U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 74-9-174

WHEELING PITTSBURGH STEEL CORPORATION
STEUBENVILLE, OHIO
FEBRUARY 1975

I. TOXICITY DETERMINATION

It has been determined that dust containing free silica is potentially toxic to blast furnace workers and to personnel working in the stock-house area. This determination is based upon air concentration levels of total dust containing free silica up to four times the Federal Standard for blast furnace workers and up to twenty-eight times the Federal Standard for larry car operators in the stockhouse as well as criteria concerning the toxic effects of free silica.

It has also been determined that potentially toxic exposures did not exist on the day of evaluation (April 25, 1974) to the crane operator in the stripper building from exposure to iron oxide fume, carbon monoxide, and free silica or to maintenance workers in the 44" soaking pit area from exposure to sulfur dioxide and carbon monoxide. Detectable levels of carbon monoxide, sulfur dioxide, and iron oxide fume were not measured while the free silica level was less than 0.4 of the Federal Standard.

II. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202.

Copies have been sent to:

a) Wheeling-Pittsburgh Steel Co., Steubenville, Ohio

b) Authorized Representative of Employees

c) U.S. Department of Labor - Region V

d) NIOSH - Region V

For the purposes of informing the approximately 500 "affected employees" the employer shall promptly "post" the Determination Report in a prominent place(s) near where exposed employees work for period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669 (a)(6) authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health received such a request from an authorized representative of employees regarding employee exposure to coal tar pitch, iron oxide, carbon monoxide, silica, graphite, manganese, calcium oxide, and dust. The areas of the plant specifically included in the request were the 80" mill, 44" soaking pits, stripper building, and the blast furnace area.

IV. HEALTH HAZARD EVALUATION

A. Plant Process

This mill manufactures iron and steel as well as hot and cold rolled steel. The eighty inch rolling mill area was visited and production workers were observed to spend most of their shifts inside control rooms. One man is required to work for extended periods on the operating floor cutting up steel scrap. This work practice had been evaluated by air sampling during a previous OSHA inspection and was not evaluated again by the NIOSH team. Some recommendations were made for improvement of industrial hygiene conditions during the tour.

Cranes are used in the stripper building to remove molds from ingots. One or two crane operators may work in this area. Observation indicated a potential for some exposure to iron oxide for these workers. The forty-four inch soaking pit area was toured with little potential exposure judged for the operators since they spend most of the shift in control rooms. Maintenance workers do work in the mill area and could possibly be exposed to gases from combustion especially sulfur dioxide and carbon monoxide.

The blast furnace area was the last area visited and some potential exposures to several substances were observed. The crew responsible for tapping the furnace has the greatest chronic exposure to several substances including iron oxide fume, graphite, sulfur dioxide, and free silica. The larry car operators working in the stockhouse may be exposed to dusts from several substances including iron ore, calcium carbonate, and coke.

B. Evaluation Design

Those operations which were judged to have the greatest potential for worker exposure were evaluated where possible with personal breathing zone samples. The two crane operators' exposures were evaluated for iron oxide, and several workers in the blast furnace and stockhouse area were evaluated with breathing zone samples to determine the exposure to free silica. The soaking pit area was monitored with detector tubes to measure carbon monoxide and sulfur dioxide levels to which maintenance workers were exposed. Worker exposure to coal tar pitch volatiles was not evaluated since the only identified source of coal tar pitch volatiles was located at another plant not subject to this request. Exposure to manganese and graphite were not evaluated since blast furnace workers were potentially exposed simultaneously to graphite, manganese, and silica. Silica was selected for evaluation since it was considered to create the greatest potential for health hazard to the workers involved. It was also judged that the use of multiple sampling devices on these workers might impede the use of safety clothing and equipment.

Exposure to calcium oxide dust involved very brief intermittent exposures. The area of use was inspected by the NIOSH investigators, but the actual use of calcium oxide was not observed during the evaluation.

C. Evaluation Methods

Samples of iron oxide and free silica were obtained using personal air sampling equipment. Total dust samples were obtained using closed faced three-piece cassettes containing the filter media while respirable dust samples were obtained using a 10 mm cyclone in series with the filter media. Total weight gain of filters was determined gravimetrically. Iron was measured by atomic absorption spectrometry,[1] and silica content of dust was determined using a colorimetric method.[2]

D. Evaluation Criteria

1. Environmental Standards

The OSHA Standards for the substances evaluated are taken from Part 1910 of Title 29 of the Code of Federal Regulations, Section 1910.93, Tables G-1 and G-3, June 27, 1974.

