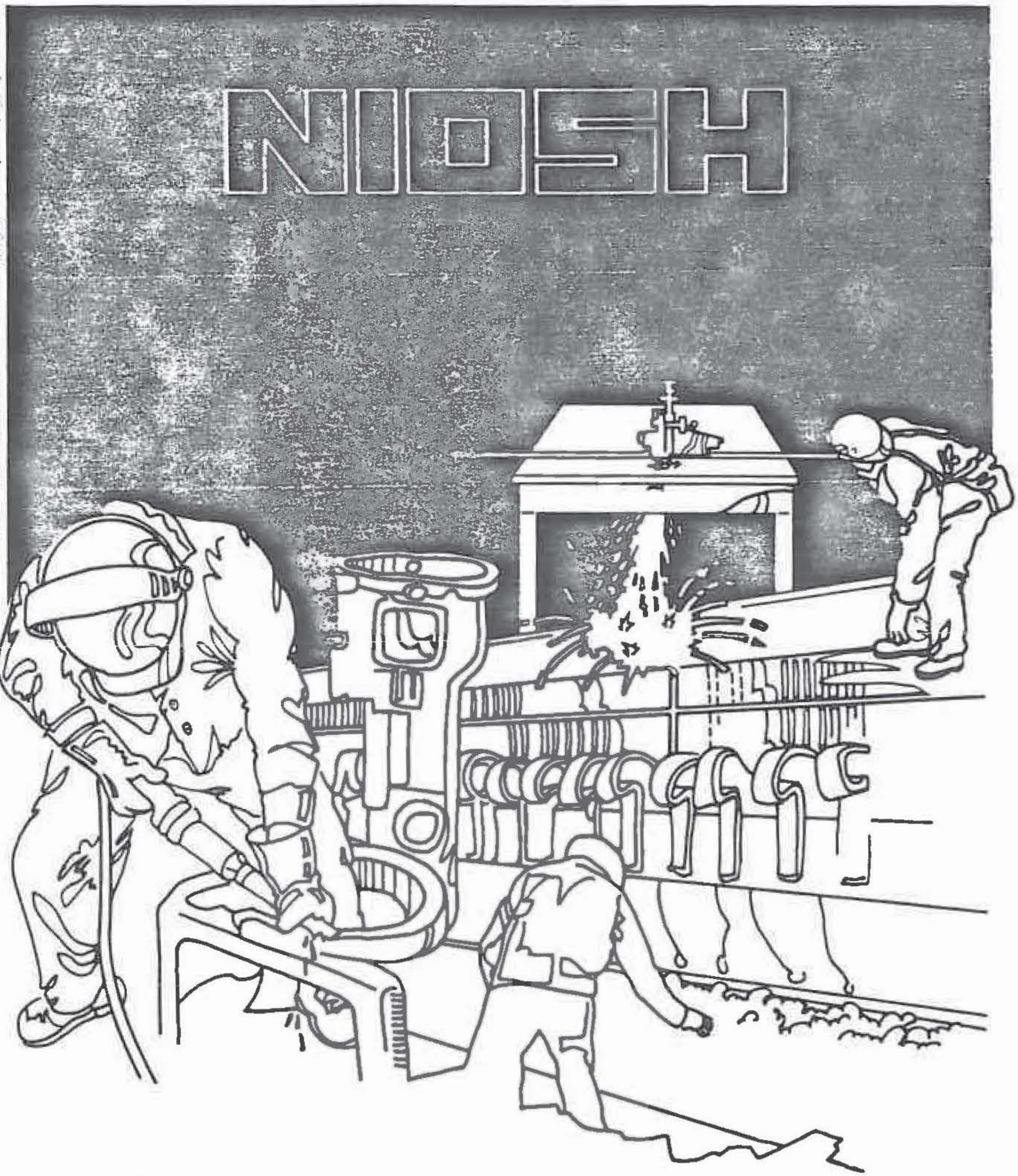
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 82-302-1461
EAST PENN FOUNDRY
MACUNGIE, 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 82-302-1461
MAY 1984
EAST PENN FOUNDRY
MACUNGIE, PENNSYLVANIA

NIOSH INVESTIGATORS:
PHILIP J. LANDRIGAN, M.D., M.Sc., D.I.H.
FRANK A. LEWIS, I.H.
MARTIN G. CHERNIACK, M.D.
LAWRENCE R. CATLETT, M.S.S.

I. SUMMARY

On June 10, 1982, the National Institute for Occupational Safety and Health (NIOSH) was requested to evaluate silicosis in workers at the East Penn Foundry, a grey iron foundry in Macungie, Pennsylvania.

On October 12, 1982, NIOSH investigators conducted an initial survey, interviewed management and workers, and obtained industrial hygiene records, medical records, and previous x-rays. On October 6, 1983, the investigators conducted an industrial hygiene evaluation. Silica sand was used extensively in this foundry, and silica flour, a very fine, highly toxic form of silica, had been in use as a parting compound until 1982.

Industrial hygiene data showed that for coremakers, past breathing zone exposures to respirable crystalline ("free") silica ranged from 500 to 1,516 ug/M^3 air in 1977; from 44 to 461 ug/M^3 in 1980; and from 23 to 77 ug/M^3 in 1982. For fettlers, past exposures ranged from 86 to 454 ug/M^3 in 1977; from 13 to 461 ug/M^3 in 1980; and from 14 to 99 ug/M^3 in 1982. NIOSH recommends that occupational exposure to respirable free silica not exceed 50 ug/M^3. In 1983, respirable free silica exposures ranged from 36 to 318 ug/M^3 for coremakers; were all less than the detection limit of 36 ug/M^3 for fettlers; and were 49 ug/M^3 for shakeout operators. Further reductions were observed in air samples obtained in 1984.

Respirable dust exposures in 1977 ranged from 0.87 to 5.60 mg/M^3, with 1 of 10 exposures (in a fettler) above the ACGIH standard of 5 mg/M^3. The maximum concentration of respirable dust in all air samples in subsequent years was 3.54 mg/M^3.

Medical evaluation found that 18 (9.6%) of 188 workers had radiologic evidence in 1977 or 1980 of silicosis: 8 had category 1 profusion of small lesions; 2 had category 2; and 8 had category 3. Two workers had large lesions diagnostic of progressive massive fibrosis (PMF). The prevalence of silicosis increased from 2 cases (2.4%) in 84 workers employed less than 20 years to 8 cases (80%) in 10 workers employed 20 or more years ($r = 0.491$; $p < 0.00001$). Four workers without silicosis in 1977 developed category 1 disease by 1980. There was no correlation between smoking history and prevalence of silicosis ($r = 0.00$; $p = 0.92$). Both pneumoconiosis and smoking increased the prevalence of cough and shortness of breath in these workers.

Based on these data, it is concluded that extremely serious overexposure to airborne free silica existed at the East Penn Foundry prior to 1982. At present, silica exposures are generally lower, but continue to exceed the NIOSH recommendation of 50 ug/M^3 in several areas. The high prevalence of silicosis in workers at the East Penn Foundry attests to the severity of the exposure hazard. Recommendatons for further reducing exposures are made in Section VIII of this report.

KEYWORDS: SIC 3321; silica; silicosis; pneumoconiosis; foundry; occupational lung disease.

II. INTRODUCTION

On June 10, 1982, the National Institute for Occupational Safety and Health (NIOSH) was asked by the International Molders and Allied Workers Union (IAMWU), Local #295, to evaluate the prevalence and severity of silicosis in workers at the East Penn Foundry, Macungie, Pennsylvania. The request followed the discovery during medical screening of workers at the foundry of several cases of advanced silicosis.

