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C F & I STEEL
PUEBLO, COLORADO

NIOSH INVESTIGATOR:
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I. Summary

In October, of l985 the National Institute for Occupational Safety and Health (NIOSH) received a request from management to evaluate occupational exposures to phenol, crystalline silica, total particulate, and fiber glass particulates during the operation of an electric furnace and a grey iron foundry at C F & I Steel, Pueblo, Colorado.

A walk-thru survey was conducted in November, l985. Due to work schedules in the arc furnace, the environmental survey was delayed until April 2l and 22, l986. During the environmental survey, general room air samples were taken in the electric arc furnace for phenol. In the foundry, air samples were collected for crystalline silica, total particulate, and fiberous glass particulates.

All general room air concentrations for phenol, crystalline silica, total particulate, and fiberglass were below the evaluation criteria. Phenol concentrations in the vicinity of the furnace were 0.04, 0.l8, and 0.20, mg/m^3. The other phenol sample was below the laboratory detection limit of 0.20 mg/sample. Three samples were collected for quartz, cristobalite, and total particulate. Quartz concentrations were 0.05 and 0.06, mg/m^3; one sample was below the detection limit of 0.0l5 mg/sample. All cristobalite concentrations were below the laboratory limit of detection of 0.0l5 mg/sample. Total particulate levels were 0.28, 0.59, and 0.07 mg/m^3 which is well below the evaluation criteria of 5 mg/m^3. Fiberglass samples were counted on three filters; all were below the detection limits of 0.03 fibers per field or l500 fibers per filter.

The respirator program in the electric arc furnace and in the foundry was reviewed and was found to be in much better condition than when a previous NIOSH Health Hazard Evaluation was conducted in l984, HHE 84-302-l542. The company has a respiratory protection program which appears to satisfy the Occupational Safety and Health Administration (OSHA) standard outlined in l9l0.l34.

On the basis of the environmental data, personal interviews, and review of the respirator program, it was concluded that a health hazard from exposures to quartz, cristobalite, total particulate, phenol and fiberglass did not exist at the time of this survey.

Keywords: SICs 33l3, 332l (Electrometallurgical products and Grey Iron Foundries, steel mill, electric arc furnace, silica, phenol, fiber glass

II. INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), received a request in October, l985 from management of C. F. & I. Steel, Pueblo, Colorado to evaluate potential exposures to phenol in the electric arc furnace and to quartz and cristobalite, total particulate and fiberglass in the grey iron foundry. Due to the work schedule, the environmental survey was not performed until April 2l, and 22, l986. Most of the workers were informally interviewed. The respiratory protection program was thoroughly reviewed and discussed.

III. BACKGROUND

C F & I Steel, Pueblo, Colorado is in the business of steel production. The two areas this request covered included the electric arc furnace and the grey iron foundry. Once a month the furnace is relined with fire brick. The brick is cemented with a compound containing phenol. When the furnace is put back on production and the new brick is heated, the area smells like the phenol present in the cement. Management and employee concern over this odor was one of the reasons for this evaluation. The grey iron foundry produces ingot molds that are used in the electric arc furnace. Before the ingot molds are poured the bottom of the mold is filled with a silica type fibrous material. This is done to provide a parting compound once the mold is poured and cooled. Management had reviewed literature that indicated that a crystalline silica might be produced during the pouring of and the removal of the ingot mold from the casting. Environmental sampling was performed to document exposures to all possible air contaminants created from these procedures.

IV. ENVIRONMENTAL DESIGN AND METHODS

Sampling consisted of general room air samples. This was done since an evaluation of the worse case conditions for air concentrations was desired. Pumps were placed at strategic sites where exposures were greatest and most of these areas did not have workers present at all times.

Phenol samples were collected with impingers and vacuum pumps operated at l.0 liters per minute. Samples were analyzed according to NIOSH Method 3502 with modifications.

Quartz, and cristobalite respirable samples were collected on preweighed FWSB 37mm filters using vacuum pumps operated at l.7 liters per minute and analyzed by the NIOSH method 7500. Total particulate analysis was also performed on these filters which included pre and post exposure weight difference in filters.

Total fiber count sampling was performed on three 37 mm AA filters using vacuum pumps operated at l.5 liters per minute. The filters were analyzed according to NIOSH method 7400 utilizing phase contrast microscopy.

The areas where these samples were collected had very few workers which is another reason for the general room air samples instead of breathing zone sampling. Most of the workers in the electric arc furnace and in the grey iron foundry were interviewed.

V. EVALUATION CRITERIA

A. Environmental

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 increase 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 Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based solely 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 standard.

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. Relevant environmental criteria for this evaluation are as follows.

Environmental Exposure Limits
8-Hour Time-Weighted Average (TWA)
mg/m^3

	ACGIH	NIOSH	OSHA
Quartz (free crystalline silica)	O.1	.05	$\frac{10\ mg/m^3}{\%SiO_2 + 2}$
Cristobalite (Free crystalline silica)	0.05	.05	$\frac{10\ mg/m^3}{\%SiO_2 + 2}$
Total particulate (respirable)	5.0	5.0	5.0
Phenol	l9.0	19.0	19.0
Fibrous Glass dust	l0.0	10.0	10.0