Substance	Concentration
Silica:	
Crystalline:	
Quartz(respirable)	$\frac{10\ mg/M^3}{\%\ SiO_2 + 2}$
Quartz(total dust)	$\frac{30\ mg/M^3}{\%\ SiO_2 + 2}$
Sulfur Dioxide	5 ppm
Iron oxide fume	10 mg/M^3
Carbon Monoxide	50 ppm

Although other sources contain recommended occupational health standards that differ from the Federal Standards cited, the most notable exception concerns free silica exposure. The recent NIOSH Criteria Document[7] contains a recommendation for control of worker exposure to no greater than a time-weighted average of 50 micrograms/M^3 respirable free silica for up to a 10-hour work day.

Environmental standards are intended to protect the health of workers occupationally exposed to a substance on an 8-hour per day, 40-hour per week basis over a normal working lifetime.

2. Toxic effects of substances investigated [3,4,5,6,7]

The following discussion describes the toxicological effects that may occur in workers exposed to free silica, the major toxic substance to which workers were found to be exposed in this evaluation. These effects are described so workers will know the symptoms and health consequences of overexposure. The effects described depend upon a number of factors such as concentration, length of exposure, individual susceptibility, and possible synergistic effect of more than one substance.

Silica

The chief concern of excessive silica exposure is the development of a condition termed silicosis. This form of pneumoconiosis usually occurs only after a number of years of exposure, although with severe exposure silicosis can occur in a short time. Early silicosis (termed "simple silicosis") is usually first diagnosed by chest x-ray examination. At this stage there is usually little if any functional impairment, and there are often no associated symptoms and signs. Symptoms occur when silicosis advances and becomes complicated by infection and emphysema.

The deposition of crystalline free silica in the lungs in sufficient amounts over a period of years may produce fibrous nodules. These nodules cause many individual alveoli (air sacs within lung) to be compressed and collapsed, thus reducing the function of the lungs. Continuous exposure to elevated concentrations of dust containing free silica may produce increased debilitating effects. These changes are marked by intolerance to exertion, episodes of coughing and production of thick purulent sputum. When silicosis has progressed to this point, the chest x-ray is usually read as "conglomerate silicosis". Conglomerate silicosis many times progresses in spite of termination of exposure and becomes incapacitating to affected workers.

E. Results and discussion

The results of personal samples with silica determinations are presented in Table I. The amount of silica and the corresponding standard was determined for each sample. For the blast furnace workers one sample result was lower than the present Federal hygiene standard while the remaining three were above the standard with the highest result being more than four times the standard. Two workers were sampled in the stockhouse since the operator was training a helper on the day of the evaluation. These two results were 21 and 28 times greater than the Federal standard. One area sample was obtained in the cab of crane No. 250 and analyzed for total weight and silica. The weight gain of this filter was less than the minimum detectable limit of the weighing method and is therefore reported as a less than value. The result of this sample is less than half the calculated standard.

A personal sample for the crane operator resulted in iron oxide exposure for this worker of 0.005 mg/M^3. Carbon monoxide could not be detected in the crane cab with the use of detector tubes. Maintenance workers were working in the vicinity of the No. 1 and No. 15 soaking pits on the day of evaluation. Carbon monoxide or sulfur dioxide could not be detected with the use of detector tubes in these areas; limits of detection for these methods are: Carbon monoxide - 10 ppm, sulfur dioxide - 1 ppm.

F. Conclusion

The measured levels of silica dust to which stockhouse and blast furnace workers are exposed demonstrates a condition of serious potential toxicity to these workers. In view of these findings it is strongly recommended that immediate measures to lower the silica air levels below the Federal Standard for free silica exposure be instituted. Other measures for protecting workers are outlined in the Recommendations Section.

V. RECOMMENDATIONS

Whenever feasible, engineering control is the preferred method of lowering environmental levels of toxic substances to protect workers from health hazards. However, the difficulty of applying engineering control in the blast furnace and stockhouse areas without careful study and evaluation is recognized. The recommendations below are all of the type which may be implemented immediately. These recommendations are based upon those contained in the recent NIOSH Criteria Document[7] concerning exposure to crystalline silica.

1. Medical

a. Medical examinations should be made available to blast furnace and stockhouse workers prior to employee placement and at least once each 3 years thereafter. Examinations should include as a minimum:

(1) A medical and occupational history to elicit data on worker exposure to free silica and signs and symptoms of respiratory disease.

(2) A chest roentgenogram (posteroanterior 14" by 17" or 14" by 14") classified according to the 1971 ILO International Classification of Radiographs of Pneumoconioses. [ILO U/C International Classification of Radiographs of Pneumoconioses 1971, Occupational Safety and Health Series 22 (rev). Geneva, International Labor Office, 1972]

(3) Pulmonary function tests including forced vital capacity (FVC) and forced expiratory volume at one second (FEV_1) to provide a baseline for evaluation of pulmonary function and to help determine the advisability of the workers using negative- or positive-pressure respirators. It should be noted that pulmonary function tests may vary significantly in various ethnic groups. For example, in black persons, the test values for the FVC should be divided by 0.85 before the percentage value is compared with normal figures.

(4) Body weight.

(5) Height.

(6) Age.