On October 12, 1982, NIOSH investigators met with plant management, a consultant to management, and officials of Local #295, IAMWU, and conducted a walk-through survey of the facility. Prior to this survey the NIOSH investigators had obtained records from management on previous industrial hygiene evaluations. Subsequently, the NIOSH physicians obtained x-rays taken in 1977 and 1980 and medical records. On October 6, 1983, the NIOSH industrial hygienist conducted a followup environmental evaluation.

A preliminary letter describing the findings of the walk-through survey was sent on October 14, 1982 by NIOSH to plant management and to local union officials. An interim report was distributed by NIOSH in July 1983 to plant management, to the plant's medical consultants, to local and international union officials, and to the Occupational Safety and Health Administration (OSHA).

III. BACKGROUND

A. The Plant

The East Penn Foundry produces 3"-15" diameter cast iron pipe in 5-10 ft. lengths along with related fittings. The foundry has been in existence at its present location for approximately 100 years and has used the current casting processes since 1964. It employs approximately 150 workers, 90-100 of them in job categories with potential exposure to airborne free silica. On a typical day, 150 tons of grey iron may be poured into castings ranging in size from 45-500 lbs. The foundry works a three-shift operation, five days a week. The day shift operates a continuous heating, melting and pouring cycle. The afternoon shift prepares cores, relines ladles and performs cleanup and maintenance operations. The night shift performs sand recovery and maintenance operations.

B. The Process

In the first stage of the process (Figures 1 and 2), a 100-ton (84' diameter) cupola is loaded with scrap iron, pig iron, coke and limestone. The resulting molten metal is poured into holding ladles and from there is poured into overhead transport ladles for use at either the three permanent mold fitting stations, fourteen permanent mold fitting "wheel" stations, or five centrifugal pipe mold stations.

Pipe is cast using De Levaud-type centrifugal casting machines. In these machines, a dry sand core is placed in a mold lined with sand or parting agent. The mold is rotated rapidly along its axis and is filled from a ladle with molten metal which flows the length of a long pouring trough extending through the center of the mold. As metal starts to flow into the rotating mold, the mold is removed slowly from the ladle, and the metal is deposited on the mold surface in a helical path. After pouring is completed, the rotation of the mold continues until all of the metal has solidified. The sand core is removed after the metal has solidified.

C. Past Exposures to Silica

Data on exposures to respirable dust and to airborne silica at the East Penn Foundry have been collected previously on three occasions: by the consulting firm of Bolt, Beranak, and Newman (Cambridge, MA) in 1977[1]; by the Allentown Area Office of the Occupational Safety and Health Administration (OSHA) in 1980[2]; and by Joseph A. Guimond and Associates (Sellersville, PA) in 1981 and 1982[3]. These evaluations have documented the existence of silica exposures at the foundry considerably in excess of the NIOSH recommended standard of 50 ug/M^3 (Appendix A).

To reduce occupational exposures to silica, foundry management have taken a series of steps, as follows:

1962

1. Temperature of asphalt lowered to decrease vapor pressure of volatiles.
2. Man-cooling fans utilized in "hot" areas.
3. Whirl-type louvers installed on roof/ceiling for general ventilation.
4. Small muller enclosed on green sand unit.

1968-1969

1. Permanent mold fitting "wheel" installed to produce fittings (pipe).
2. A new parting spray mix for the large and small diameter pipes introduced.

1971

1. The "wheel" was relocated for better operations flow.

1972-1973

1. Exhaust system for pedestal grinders and roto-blast (wheel-rotor) unit installed.

2. Resin sand muller updated (does not use as much phenolic resin).

3. General ventilation updated (large ceiling exhaust fans installed).

1974

1. First phase of cupola modifications (charge system changed and particulate control installed).

1975

1. Air pollution control (exhaust) on mulling operations installed.

2. Roof fans installed over centrifugal machines.

1976

1. Automatic asphalting lines equipped with exhaust hoods.

1978

1. Overhead exhaust fans replaced with larger units.

1982

1. Automatic green sand muller with exhaust unit installed.

1982 to Present

1. The introduction of a "special", low silica parting compound for the centrifugal casting machines to replace silica flour.

2. Automatic reamer installed to partially eliminate the manual grinding of pipe ends.

As a consequence of those measures, occupational exposures to silica have gradually been reduced. Because of a lack of air sampling data prior to 1977, it is not possible to quantify silica exposures prior to that date. However, on the basis of data collected since 1977, it is possible to demonstrate the following reductions in silica exposure:

Job Operation	Mean Airborne Concentrations of Respirable Free Silica in Breathing Zone Samples (ug/M^3)*		
	1977	1980	1982
Coremaking	1174	143	44
Fettling	270	204	55

* NIOSH recommends that time-weighted occupational exposure to respirable free silica not exceed 50 ug/M^3 air.

Additional air sampling conducted in February, 1984 (after the conclusion of the NIOSH field survey) showed a further reduction in airborne concentrations of crystalline free silica (Appendix A).

D. Past Medical Evaluation

To evaluate the health effects of occupational exposure to silica at the East Penn Foundry, management have instituted medical screening programs for workers. X-ray evaluations have been conducted at the plant three times, in 1973, 1977, and 1980. The first x-rays, in 1973, were taken on 70 mm films by the Lehigh Valley Tuberculosis and Health Association, Allentown, Pennsylvania. Those films were discarded, but written reports from the Association indicate that three of 139 workers examined had abnormal findings. Those abnormalities included "generalized parenchymal emphysema" in one worker, and a "pleural" lesion in another. No cases of silicosis were reported. (Seventy mm x-rays are not recommended for industrial use, because of their insensitivity in detecting cases of pneumoconiosis.)

The 1977 x-rays were taken on 14" x 17" films by Professional Health Services, Inc., Havertown, Pennsylvania. One hundred twenty-three workers were examined. The films were examined initially by a radiologist at Professional Health Services. However, any x-rays with suspicious or frankly abnormal findings were referred by the company to a pulmonary physician in Allentown, Pennsylvania, specially certified in the interpretation of chest films for pneumoconiosis ("B reader"). Based on his evaluation, 20 (16.3%) workers were found to have findings consistent with a diagnosis of pneumoconiosis: 13 were classified as category 1, 6 as category 2, and 1 as category 3. Additionally, 3 workers had mild radiologic abnormalities suggestive of, but not diagnostic of pneumoconiosis and were classified as category 0/1. There was no formal process of notification of workers of these findings.

The 1980 x-rays were also taken on 14" x 17" film by Professional Health Services. All of these films were referred to the same pulmonary physician in Allentown for interpretation. A total of 15 (11.2%) of 134 workers examined were diagnosed as having findings consistent with a pneumoconiosis: 11 workers were classified as category 1; four as category 2; and none as category 3. All workers were individually notified of their x-ray results by letter from the physician.

In addition to the x-rays, respiratory screening questionnaires (Appendix B) were administered and pulmonary function testing of workers was conducted at the plant in 1980 and in 1982 by the American Lung Association of the Lehigh Valley, Bethlehem, Pennsylvania. One hundred fifty-five workers were tested in 1980, and 159 in 1982. In the 1982 evaluation, test results in 17 workers were interpreted by the Lung Association as abnormal. The pulmonary function testing was performed using a Vitalograph (Buckingham, England) spirometer. This instrument was calibrated twice each year. The tests were administered by either a registered nurse or a laboratory technician, neither of whom had received certification in pulmonary function testing.