B. TOXICOLOGICAL

Silica [1] - Crystalline silica, usually referred to as free silica, is defined as silicon dioxide (SiO_2) molecules arranged in a fixed pattern as opposed to a non-periodic, random molecular arrangement defined as amorphous silica. The three most common crystalline forms of free silica encountered in industry are quartz, tridymite, and cristobalite, with quartz being by far the most common of these. NIOSH, in its recommendations for a free silica standard, has proposed that exposures to all forms of free silica be controlled so that no worker is exposed to respirable airborne concentrations greater than 0.05 mg/m^3, as averaged over a 10 hour working day, 40 hour working week. This recommendation was designed to protect workers from silicosis, a pneumonconiosis due to the inhalation of silicon dioxide-containing dust. Exposures to free silica greater than one half the recommended standard or "action level" should initiate adherence to the environmental, medical, labeling, recordkeeping, and worker protection guidelines as contained in Chapter 1 of the NIOSH criteria document, "Occupational Exposure to Crystalline Silica." The current federal or OSHA standard for respirable free silica exposure is an 8 hour time-weighted average based upon the 1968 ACGIH TLV formulas of 10 mg/m^3 divided by the percent SiO_2 plus 2 ($10\ mg/m^3/\%SiO_2+^2$) for respirable quartz. One-half this amount was established as the limit for cristobalite and tridymite. As can be seen from the calculation, the OSHA regulation is based on the percentage of free silica contained in the repirable particulate exposure, whereas the NIOSH recommended standard applies directly to the airborne concentrations of respirable free silica.

Total Respirable Particulate - Exposures to respirable particulate may cause unpleasant deposits in the eyes and nasal passages. Some respiration problems due to deposition in the lungs may also occur.

Phenol [2] - Phenol may be toxic either by inhalation, ingestion, or percutaneous absorption. Excessive exposures to

phenol may produce cellular necrosis, cerebral edema, damage to the liver and kidney and pulmonary edema. The central nervous system (CNS) is first stimulated then depressed. Acute signs and symptoms of exposure include conjunctival burns, corneal necrosis, and severe skin burns. The effects of ingestion include burns of the mouth, pharynx, and gastrointestinal tract, perforation of the intestinal tract, nausea, vomiting, abdominal pain, and jaundice. Acute symptoms of inhalation include dyspnea, cough, cyanosis, and pulmonary edema.

Workers that are chronically exposed to phenol should receive annual physicals including evaluation of liver and kidney function. Individuals with serious disease of the CNS, liver, kidney, and lung should be precluded from exposure. Maintaining a worker's exposure below a time weighted average (TWA) of l9 mg/m3 should be adequate protection.

Fiberglass - Exposure to fiberglass will produce dermatitis. The most hazardous exposure when working with fiberglass is usually to the solvents and catalysts that are used in conjunction with the fiberglass. None of these agents were used in this study. The only problems one would normally find when fiberglass is used alone are contact dermatitis and physical irritation. Some individuals are allergic to fiberglass.

VI. Results

A. Environmental

Four general room air samples were collected for phenol. Levels measured were 0.O4, O.l8, O.20 mg/m^3 and below detection limits. Cristobalite concentrations were below laboratory detection limits. Levels of quartz were 0.05, 0.06, mg/m^3 and below laboratory limits of detection. Total particulate measurememts were 0.28, 0.59, and 0.07 mg/m^3. Fiberglass fibers were not found on any of the filters that were analyzed. All environmental results were far below the evaluation criteria and did not pose a health hazard. Interviews with workers in all areas of the plant did not indicate any complaints that appeared to be work related. The respirator program in the electric arc furnace, and in the foundry appeared to meet the OSHA requirements outlined in l9l0.l34.

Vll. DISCUSSIONS AND CONCLUSIONS

Based on the environmental sampling, personal observations, and employee interviews we concluded that a health hazard did not exist at the time of this survey. Both management and the workers should be congratulated on the progress that has been made in the respiratory protection program.

Vlll. RECOMMENDATIONS

1. Continued compliance with the respiratory protection program in both the foundry and in the electric arc furnace should help prevent any hazardous exposures.

2. All workers should be advised on all chemicals used in the foundry and the electric arc furnace as to their toxicity.

IX. REFERENCES

1. National Institute for Occupational Safety and Health. Occupational Diseases: A Guide To Their Recognition. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1977. (DHEW (NIOSH) Publication No. 77-181).

2. Chemical Hazards of the Workplace, Proctor, N.H., Hugh, J.P., 1978, pp. 488-489.

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XI. DISTRIBUTION AND AVAILABILITY

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

Copies of this report have been sent to:

1. CF & I Steel, Pueblo, Colorado
2. U. S. Department of Labor/OSHA, Region VIII
3. NIOSH, Region VIII
4. Colorado Department of Health

Table 1

General Room Air Concentrations of Phenol
in the Electric Arc Furnace Area of
C F & I Steel in
Pueblo, Colorado
April 21, 1986

Sample #	Location	Sampling Time	mg/m^3 Phenol
I-1	Control Box	8:05a - 4:30p	0.04
I-2	Work Station	8:05a - 4:30p	0.18
I-3	Valve on Furnace	8:05a - 4:30p	*
I-4	Behind Furnace	8:05a - 4:30p	0.20

Evaluation Criteria 19

Laboratory Limit of Detection - 0.02 mg/sample

Table 2

General Room Air Concentrations of
Quartz, Cristobalite, and Total Particulate in
a Grey Iron Foundry at
C F & I Steel,
Pueblo, Colorado
April 21, 1986

Sample #	Location	Sampling Time	mg/m^3 Qz	Cbt	TP
6122	South end of Pouring Table	1:15p - 5:30p	0.05	*	0.28
6123	Number (I) Crane	1:10p - 5:40p	0.06	*	0.59
6137	North end of Pouring Table	1:15p - 5:30p	*	*	0.07
Evaluation Criteria			0.1	0.05	5
Laboratory Limit of Detection mg/sample			0.015	0.015	0.01

A - 1985-1986 - ACGIH Notice of Intended Change

Qz = Quartz
Cbt = Cristobalite
TP = Total Particulate