foundries. Individual process operations include core making, sand molding, melting and pouring, shakeout and sand reclaim, and cleaning. Cores are made by mixing sand with a binder system, forming it in a pattern box, and allowing it to cure. After curing, the cores are assembled if necessary and painted. For this core making operation, a no-bake furan sand binder is used predominately. Other no-bake binders or conventional oven-bake oil binders may also be used for making some of the small cores.

The sand molds are made, usually in a mold flask, by compacting prepared sand around a pattern so that a cavity conforming to the desired pattern remains to accept the molten metal. Any necessary cores are appropriately placed in the mold during this operation to create the empty spaces desired in the finished casting. A green sand mold preparation process is used at Cooper Energy Services.

After the sand mold has been prepared, it is ready to accept the molten metal. The metal alloy is melted in one of three 15-ton electric coreless induction furnaces. These furnaces are charged with preheated scrap to form the alloy mix. The metal is held at 2600°F. The molten metal is transferred from the furnace to a ladle which carries it to the mold. The molten metal is then poured into the mold and allowed to cool, solidifying the metal. After the metal has cooled sufficiently, the mold and core sand is removed from the casting in a shakeout procedure. At Cooper Energy Services, this operation is performed on a large, ventilated vibrating table. The sand that is removed is then reclaimed and reconditioned for future use.

The casting is then cleaned. Cleaning operations may include abrasive cleaning, chipping, grinding, cutting, and annealing. After the cleaning is completed, the casting is painted as necessary and inspected.

There have been some health and safety related activities at the Cooper Energy Services foundry.

The Occupational Safety and Health Adminstration (OSHA) had conducted an inspection which included two site visits in Fall of 1979. As a result of this inspection, Cooper Energy Services was issued a serious citation with 13 individual violations specified. The violations pertinent to this NIOSH Health Hazard Evaluation were essentially excessive worker exposure to crystalline silica, lack of engineering controls and an appropriate respiratory protection program to prevent this excessive exposure, and lack of an appropriate surveillance program. A Stipulation of Settlement Agreement was later reached which established abatement actions to be completed on or before December 19, 1983.

To meet the deficiencies noted by OSHA, the company installed a new concrete floor in the cleaning area of the foundry as a dust control measure. They also developed a comprehensive respiratory protection program that provided powered air-purifying particulate respirators for the employees performing cleaning operations (such as chipping). Additionally, the company implemented both medical and environmental surveillance programs for the foundry employees.

A review of the OSHA environmental data showed that personal samples were collected for crystalline silica, iron oxide, coal tar pitch volatiles, lead, nickel, and asbestos. Of these, the only exposures in excess of their standards were some of the crystalline silica samples. Of the 26 personal samples collected for crystalline silica, 6 were above the OSHA permissible exposure limit (PEL). All 6 were employees involved in cleaning operations. Indeed, the data indicated that chippers and grinders had generally higher exposures to crystalline silica than employees in other operations.

A review of company environmental data showed similar findings. Personal samples were collected for crystalline silica, iron oxide, lead, copper, nickel, manganese, chromium, formaldehyde, methylene bisphenyl isocyanate, and coal tar pitch volatiles. Of these, only exposures to crystalline silica were in excess of the OSHA standards. Of the 55 personal samples collected for crystalline silica, 12 were above the OSHA PEL. Nine of these 12 were employees in cleaning operations; notably chipping and grinding.

IV. METHODS AND MATERIALS

A. Medical

Cooper Energy Services initiated a medical surveillance program in 1982 to screen employees, who had been exposed to silica in the past, for the presence of pneumoconiosis. The initial screening included 181 employees from the shakeout, pouring, chipping, grinding, and maintenance areas of the foundry, who were felt to have had the most exposure to silica. This initial screening included chest x-rays, read by a qualified B-reader, and pulmonary function tests, which included forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), FEV1/FVC ratio, forced expiratory flow 25-75 (FEF25-75), and peak expiratory flow rate (PEFR). Twenty-five employees determined by initial screening to have abnormal results, were referred to a private physician for more extensive medical histories and physical examinations. Three of these employees, diagnosed as having the most severe cases of pneumoconiosis, were again reexamined for progression of their disease one year later.