IV. METHODS

A. Initial Survey

On October 12, 1982, a NIOSH industrial hygienist and two NIOSH physicians visited the East Penn Foundry. Following an opening conference with representatives of management and labor and with a representative of the consulting firm of Joseph A. Guimond and Associates, a walk-through survey of the plant was conducted with management and labor representatives.

Each area was observed, photographs taken, and work processes and practices explained by management or union representatives. Engineering and work practice modifications which were directed at improving safety and health conditions were noted.

B. Industrial Hygiene

On October 6, 1983, ten personal, breathing zone air samples for measurement of exposure to respirable dust and to free silica were obtained for various job operations throughout the foundry; particular emphasis was placed on the high exposure operations (coremakers and fettlers).

Respirable dust and free silica were sampled using a personal sampling pump, a 10 mm nylon cyclone and a pre-weighed polyvinyl chloride membrane filter (37 mm, 5 mm pore size) at a flow rate of 1.7 liters per minute over the entire work shift.

Bulk settled dust samples were also collected from each area where air samples were taken in order to determine the silica content of settled dust.

The total weights of the dust collected in the air samples were determined by weighing the samples plus the filters on an electrobalance and subtracting the previously determined tare weight of the filters. The tare and gross weighings were done in duplicate.

The samples were analyzed for quartz and cristobalite using x-ray diffraction. NIOSH Method P&CAM 259 was used in these analyses with the following modifications: (1) Filters were dissolved in tetrahydrofuran rather than being ashed in a furnace. (2) Standards and samples were run concurrently and an external calibration curve was prepared from the integrated intensities rather than using the suggested normalization procedure. The lower limit of quantitation was estimated to be 0.03 milligrams or 1.5% on a two-milligram portion for both polymorphs of silica.

C. Medical

To perform an independent assessment of the prevalence and severity of silicosis in workers at the East Penn Foundry, we arranged for the x-rays obtained in 1977 and 1980 to be reread by 3 NIOSH-certified B readers. Each of these readers (independent of one another) interpreted each film for the presence of pneumoconiosis, utilizing the 1980 Revision of the International Labour Office (ILO) Classification System.[4] In this system, the initial grading of each film is based on the number, or profusion, of small lesions in the lungs. Films without silicosis are graded as category 0, while films with increased numbers of small lesions are graded as categories 0/1, 1, 2, or 3, with 3 being the most severe. The ILO Classification System also requires standardized recording of the size, shape and distribution within the lungs of these small lesions. Further, the ILO System requires that all films be examined for the presence of large lesions indicative of a diagnosis of complicated pneumoconiosis or progressive massive fibrosis (PMF); PMF lesions are graded according to their size and number as category A, B, or C, with C being the most severe. Finally, the system requires the notation, according to a standard format, of any other abnormalities observed in the lungs, heart, great vessels, or chest wall.

To assess any progression of pneumoconiotic lesions over time for those workers who had x-ray examinations in both 1977 and 1980, the B readers (independent of one another) read the paired films side-by-side with knowledge of their temporal sequence.[5] This approach is considered the method of choice for reading serial films on an individual, because it enables the readers to compensate for differences in film quality, and it increases the ability (sensitivity) of the readers to detect changes over time.[6]

For the majority of workers at the East Penn Foundry, the three B readers agreed with one another in their interpretation of the profusion of lesions. However, in cases where there was disagreement among the readers, we adopted the following standard procedure[7] to derive a consensus interpretation:

-- consensus was based solely on the readers' interpretations of the profusion of lesions - considerations of shape, size and distribution did not enter into the development of consensus;

-- consensus was then defined as follows:

(a) if two or more of the three readers' interpretations on profusion fell within the same major category - i.e., 0, 1, 2, or 3 for small lesions, and 0, A, B, or C for large lesions - then consensus was defined according to that category;

(b) if the readings fell into three different major categories, then consensus was defined according to the middle (median) of those three categories.

If one of the B readers declared a film to be of unreadably poor quality, then consensus on profusion among the two remaining readers was derived as follows:

(a) if both read profusion as being within the same major category, consensus was defined according to that category.

(b) if the two readings were in different major categories but separated by no more than one minor category - e.g. 1/2 and 2/1, or 2/3 and 3/2 - then consensus was defined according to the higher of those two readings.

If two or all three of the readers declared a film to be of unreadably poor quality, then we considered that to represent a consensus interpretation of unreadability, and we did not analyze the results of that film further.

To assess the data obtained on the respiratory screening questionnaires, we considered only the information obtained on the more recent interview. We evaluated the reported presence or absence of cough, of phlegm production and of shortness of breath either on level walking or while climbing stairs. We also noted smoking history, and for each cigarette smoker we calculated to total number of pack-years (packs per day times number of years) smoked.

To assess the results of pulmonary function testing, we adopted the following definitions:

-- restrictive impairment was defined as the presence in either the 1980 or the 1982 test of a forced vital capacity (FVC) of less than 75% of that predicted on the basis of an individual's age, sex, race, and height.

-- obstructive impairment was defined as the presence in either test of a one-second forced expiratory volume (FEV_1) of less than 70% of an individual's FVC.

V. EVALUATION CRITERIA

A. 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.

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 primarily on concerns relating to the prevention of occupational disease.

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 Occupational Safety and Health Administration's (OSHA) standard for occupational exposure to respirable crystalline (free) silica (SiO_2) over an 8-hour workshift is expressed by the formula:

$$\frac{10 \text{ mg } SiO_2/M^3}{\% \, SiO_2 + 2}$$

where mg SiO_2/M^3 = mg silica per M^3 air, and
% SiO_2 = percentage of silica in respirable dust.

In 1974, NIOSH recommended that the exposure limit for respirable crystalline silica be set at 50 ug/M^3, averaged over a workshift of up to 10 hours per day, 40 hours per week.[14] This recommended standard is lower than the OSHA standard; it is based on information which indicates that the prevention of silicosis requires adherence to a time-weighted average exposure limit no higher than 50 ug/M^3.[10,11]

In 1981, NIOSH[12] reaffirmed its recommendation that time-weighted average occupational exposure to respirable free silica should not exceed 50 ug/M^3. Also in both 1974 and 1981, NIOSH pointed out the extreme health hazard which is associated with the use of silica flour, a very fine and therefore highly toxic form of crystalline silica. NIOSH recommends that, wherever possible, safer substitutes should be found for silica flour.

For respirable dust, the OSHA exposure standard is 10 mg/M^3, averaged over a workshift of 10 hours per day, 40 hours per week. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that time-weighted average exposure to respirable dust not exceed 5 mg/M^3.

B. Medical Criteria

Silicosis is a form of diffuse interstitial pulmonary fibrosis resulting from the deposition of respirable crystalline silica in the lung.(13) Conditions of exposure may affect both the occurrence and severity of silicosis. Although the disease usually occurs after 15 or more years of exposure,(10,11) some forms of silicosis with latency periods of only a few years or less are well recognized and are associated with intense exposures to very fine dust high in free silica content, such as with silica flour.(12,19) Early, simple silicosis usually produces no symptoms. However, both acute and complicated silicosis (PMF) are associated with shortness of breath, intolerance for exercise, and a marked reduction in measured pulmonary function. Diagnosis is based on a history of occupational exposure to free silica and the characteristic appearance of a chest radiograph. Respiratory failure and premature death may occur in advanced forms of the disease. Individuals with silicosis are at increased risk of contracting tuberculosis. A variety of rheumatoid conditions, including rheumatoid lung and scleroderma, are also associated with silicosis. No specific treatment for silicosis is available, and the disease may progress even after a worker is no longer exposed to silica. Further, continued exposure to silica of a worker who already has silicosis increases the likelihood that the worker will develop progressively more advanced disease.