(7) Initial medical examinations for presently employed workers should be offered within 6 months.

b. Medical Management

An employee with or without roentgenographic evidence of silicosis who has respiratory distress and/or pulmonary functional impairment should be fully evaluated by a physician qualified to advise the employee whether he should continue working in a dusty trade.

c. Medical records should be maintained for at least 30 years following the employee's termination of employment.

2. Posting

a. Warnings should be posted at or near entrances or accessways to the stockhouse and blast furnace work areas to warn unauthorized persons to stay out of these areas.

b. Warnings should be posted in the stockhouse and blast furnace work areas warning personnel that these are free silica work areas and breathing the dust in these areas may cause delayed lung injury.

3. Respiratory Protection

a. Until environmental free silica levels have been reduced below the Federal Standard, respiratory protection should be provided to and used by exposed workers in the stockhouse and blast furnace areas. Respirators provided should be approved by NIOSH or the Bureau of Mines and have been approved to provide sufficient protection at the concentration of free silica occurring in the work area in which used.

b. A respiratory protective program meeting the requirements of Section 1910.134 of the Occupational Safety and Health Standards should be established and enforced by the employer.

4. Work Practices

Stockhouse and blast furnace workers should vacuum work clothing before removal. Clothes <u>should not</u> be cleaned by blowing or shaking.

5. Monitoring and Record Keeping

a. In all monitoring, samples representative of the exposure in the breathing zone of employees should be collected. An adequate number of samples should be collected to permit construction of a full-shift exposure for every operation or process. The Sampling Schedule below is a guide for determining the number of samples to be taken.

SAMPLING SCHEDULE

Number of Employees Exposed	Number of Time-weighted Average Determinations
1-20	50% of the total number of workers
21-100	10 plus 25% of the excess over 20 workers
over 100	30 plus 5% of the excess over 100 workers

b. Samples should be collected and analyzed at least every 6 months for the evaluation of the workers' exposure with respect to the Federal Standard.

c. Work environment (breathing zone) samples should be taken within 30 days after installation of a new process or process changes.

d. Records should be maintained of medical examinations and all sampling schedules to include the sampling and analytical methods, type of personal protection devices, if any, in use at the time of sampling and the determined free silica dust concentration. Records should be maintained for at least 30 years following termination of workers' employment. Each employee should be able to obtain information on his exposure.

VI. REFERENCES

1. General Procedure for Metals by Atomic Absorption, P & CAM 173, Physical and Chemical Analysis Branch, NIOSH, CDC, PHS, U.S. DHEW, September, 1973.

2. Colorimetric Method for Free Silica, P & CAM 106, Physical and Chemical Analysis Branch, NIOSH, CDC, PHS, U.S. DHEW, September, 1973.

3. Documentation of the Threshold Limit Values, ACGIH, 3rd Ed., Cincinnati, Ohio, 1971.

4. Hygiene Guide Series, ACGIH, 14125 Prevast, Detroit, Michigan.

5. Patty, F. A., Industrial Hygiene and Toxicology, Second Revised Edition, Vol. II, Interscience Publishers, New York, 1967.

6. Encyclopedia of Occupational Health and Safety, International Labor Office, McGraw-Hill Book Co., New York, 1971

7. Criteria for a recommended standard... Occupational Exposure to Crystalline Silica, NIOSH, CDC, PHS, DHEW, HEW Publication No. (NIOSH) 75-120, 1974.

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TABLE 1

Results of Personal Sampling for Airborne Free Silica in Blast Furnace and Stockhouse Areas-April 25, 1974*

JOB DESCRIPTION	SAMPLE WEIGHT GAIN (mg)	LENGTH OF SAMPLE (minutes)	FREE** SILICA (%)	CALCULATED FEDERAL STANDARD (mg/M^3)	SAMPLE CONCENTRATION (mg/M^3)	RATIO $\frac{\text{Sample}}{\text{Standard}}$	TYPE SAMPLE
Cinder Keeper	1.23	381	3.5	1.8	1.9	1.1	Respirable
1st Helper	4.08	377	12.4	2.1	7.2	3.4	Total
2nd Helper	0.81	377	1.4	2.9	1.3	0.4	Respirable
3rd Helper	4.40	369	15.9	1.7	7.9	4.6	Total
Larry Car Operator	42.6	367	9.0	2.7	77.3	28.6	Total
Larry Car Helper	19.6	362	15.7	1.7	36.1	21.2	Total
General Area Crane #230	<.51	377	12.4	2.1	<.90	<0.4	Total

*Respirable samples may be compared to the NIOSH Criteria Document Standard of 50 $\mu g/M^3$. Results of this comparison are:

	Sample Concentration	Ratio - $\frac{\text{Sample}}{\text{Standard}}$
Cinder Keeper	66 $\mu g/M^3$	1.3
2nd Helper	17 $\mu g/M^3$	0.34

**Corrected for free silica content of filter blanks.