NIOSH investigators reviewed the medical records of the 25 employees selected for the follow-up examinations and a random sample of the remaining employees who were not followed-up. A case-control study of workers with and without diagnosed pneumoconiosis was conducted, to determine what job classifications were at greatest risk for pneumoconiosis, and during what time period.

B. Environmental

A detailed process characterization of the foundry operations was made to identify potentially toxic materials used presently and in the past. Additional information was obtained from material safety data sheets as necessary. Hazard control measures implemented recently and existing foundry conditions and work practices were observed. Air sampling data provided by OSHA and the company concerning exposures to crystalline silica, heavy metals, coal tar pitch volatiles, methylene bisphenyl isocyanate, formaldehyde, and asbestos were reviewed.

V. EVALUATION CRITERIA

A. Medical Criteria

In reviewing these medical records, pneumoconiosis was determined based on the interpretation of chest x-rays using ILO criteria [1]. Restrictive and obstructive lung changes were determined on the basis of pulmonary function test results [2]. More detail on these diagnostic criteria appear where appropriate in the Results and Discussion Section of this report.

B. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increasing the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH recommended exposure limits (REL's), (2) American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and (3) OSHA PEL's. Often, the NIOSH REL's and ACGIH TLV's are lower than the corresponding OSHA PEL's. Both NIOSH REL's and ACGIH TLV's usually are based on more recent information than are the OSHA PEL's. The OSHA PEL's also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH REL's, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA PEL.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

The evaluation criteria for contaminants with the greatest hazard potential at the Cooper Energy Services Grove City foundry are presented in Table 1.

VI. RESULTS AND DISCUSSION

A. Medical

Ten persons were noted on chest x-rays to have at least grade 1/1 opacification by ILO criteria. Three of these ten had 2/2, and one of the 10 had 3/3 opacification. These ten persons are hereafter referred to as "unequivocal cases" of pneumoconiosis. Their mean age was 59.0 years with a standard deviation of 2.5 years. All were born prior to 1930.

Six persons were noted to have grade 0/1 or 1/0 opacification, and are hereafter referred to as "possible cases" of pneumoconiosis. Their mean age was 43.5 years.

Seven workers had pulmonary function results suggestive of restrictive changes (FVC less than 80 percent of the predicted standarized for age and height.) Only two of these seven had chest x-rays read as normal. The others had: unequivocal pneumoconiosis (1), possible pneumoconiosis (1), pleural thickening (1), increased intersitial markings (1), and emphysematous changes (2).

Ten workers, noted on a company listing to have "moderate" to "severe" obstructive changes, without evidence of pneumoconiosis, were sent by the company for further evaluation. Nine of the 10 were confirmed to have obstructive changes without restrictive changes. One had obstructive plus restrictive changes.

There were 131 workers determined in the company screen to be "normal". Nine charts were reviewed. One of the nine was noted to have a reduced FEF 25-75; no other pulmonary function abnormalities were noted.

In a return visit by the medical officer in February 1984, the work histories of all workers born prior to 1930, who had participated in the screening program were compiled. This included the 10 unequivocal cases of pneumoconiosis, plus 29 others without pneumconiosis. Possible cases of pneumoconiosis were excluded. Work as a "chipper" was noted for seven cases at some time during their job history; all other job titles were held by three or fewer cases. Odds ratios for silicosis were computed for cases compared to non-cases for each year of employment as a chipper (Figure 1). The odds ratio for pneumoconiosis (silicosis) exceeded one for all years between 1951 and 1970.

B. Environmental

As determined by the environmental findings, the contaminants with the greatest hazard potential at the Cooper Energy Services Grove City foundry appear in Table 1 along with their respective evaluation criteria as previously discussed.