VI. RESULTS

A. Environmental

The industrial hygiene evaluation conducted on October 6, 1983, showed airborne exposures to respirable free silica of below the lower limit of analytical detection (LLD) of 36 ug/M^3 for fettlers; from below the LLD to 318 ug/M^3 for coremakers (mean 94 ug/M^3); of 36 ug/M^3 for the iron pourer; of 61 ug/M^3 for the sand muller; and of 49 ug/M^3 for the shakeout operator. All concentrations are time-weighted averages based on an eight-hour exposure (Table 1).

In 1983, silica exposures above the NIOSH-recommended standard of 50 ug/M^3 were observed for the coremakers, the muller operator, the shakeout operator and the PMF mold cleaning operator.

Mean exposures to respirable dust on October 6, 1983 were 0.49 mg/M^3 for fettlers; 0.81 mg/M^3 for coremakers; 1.28 mg/M^3 for the iron pourer; 1.34 mg/M^3 for the sand muller; and 0.63 mg/M^3 for the shakeout operator (Table 1). All of these exposures were below the ACGIH exposure limit for respirable dust of 5 mg/M^3.

Evaluation of the silica content (% free silica quartz - no other polymorphs present) in the samples of bulk, settled dust showed the following: 7.4% for coresetting, 9% for grinding, 12% for iron pouring, 18% for coremaking, 52% for PMF mold cleaning and 78% for the fitting conveyor shakeout. These relatively high percentage values may reflect a disproportionate concentration of crystalline silica in the larger particles characteristic of settled dust. Also the settled dust samples may contain residual silica flour, which was used at the foundry as a parting agent until 1982.

An analysis of a bulk sample of the new parting agent used in the centrifugal mold since 1982 showed a silica content of less than 1.5% (lower limit of quantitation) for all polymorphs of silica.

B. Medical

For the medical evaluation, we obtained at least partial data on 223 present and former workers at the East Penn Foundry. The average age of these workers as of January 1, 1983 was 35.1 years (standard deviation, 12.6 years). Their mean duration of employment was 8.6 years (standard deviation, 7.5 years).

We obtained chest x-rays from 1980 for 153 workers; 134 of these films were readable. We obtained x-rays from 1977 for 120 workers; 118 of these films were readable. Altogether, we obtained at least one readable chest x-ray for 188 workers. On consensus interpretation of the most recent readable film for each worker by NIOSH's B readers, 18 (9.6%) of 188 workers were found to have radiologic changes in their lungs compatible with a diagnosis of silicosis: eight had ILO category 1 profusion of small lesions; two had category 2; and eight had category 3. In addition, one worker had 0/1 profusion of small lesions, suggestive of, but not diagnostic of silicosis. Two workers were found to have large opacities (one category A, and one category C) consistent with a diagnosis of complicated pneumoconiosis or progressive massive fibrosis (PMF); both of these workers had underlying grade 3 silicosis. Two workers had X-ray evidence of inactive tuberculosis; neither of those workers had evidence of silicosis.

Sixty-four workers had readable x-rays obtained in both 1977 and 1980. When these films were examined side-by-side[5,6] by NIOSH's B readers, three workers who had no detectable silicosis in 1977 were found to have developed grade 1 pneumoconiosis between 1977 and 1980; two of these workers had been employed at the foundry for less than 10 years. Another worker who had grade 0/1 profusion in 1977 had advanced to grade 1 in 1980; and one worker who had grade 1 profusion in 1977 had advanced to grade 2 in 1980. No new cases of PMF developed between 1977 and 1980; the same two workers had PMF in both years.

To examine the occurrence of silicosis on x-ray in relation to duration of employment at the East Penn Foundry, we compared the results of each worker's most recent consensus x-ray reading with data on his duration of employment. We found that the prevalence of pneumoconiosis increased from 2 cases (2.4%) in 84 workers employed for less than 20 years to 8 cases (80%) in 10 workers employed for 20 or more years (Table 2); also all workers with grade 2 or grade 3 pneumoconiosis or with PMF had been employed for more than 20 years. The correlation between duration of employment and prevalence of silicosis was highly significant (correlation coefficient, r-value = 0.491; $p < 0.00001$).

One hundred four (74.8%) of 139 workers who completed respiratory screening questionnaires reported that at some time in their lives they had smoked cigarettes. We compared the frequency of pneumoconiotic lesions in persons who had ever smoked with that in lifelong non-smokers, and we found no significant difference.[8,9] Three (14.3%) of 21 non-smoking workers for whom readable x-rays were available had evidence of pneumoconiosis, and seven (9.6%) of 73 workers who had ever smoked had evidence of pneumoconiosis. Also we examined the prevalence of pneumoconiotic lesions according to the number of pack-years smoked (Table 3). We found no evidence of a dose-response relationship between cigarette smoking and the prevalence of pneumoconiosis (correlation coefficient, r-value = 0.00; $p = 0.92$).

On their most recent respiratory screening questionnaire, 23 (16.5%) workers reported cough occurring daily for more than 3 months of the year; 14 (10.1%) reported production of phlegm every morning; and six (4.3%) reported shortness of breath either when walking on level ground or while climbing stairs. The prevalence of each of these symptoms was higher in smokers than in non-smokers (Table 4). In addition, the prevalence of cough and of shortness of breath, but not of phlegm production, was higher in workers with pneumoconiosis than in workers without pneumoconiotic lesions (Table 5). Although numbers were small, there appeared to be evidence of an interaction between cigarette smoking and pneumoconiosis in the causation of shortness of breath (Table 6).

Three (2.2%) of 139 workers who underwent pulmonary function testing in either 1980 or 1982 had evidence of restrictive impairment (defined as less than 75% predicted FVC for age, race, sex, and height). We examined the prevalence of restrictive impairment in relation to smoking history, years of employment at the foundry, and x-ray evidence of pneumoconiosis.[10,11] We found no significant association between restrictive impairment and the number of pack-years of cigarettes smoked (correlation coefficient, r-value = 0.22; $p = 0.09$) (Table 7). We also observed no correlation between the prevalence of restrictive impairment and duration of employment at the foundry ($r = 0.00$; $p = 0.93$) (Table 8). One worker with restrictive impairment also had PMF.

Thirteen (9.4%) of the workers who participated in pulmonary function testing in either year had evidence of pulmonary outflow obstruction (defined as an FEV_1/FVC ratio less than 70% predicted). All 13 of these workers were smokers, and a strong association was evident between cumulative pack-years of cigarettes smoked and the prevalence of obstructive impairment ($r = 0.35$; $p = 0.0007$) (Table 7). We found no association between duration of employment at the foundry and prevalence of obstructive impairment ($r = 0.00$; $p = 0.57$) (Table 8).

VII. DISCUSSION AND CONCLUSIONS

The industrial hygiene data reviewed in this evaluation indicate that past occupational exposures to airborne free silica at the East Penn Foundry were extremely high. As recently as 1977, coresetters were exposed to respirable silica concentrations up to 30 times the current NIOSH-recommended exposure limit of 50 ug/M^3, and grinders were exposed to concentrations up to 9 times that level. Since 1977, management have made a concerted effort to reduce silica exposures through modifications of the plant processes and improvements in ventilation. A most significant improvement was the replacement in 1982 of silica flour with a less toxic parting compound of low silica content. That change was long overdue. Relatively safe substitutes for the highly toxic silica flour have been known and have been used widely in the foundry industry for many years.[12,13]

The air sampling conducted by NIOSH in 1983 showed continuing, but lower overexposures to free silica for the coresetters, the muller operator, and the shakeout operator. The excessive exposure of the muller operator, which had not been seen in previous evaluations (Appendix A), may be explained by the absence of a functioning dust collector on the muller on the day of the NIOSH evaluation. At the muller, fine, dry silica sand was dropped from a holding bin into wheelbarrows in order to test a newly installed system; the ventilation for that operation had not been balanced and was not operational. The NIOSH industrial hygienist observed large clouds of silica sand emanating from this area and exposing the muller operators to higher concentrations of silica than would be present under normal conditions.

The most recent air sampling, conducted by consultants to management in February 1984, showed further reductions in airborne free silica exposures.

The medical evaluation showed that 18 (9.6 %) of 188 workers evaluated in either 1977 or 1980 had radiologic evidence of silicosis in the best judgement of NIOSH's panel of three B readers. Two of these workers had progressive massive fibrosis (PMF). Four new cases of radiologically evident silicosis developed between 1977 and 1980. Eighty percent of workers employed for twenty or more years had evidence of silicosis. These findings attest both to the severity of the past exposure hazard and to the continuing hazard of overexposure to airborne free silica at this foundry. Also they suggest that the prevalence of silicosis among workers who left the workforce prior to the first full-fledged radiological evaluation in 1977 may actually have been higher than that observed in more recent years.

An important finding in these medical studies was that cigarette smoking, whether evaluated categorically (yes/no) or quantitatively in terms of pack-years, had no influence on the development of radiologically evident silicosis (Table 3). This finding parallels similar observations which have been made in regard to the lack of an association between cigarette smoking and the development of asbestosis.[8] Cigarette smoking did, however, influence the prevalence of pulmonary obstruction. Also, in apparent synergy with exposure to silica, smoking was found to influence the reported prevalence of pulmonary symptoms.

VIII. RECOMMENDATIONS

A. Environmental

1. Material Substitutions

Replacement of a toxic material with a harmless or less hazardous substance is the single, most effective method of eliminating an occupational health hazard. At the East Penn Foundry the replacement of silica flour with a parting compound containing less than 1.5% free silica represents an example of materials substitution.

2. Engineering Controls

Short of substitution, the most effective control of airborne free silica is achieved by enclosure of operations which generate silica dust and/or by use of local exhaust ventilation. Guidelines for ventilation of processes and operations can be found in NIOSH's Recommended Industrial Ventilation Guidelines and in the American Conference of Governmental Industrial Hygienist's Industrial Ventilation - A Manual of Recommended Practice.

When enclosing a process or operation, a slight vacuum should be employed to create negative pressure so that leakage will result in the flow of external air into the enclosure rather than from the enclosure to the outside. This approach will minimize contamination of the workplace, and can be accomplished with a well-designed exhaust ventilation system that physically encloses the process and has sufficient capture velocity to keep the contaminant from entering the work atmosphére.

Ventilation equipment should be checked at least every three months to ensure adequate performance. System effectiveness should be checked soon after any change in production, process, or control which might result in significant increases in airborne exposure to free silica.

It is the recommendation of NIOSH that the ventilation system in the muller area be made operational as soon as possible, in order to abate the health hazard created there by overexposures to airborne free silica. Furthermore, air sampling should be conducted in that area to assure that the ventilation system is effective and that future silica concentrations in the area are within the NIOSH-recommended standard of 50 ug/M^3.

3. Exposure Monitoring

Exposure surveys should be made periodically throughout the foundry by competent industrial hygiene and engineering personnel. Surveys are necessary to determine the extent of worker exposure and to check the effectiveness of engineering controls.

It is the stated opinion of NIOSH[12,14] that the prevention of silicosis requires that all time-weighted average occupational exposures to airborne free silica must be kept below 50 ug/M^3. We recognize that this recommended level is only half the OSHA standard for airborne free silica. NIOSH's assessment of the medical literature indicates however, that the OSHA standard is set too high for protection of workers against silicosis. Adherence with the NIOSH recommended standard constitutes prudent practice.

B. Medical Surveillance

Preplacement and periodic medical examinations should be made available to all workers who manufacture, use, or handle free silica or materials containing free silica. These examinations should include at least:

1. Comprehensive work and medical histories to evaluate exposure and signs and symptoms of respiratory disease;

2. A 14 x 17 inch posteroanterior chest radiogram, preferably interpreted using the 1980 ILO U/C classification;

3. Pulmonary function tests, including measurement of forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1), with calculation of the FEV_1/FVC ratio; and

4. Because of the known association between silicosis and pulmonary tuberculosis, workers with silicosis should periodically be offered screening for TB.

   Workers with radiographic evidence of silicosis should be notified of those findings and be given the opportunity to transfer to jobs without silica exposure (defined as exposure at concentrations less than half of the NIOSH-recommended standard of 50 ug/M^3). It is very important that workers be properly notified of their x-ray and other medical findings and that workers with demonstrable silicosis be provided with a forthright and fully accurate assessment of their situation. In such notification, workers should be informed of the stage of their silicotic lesions, and of the meaning of that staging.

   There is a strong likelihood that cases of silicosis exist among workers who were exposed to airborne free silica in past years at the East Penn Foundry and who terminated employment before the first formal radiographic evaluation in 1977. These workers should be traced by the company and/or the union and offered proper medical evaluation, as outlined above.

C. Work Practices

The following improvements in work practices are recommended:

1. Work procedures should be modified so they do not produce dust. Wet mopping and vacuuming should be used whenever possible, and dry sweeping avoided;

2. Work clothes should be vacuumed before removal;

3. General housekeeping should be intensified so that there is no dust accumulation on machinery, beams, corners, and other surfaces. Such accumulations often contain respirable silica particles which can become airborne when disturbed. Dustless methods of cleaning such as vacuuming or wetting down should be used. Dry sweeping or blowing with compressed air should be avoided; and

4. Emphasis should be given to cleanup of spills, preventive maintenance, and timely repair of equipment.

D. Personal Protective Equipment

Personal protective equipment is not recommended as a primary means of control. Exposure of workers to airborne free silica should not be controlled with the use of respirators except:

1. During installation and implementation of engineering or work practice controls;

2. In work situations in which engineering and work practice controls are not technically feasible;

3. During major overhaul and repair of equipment, if exposure to free silica is possible;

4. In operations that require entry into tanks or closed vessels; or

5. In emergencies.

When respirators are used at the East Penn Foundry, a respirator program must be established, and this program must conform to OSHA's requirements for a minimal acceptable respirator program, as published in OSHA's General Industry Occupational Safety and Health Standards, 29 CFR 1910.134(b) 1-11, as revised March 11, 1983.

E. Worker Education

Worker education is a vital aspect of a good control program. Workers should be informed of the hazardous nature of airborne silica dust, the results of workplace monitoring and medical tests, and the correct usage and maintenance of respirators. Also workers should be informed about the additional health hazards which develop as a result of synergy between silica dust and cigarette smoking. Smoking does not cause silicosis, but it can increase the attendant disability. Workers should be encouraged to quit smoking, and NIOSH encourages the development of an anti-smoking campaign at the East Penn Foundry.

F. Labelling

Packaged free silica, including silica flour, should be labelled correctly, and health warnings should be placed on each container to alert users and handlers as well as producers to the hazards of free silica.

IX. REFERENCES

1. Bolt, Beranak and Newman, Inc: Report on Industrial Health and Safety Consultation Visit at Tyler Pipe, Macungie, Pennsylvania, Report #3468, Cambridge, Massachusetts, 1977.

2. U.S. Occupational Safety and Health Administration, Allentown, Pennsylvania Area Office: OSHA Inspection H-7499, Report 032, Complaints MIS #950 and MIS F1330 - Tyler Pipe Industries, Inc., Macungie, Pennsylvania, Allentown, Pennsylvania, 1980.