In addition, environmental sample data from several previous surveys were used to determine whether any of these contaminants had reached hazardous levels.

In Fall 1979, OSHA conducted an inspection which included two site visits. During these two visits, personal samples were collected for asbestos, coal tar pitch volatiles, crystalline silica, iron oxide, lead, and nickel. Except for crystalline silica, none of the exposures were above the corresponding OSHA PEL, ACGIH TLV or NIOSH REL. Of the 26 personal samples collected for respirable crystalline silica, 6 were above the OSHA PEL (3 were sufficiently above the PEL to result in non-compliance) and ACGIH TLV. All 6 employees were involved in cleaning operations (chipping and grinding). Not enough information was provided to compare these silica exposures to the NIOSH REL for crystalline silica.

Since 1980, the company had conducted quarterly environmental surveys. The data from these surveys (through February 1982) showed that personal samples were collected for chromium, coal tar

pitch volatiles, copper, crystalline silica, formaldehyde, iron oxide, lead, manganese, methylene bisphenyl isocyanate, and nickel. Except for crystalline silica, none of the exposures were above the corresponding OSHA PEL, ACGIH TLV or NIOSH REL. Of the 55 personal samples collected for respirable crystalline silica, 12 were above the OSHA PEL and ACGIH TLV. Nine of these 12 employees were involved in cleaning operations (chipping and grinding). Not enough information was provided to compare these silica exposures to the NIOSH REL for crystalline silica.

To reduce worker exposure to respirable crystalline silica (as required by OSHA), the company implemented several corrective actions. Included in these was a new concrete floor installed in the cleaning area of the foundry as a dust control measure and the development of a comprehensive respiratory protection program that provided powered air-purifying particulate respirators for the employees performing cleaning operations (such as chipping).

VII. CONCLUSIONS

The medical surveillance program at Cooper Energy Services has identified 10 definite cases of silica-induced pneumoconiosis, and 6 possible cases of silicosis out of 181 foundry employees tested. Four of the cases had restrictive lung changes on pulmonary function tests, consistent with early pneumoconiosis, and with non-diagnostic chest x-rays.

Epidemiologically, the risk for silicosis was clearly associated with work as a chipper between 1951 and 1970. The environmental sampling data support this, since cleaning operation employees (chippers and grinders) seemed to consistently have the greatest exposures to respirable crystalline silica. That no increased risk was apparent after 1970 may simply be a reflection of insufficient time having elapsed for newer cases to manifest themselves.

The prevalence of silicosis that we found at Cooper Energy Services is comparable to prevalences found in other NIOSH Health Hazard Evaluations. At Cooper Energy Services we found 5.5% definite cases and 3.3% possible cases, or 9.0% total. Two other NIOSH studies in which X-ray data were examined had demonstrated rates ranging from 7.9% to 12.8% in foundry employees [14,15]. Of course, these rates are not directly comparable because the composition of the populations tested may be quite different (e.g., differing degrees of exposure, past work histories, job classifications, and age of employees).

VIII. RECOMMENDATIONS

1. As described in the NIOSH criteria document for crystalline silica [8], we recommend that all current employees exposed to an airborne concentration of respirable crystalline silica equal to or greater than 25 ug/m^3 averaged over an 8- to 10-hour workshift be included in the medical screening program. Since the latent period for development of chronic pneumoconiosis is typically 10 to 20 years, employees exposed to this or greater concentrations of silica in the past should also be included in the screening program and followed-up for at least this 20 year period.

2. The existing environmental surveillance program should be used to determine the efficacy of the dust controls implemented as a result of the OSHA citation. To minimize the likelihood of developing chronic pneumoconiosis, NIOSH recommends that worker exposure to crystalline silica be limited to 50 ug/m^3 averaged over an 8- to 10-hour workshift [8].