3. Joseph A. Guimond & Associates, Inc.: Summary of Individual Respirable Dust Sample Tests - Tyler Pipe, Macungie, Pennsylvania, Sellersville, Pennsylvania, 1983.

4. International Labour Office (1980). ILO International Classification of Radiographs of Pneumoconioses. Occupational Safety and Health Series, No. 22. Geneva: International Labour Office.

5. Liddell FDK, Morgan WKC: Methods of assessing serial films of the pneumoconioses: a review. J Soc Occup Med 28:6-15, 1978.

6. Reger RB, Butcher DF, Morgan WKC: Assessing change in the pneumoconioses using serial radiographs. Amer J Epidemiol 98:243-254, 1973.

7. Felson B, Morgan WKC, Bristol L, Pendergrasse E, Dessen E, Linton O, Reger R: Observations on the results of multiple readings of chest films in coal miners' pneumoconiosis. Radiology 109:19-23, 1973.

8. Kilburn KH: Cigarette smoking does not produce or enhance the radiologic appearance of pulmonary fibrosis. Amer J Industr Med 2:305-308, 1981.

9. Sepulveda M-J, Merchant JA: Roentgenographic evidence of asbestos exposure in a select population of railroad workers. Amer J Industr Med 4:631-639, 1983.

10. Theriault GP, Peters JM, Fine LJ: Pulmonary function in granite shed workers of Vermont. Arch Environ Health 28:18-22, 1974.

11. Theriault GP, Peters JM, Johnson WM: Pulmonary function and roentgenographic changes in granite dust exposure. Arch Environ Health 28:23-27, 1974.

12. National Institute for Occupational Safety and Health: Current Intelligence Bulletin No. 36, Silica Flour: Silicosis (Crystalline Silica). Cincinnati:U.S. Department of Health and Human Services, Centers for Disease Control, National Institute for Occupational Safety and Health, 1981.

13. Parkes WR: Occupational Lung Disorders, 2nd ed. Chapter 7: Diseases Due to Free Silica. London: Butterworths, 1982.

14. National Institute for Occupational Safety and Health: Criteria for a Recommended Standard...Occupational Exposure to Crystalline Silica. Cincinnati:Department of Health, Education and Welfare, NIOSH Publication No. 75-120, 1974.

15. Brooks SM, Campbell G, Majors M, Kominsky J, Singal M: Health Hazard Evaluation Report No. 78-66-542, U.S. Steel South Works, Chicago, Illinois. Cincinnati:National Institute for Occupational Safety and Health, November 1978.

16. Centers for Disease Control: Silicosis - South Dakota, Wisconsin. MMWR 32:318-319, 1983.

17. Ziskind M, Weill H, Anderson AE, Samimi B, Neilson A, Waggenspack C: Silicosis in shipyard sandblasters. Environ Res 11:237-243, 1976.

18. Hughes JM, Jones RN, Gilson JC, Hammad YY, Samimi B, Hendrick DJ, Turner-Warwick M, Doll NJ, Weill H: Determinants of progression in sandblasters' silicosis. Ann Occup Hyg 26:701-712, 1982.

19. Banks DE, Morring KL, Boehlecke BA: Summary reports...Silicosis in the 1980's. Amer Industr Hyg Assoc J 42:77-79, 1981.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by: Philip J. Landrigan, M.D.
Martin G. Cherniack, M.D.
Frank Lewis, I.H.
Lawrence R. Catlett, M.S.S.

Originating Office: Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations, and Field Studies

XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 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. East Penn Foundry
2. IMAWU, Local 295
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

RESULTS OF NIOSH AIR SAMPLING - OCTOBER 6, 1983
EAST PENN FOUNDRY
MACUNGIE, PENNSYLVANIA

HE 82-302

Location/Operation (Personal Samples)	Sampling Time (minutes)	Respirable "Dust" Concentration (Mg/M^3)*	Respirable "Free Silica" Concentration (ug/M^3)**
Fitting/Pedestal Grinder #1	492	0.60	< 36
Fitting/Pedestal Grinder #2	490	0.37	< 36
Coresetter 10 Ft. Line, No. 2 Small Diameter	487	0.56	60
Coresetter 5 Ft. Line Small Diameter	360	0.77	37
Coresetter 10 Ft. Small Diameter No. 1	487	0.69	< 36
Coremaker	460	0.82	37
Iron Pourer 10 Ft. Line No. 2	465	1.28	36
Muller (Resin)	465	1.34	61
PMF Mold Cleaning	450	1.20	318
Shakeout (Fitting Conveyor)	354	0.63	49

* Milligrams per cubic meter, time-weighted average based on 8-hour exposure.

** Micrograms (quartz) per cubic meter, time-weighted average based on 8-hour exposure.

NIOSH recommended exposure limit for respirable free silica is 50 micrograms per cubic meter of air.

TABLE 2

PREVALENCE IN 1980 OF PNEUMOCONIOSIS BY DURATION OF EMPLOYMENT
EAST PENN FOUNDRY
MACUNGIE, PENNSYLVANIA
HE 82-302

DURATION OF EMPLOYMENT (Years)	NO. OF WORKERS	NO. (%) WITH PNEUMOCONIOSIS
0 - 4	29	0 (-)
5 - 9	30	2 (6.7)
10 - 14	22	0 (-)
15 - 19	3	0 (-)
20 - 24	2	1 (50.0)
25+	8	7 (87.5)
TOTAL	94	10 (10.6)

TABLE 3

PREVALENCE IN 1980 OF PNEUMOCONIOSIS BY PACK-YEARS OF CIGARETTES SMOKED
EAST PENN FOUNDRY
MACUNGIE, PENNSYLVANIA
HE 82-302

PACK YEARS	NO. OF WORKERS	NO. (%) WITH PNEUMOCONIOSIS	
0 (non-smokers)	21	3	(14.3)
1 - 19	47	3	(6.4)
20 - 39	14	2	(14.3)
40+	12	2	(16.7)
TOTAL	94	10	(10.6)

TABLE 4

PREVALENCE OF RESPIRATORY SYMPTOMS BY SMOKING STATUS
EAST PENN FOUNDRY
MACUNGIE, PENNSYLVANIA
HE 82-302

SMOKING STATUS	NO. OF WORKERS	PREVALENCE OF SYMPTOMS					
		COUGH		PHLEGM		SHORTNESS OF BREATH	
		NO.	(%)	NO.	(%)	NO.	(%)
Ever Smoked	104	22	(21.2)	14	(13.5)	5	(4.8)
Never Smoked	35	1	(2.9)	0	(-)	1	(2.9)
TOTAL	139	23	(16.5)	14	(10.1)	6	(4.3)

TABLE 5

PREVALENCE OF RESPIRATORY SYMPTOMS BY PRESENCE OF PNEUMOCONIOSIS
EAST PENN FOUNDRY
MACUNGIE, PENNSYLVANIA
HE 82-302

PNEUMOCONIOSIS	TOTAL NO. OF WORKERS	NO. (%) OF WORKERS WITH SYMPTOMS		
		COUGH	PHLEGM	SHORTNESS OF BREATH
Absent	84	11 (13.1)	8 (9.5)	1 (1.2)
Present	12	3 (25.0)	1 (8.3)	4 (33.3)
TOTAL	96	14 (14.6)	9 (9.4)	5 (5.2)

TABLE 6

PREVALENCE OF SHORTNESS OF BREATH BY SMOKING
HISTORY AND PNEUMOCONIOSIS
EAST PENN FOUNDRY
MACUNGIE, PENNSYLVANIA
HE 82-302

	NON-PNEUMOCONIOTIC		PNEUMOCONIOTIC	
Non-smokers	0/19	(0%)	1/4	(25.0%)
Smokers	1/65	(1.5%)	3/8	(37.5%)
TOTAL	1/84	(1.2%)	4/12	(33.3%)

TABLE 7

PREVALENCE OF RESTRICTIVE* AND OBSTRUCTIVE** LUNG IMPAIRMENT
BY CUMULATIVE PACK-YEARS CIGARETTE SMOKING
EAST PENN FOUNDRY
MACUNGIE, PENNSYLVANIA
HE 82-302

PACK-YEARS	NO. OF WORKERS	PREVALENCE OF ABNORMALITY: DEPRESSED FVC NO.	(%)	DEPRESSED FEV1/FVC NO.	(%)
0	35	0	(0.0)	0	(0)
1-9	40	1	(2.5)	2	(5.0)
10-19	30	0	(0.0)	5	(16.7)
20+	34	2	(5.9)	6	(17.6)
TOTALS	139	3	(2.2)	13	(9.4)

*Defined as forced vital capacity (FVC) value of less than 75% that predicted on the basis of age, sex, height, and race.
**Defined as ratio of one-second forced expiratory volume (FEV_1) to FVC of less than 70% that predicted.

TABLE 8

PREVALENCE OF RESTRICTIVE* AND OBSTRUCTIVE** LUNG IMPAIRMENT
BY DURATION OF EMPLOYMENT
EAST PENN FOUNDRY
MACUNGIE, PENNSYLVANIA
HE 82-302

DURATION OF EMPLOYMENT (YEARS)	NO. OF WORKERS	PREVALENCE OF ABNORMALITY			
		DEPRESSED FVC		DEPRESSED FEV1/FVC	
		NO.	(%)	NO.	(%)
0-4	53	0	(0.0)	4	(7.5)
5-9	39	1	(2.6)	4	(10.3)
10-14	26	1	(3.8)	2	(7.7)
15+	18	0	(0.0)	3	(16.7)
TOTAL	136***	2	(1.5)	13	(9.6)

*Defined as forced vital capacity (FVC) value of less than 75% that predicted on the basis of age, sex, height, and race.

**Defined as ratio of one-second forced expiratory volume (FEV_1) to FVC of less than 70% that predicted.

***Data on years of employment were missing for 3 workers.

Figure 1

FLOW DIAGRAM OF FOUNDRY PROCESSES, EAST PENN FOUNDRY, MACUNGIE, PA

HE 82-302

<u>Grey Iron Casting</u>

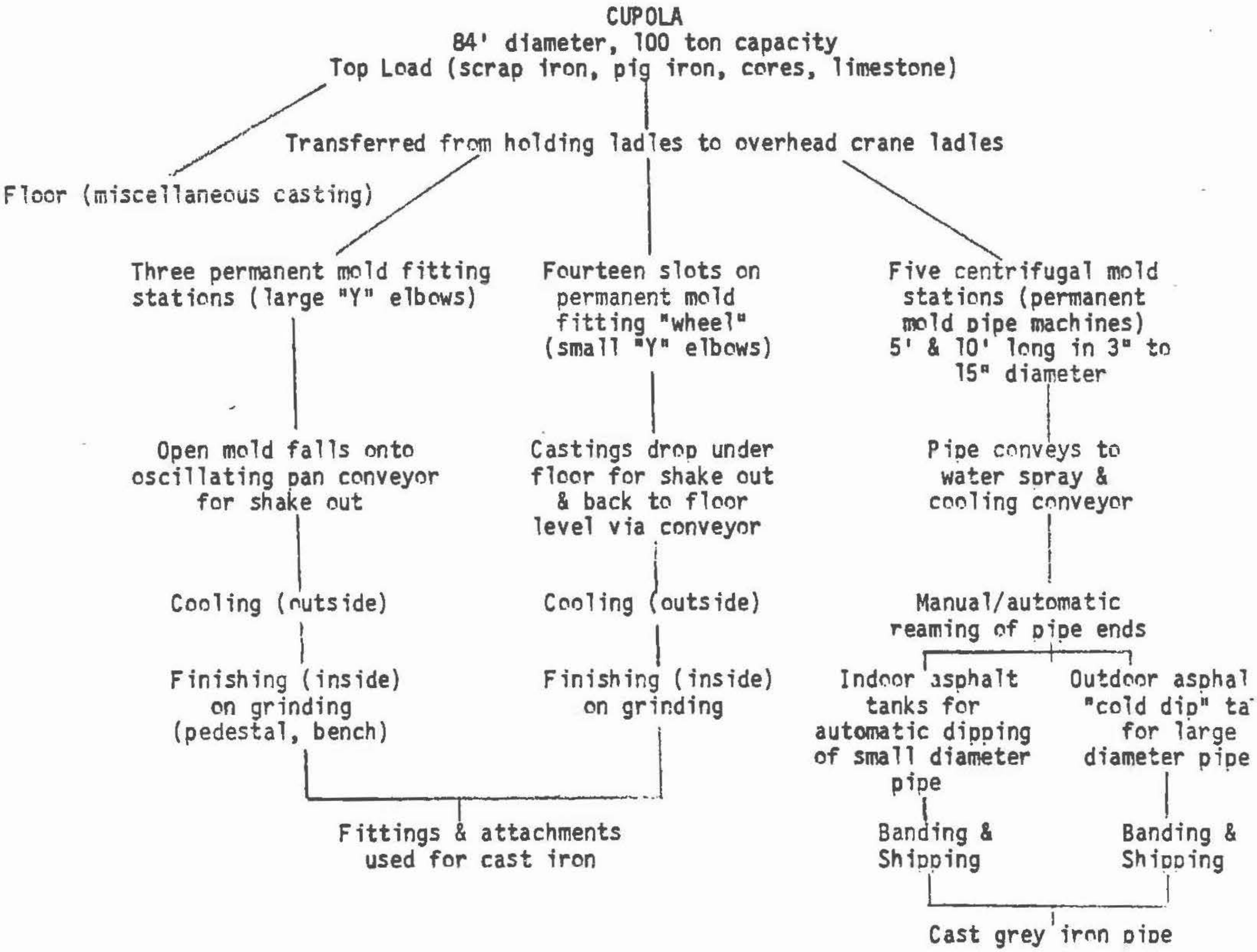


Figure 2

FLOW DIAGRAM OF FOUNDRY PROCESSES, EAST PENN FOUNDRY, MACUNGIE, PA

HE 82-302

Mulling and Core-Making

Sand Mulling for Shell and Hub Cores
(Silica Sand + Phenol-Formaldehyde +
Wax + Hexamethylenetetramine)

Resin-Coated Sand Goes to
Four Hub Core Machines &
Six Shell Core Machines

Used in Permanent Casting
Machines to Create Openings
& Various Shaped Cavities in the Castings
(e.g., Bell-Shaped on Pipe End)

MIXING OF PARTING SLURRY

Mixing of Ground Silica Sand,
Olivine Sand, Water, & Soap

To Spray Tanks & Sprayed onto
Interior of Molds on Centrifugal Casting Machines

* NOTE: Parting agent is currently a non-silica refractory, accounting for low free silica exposures in the foundry, but until 1982 the parting agent was comprised of silica flour.