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. 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. Cooper Energy Services, Grove City, Pennsylvania
2. Cooper Industries, Houston, Texas
3. USWA Local 1153, Grove City, Pennsylvania
4. USWA, Pittsburgh, Pennsylvania
3. NIOSH, Region III
4. OSHA, Region III

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

Table 1

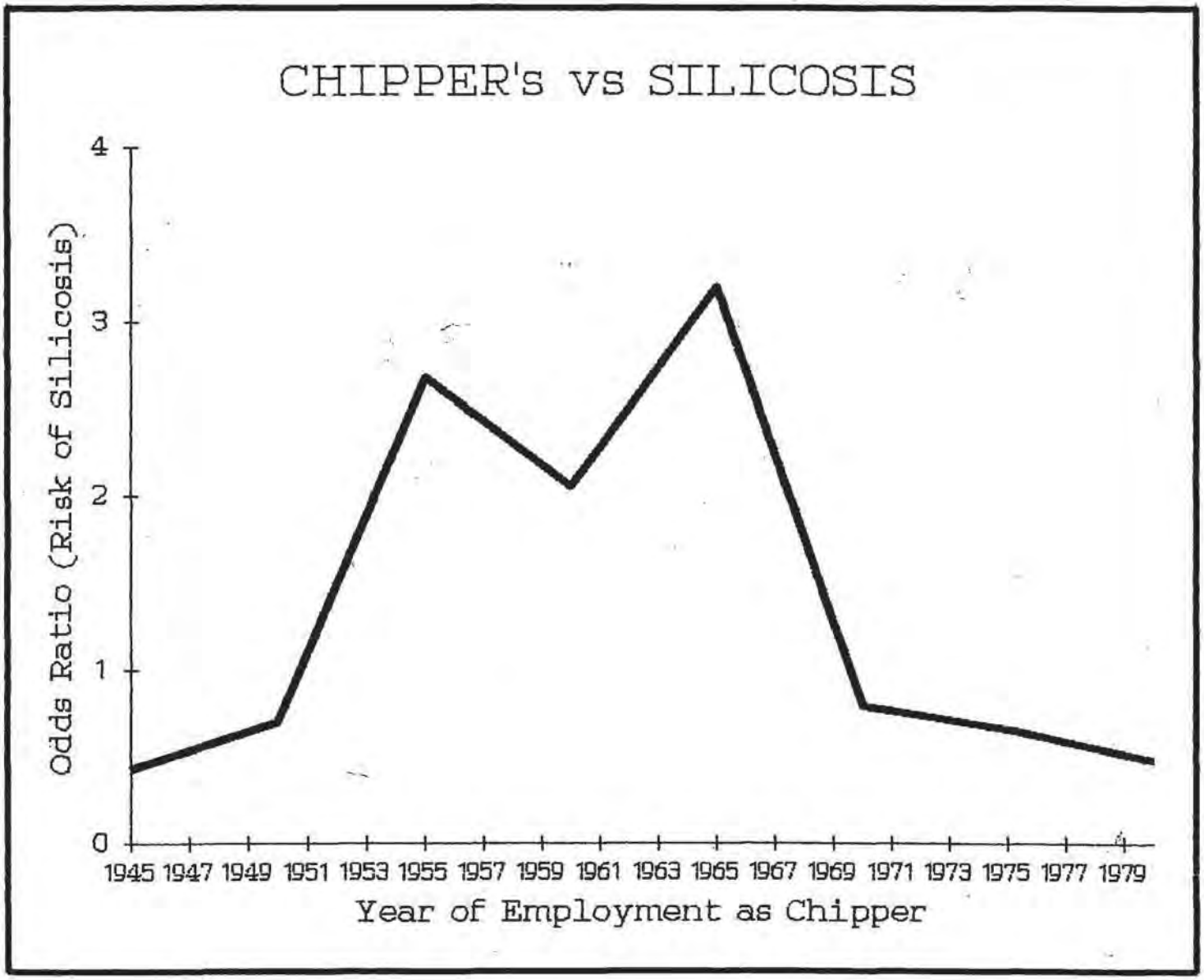
Evaluation Criteria[a]