Appendix A

RESULTS OF PREVIOUS INDUSTRIAL HYGIENE EVALUATIONS
EAST PENN FOUNDRY
MACUNGIE, PENNSYLVANIA

HE 82-302

Date	Agency	Area	Respirable "Dust" Concentration (Mg/M3)*	Respirable "Free Silica" Concentration (ug/M3)**
4/20/77	Bolt, Beranek & Newman Consultants Cambridge, MA	Grinder	1.06	86+
		10' Pipe Core Setter	2.81	1505+
		Spray Mix	1.26	500+
		Large Muller	1.48	74+
		Casting Operation (5' Pipe)	0.87	130+
		Core Setter (10' Pipe)	2.83	1516+
		Area Between Silica Box	1.10	99+
		Area Between Cast Pipe	0.70	28
		Grinder	5.60	454+
5/14/80	OSHA-Allentown Area Office	#2-10 Small Diameter	0.98	461+
		Pipe Machine (Coresetter) Iron Pourer	0.91	80+
		#2-10' Wall Diameter (Grinder Southside)	2.05	185+
		Grinder	0.26	13
6/ 6/80	OSHA-Allentown Area Office	Finishing Department (Grinder Stat. #5)	1.19	144+
		Grinder Stat. #3	0.84	126+
		10' Large Diameter Pipe Long Line (Grinder Northside)	1.05	288+
		(Grinder-Southside)	0.95	192+
		10' Large Diameter Pipe Machine (Coresetter)	0.82	148+
		Phenol-Formaldehyde Resin Sand Muller, #1-10' Small Diameter Pipe Machine	0.79	38
		(Coresetter)	1.06	300+
		Floor Molder (Wall Area)	1.65	166+
		Roto Blast Operator	1.42	461+
		Permanent Machine (Gate Clearer)	1.23	44
		Throughout Foundry	0.47	44

+ Indicates that NIOSH-recommended exposure limit (50 ug/M3) is exceeded.

Appendix A (continued)

RESULTS OF PREVIOUS INDUSTRIAL HYGIENE EVALUATIONS
EAST PENN FOUNDRY
MACUNGIE, PENNSYLVANIA

HE 82-302

Date	Agency	Area	Respirable "Dust" Concentration (Mg/M^3)*	Respirable "Free Silica" Concentration (ug/M^3)**
3/18/81	Joseph A. Guimond & Associates, Inc.	Gate Cleaner on PM for "Wheel"	1.22	24
	Sellersville, PA	Pick-Off Man on Shaker Conveyor (PMF Wheel)	2.19	22
******				
5/14/82	Joseph A. Guimond & Associates, Inc.	PMF Wheel	1.63	33
	Sellersville, PA	Core Setter 5' Small Diameter Line	2.26	23
		Area Sample & Core Setter 5' Small Diameter Line	1.07	43
		Area Sample Between 5' & 10' Small Diameter	1.56	47
		Line Grinding Grinder - 10' Small Diameter Line (Northside)	1.41	14
		Grinder - 10' Small Diameter Line (Southside)	1.24	99+
		Area Sample & Coresetter - 10' Small Diameter Line	0.39	27
		(Eastside)	0.67	27
		Area Near Blow-Off for 10' Small Diameter Line	1.39	42
		Coresetter/Grinder 10' Large diameter Line	1.45	44
		Pourer/grinder 10' Large Diameter Line	3.54	35
		Grinding - 10' Large Diameter Line	0.53	37

****

+ Indicates that NIOSH-recommended exposure limit (50 ug/M^3) is exceeded.

Appendix A (continued)

RESULTS OF PREVIOUS INDUSTRIAL HYGIENE EVALUATIONS
EAST PENN FOUNDRY
MACUNGIE, PENNSYLVANIA

HE 82-302

Date	Agency	Area	Respirable "Dust" Concentration (Mg/M^3)*	Respirable "Free Silica" Concentration (ug/M^3)**
8/ 5/82	Joseph A. Guimond & Associates, Inc. Sellersville, PA	Coresetter 5' Small Diameter Pipe Line	1.23	49
		Area Sample & Coresetter 5' Small Diameter Pipe Line	2.63	53+
		Area Sample & Iron Pour - 5' Small Diameter Pipe Line	2.18	22
		Area Sample & Core Setter #1 (West Side) - 10' Small Diameter Pipe Line	0.61	24
		Coresetter #2 (East Side) - 10" Small Diameter Pipe Line	1.10	77+
		Area Sample & Coresetter #2 (East Side) - 10' Small Diameter Pipe Line	1.10	77+
		Iron Pourer #2 (East Side) - 10' Small Diameter Pipe Line	0.25	13
		Pedestal Grinder Station #1	1.23	86+
		Area Sample & Grinding Behind Station #1	0.98	39
		Area Sample & Station #3 (on exhaust duct)	0.74	37
		Pedestal Grinder Station #5	1.10	66+

****

* Milligrams per cubic meter; time-weighted average based on 8-hour day exposure.

** Micrograms per cubic meter; time-weighted average based on 8-hour day exposure.

\+ Indicates that NIOSH-recommended exposure limit (50 ug/M^3) is exceeded.

Appendix A (continued)

RESULTS OF PREVIOUS INDUSTRIAL HYGIENE EVALUATIONS
EAST PENN FOUNDRY
MACUNGIE, PENNSYLVANIA

HE 82-302

Date	Agency	Area	Respirable "Dust" Concentration (Mg/M^3)*	Respirable "Free Silica" Concentration (ug/M^3)**
2/28/84	Joseph A. Guimond & Associates, Inc.	Core Sand Muller Operator	1.12	36.76
		Area @ Core Sand Muller Control Panel	1.12	36.76
		#1 Operator @ 10 Ft. Small Diameter Line	1.12	36.76
		Area #1 @ 10 Ft. Diameter Line	0.98	12.25
		#2 Operator @ 10 Ft. Small Diameter Line	1.22	12.25
		#2 Area @ 10 Ft. Small Diameter Line	1.26	12.25

****

* Milligrams per cubic meter; time-weighted average based on 8-hour day exposure.

** Micrograms per cubic meter; time-weighted average based on 8-hour day exposure.

\+ Indicates that NIOSH-recommended exposure limit (50 ug/M^3) is exceeded.

APPENDIX B

Name____
Last First Initial Telephone

Address____________________________Age____ Height____ Weight____ Sex M F

Occupation_________________________Place of Employment__________________

Physician's Name and Address____

Pulmonary Function Test (yes___ no___) (qualified___ did not qualify___)

1. Have you been referred by your physician? yes___ no___
2. Do you cough daily more than three months out of the year? yes___ no___
3. Do you bring up phlegm every morning? yes___ no___
   If yes; for how many year______________
4. Do you ever get short of breath when you walk? yes___ no___
5. How far can you walk on level surfaces without stopping?(in blocks)
   1___2___3___more___
6. Can you walk up a flight of stairs without stopping? yes___ no___
   2 flights? yes___ no___
7. Do you smoke? yes___ no___ cigarettes___ cigars___ pipe___
   Have you ever smoked? yes___ no___
   How old were you when you started to smoke? ________
   How old were you when you stopped? _________
   How many packs a day do you smoke now?__________
   How many packs a day did you average through the years?__________
   (multiply: the average of packs per day x number of years)
8. Do you have lung trouble of any type? yes___ no___
   What is the diagnosis?__________________
   Are you being treated for this condition?_______________
9. Do you have heart trouble? yes___ no___ If yes:
   explain_________________
10. Have you ever had pneumonia? yes___ no___
    If yes: (a) how often___________ (b) when was the last
    time______________
11. Have you ever had pleurisy? yes___ no___
    If yes: (a) how often___________ (b) when was the last
    time______________
12. Did you ever have tuberculosis? yes___ no___
    when_______________________

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226