Cooper Energy Services
Grove City, Pennsylvania

Compound	NIOSH REL[b]	OSHA PEL[c][3]	ACGIH TLV[d][4]	Possible Health Effects
Asbestos	0.1 fibers/cm^3 (>5um long)[e][5]	2 fibers/cm^3 (>5um long)	2 fibers/cm^3 (>5um long)	Asbestosis; lung cancer; mesothelioma
Carbon Monoxide	35 ppm [6]	50 ppm	50 ppm	Headache; nausea; dizziness; weakness; rapid breathing; unconsiousness and death can occur at high concentrations
Chromium (Metal and Insoluble Salts)	-	1mg/m^3	0.5 mg/m^3	Histologic fibrosis of lungs
Coal Tar Pitch Volatiles	0.1 mg/m^3 f,g[7]	0.2mg/m^3h	0.2 mg/m^3h	Bronchitis; dermatitis; cancer of lungs, skin, bladder and kidneys
Copper Dust (Fume)	-	1mg/m^3 (0.1 mg/m^3)	1mg/m^3 (0.2 mg/m^3	Irritation of mucous membranes, pharnyx and eyes; metallic taste; dermatitis
Crystalline Silica	50 ug/m^3f,i[8]	j	k	Silicosis
Formaldehyde	LFL[l][9]	3ppm	1ppm	Irritation of eyes, nose and throat; lacrimation; dermatitis, pulmonary irritation; cough; nausea; vomiting
Furfuryl Alcohol	50 ppm[f][10]	50 ppm	10 ppm	Dizziness; diarrhea; nausea; vomiting
Iron Oxide Fume	-	10 mg/m^3	5 mg/m^3	Benign pneumonoconiosis; x-ray changes of lungs
Lead	<100 ug/m^3f,m[11]	50 ug/m^3	150 ug/m^3	Anemia; colic; encephalopathy; peripheral neuropathy; renal disease
Manganese Dust (Fume)	-	-	5 mg/m^3 (1 mg/m^3)	Manganism
Methylene bisphenyl Isocyanate	-	0.2 mg/m^3	0.2 mg/m^3	Irritation of eyes, nose and throat; cough; pulmonary secretions; chest pain; dyspnea; asthma
Nickel	15 ug/m^3f[12]	1 mg/m^3	1 mg/m^3	Dermatitis; pneumonitis; asthma; cancer of lungs and sinuses
Phenol	20 mg/m^3f[13]	19 mg/m^3	19 mg/m^3	Irritation of eyes, nose and throat; dermatitis; skin burns; headache; dizziness; mental disturbances; annorexia; vomiting; diarrhea; liver and kidney disease; dark urine

a All values are 8-hour time-weighted averages (TWA's) except where noted.
b Recommended exposure limit
c Permissible exposure limit
d Threshold limit value
e Lowest airborne level that can be reliably quantified by phase contrast microscopy in general industry environments
f 10-hour TWA
g Cyclohexane solubles
h Benzene solubles
i Respirable free silica
j Respirable quartz PEL = $\frac{10\ mg/m^3}{\%\ SiO_2 + 2}$ total quartz PEL = $\frac{30\ mg/m^3}{\%\ SiO_2 + 2}$
k Respirable quartz TLV = $\frac{10\ mg/m^3}{\%\ quartz + 2}$ total quartz TLV = $\frac{30\ mg/m^3}{\%\ quartz + 3}$
l Lowest Feasible Level
m Airborne lead level to be maintained so worker blood lead remains $\leq$60 ug/100g

FIGURE I


CHIPPER's vs SILICOSIS
Odds Ratio (Risk of Silicosis)
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1945 1947 1949 1951 1953 1955 1957 1959 1961 1963 1965 1967 1969 1971 1973 1975 1977 1979
Year of Employment as Chipper