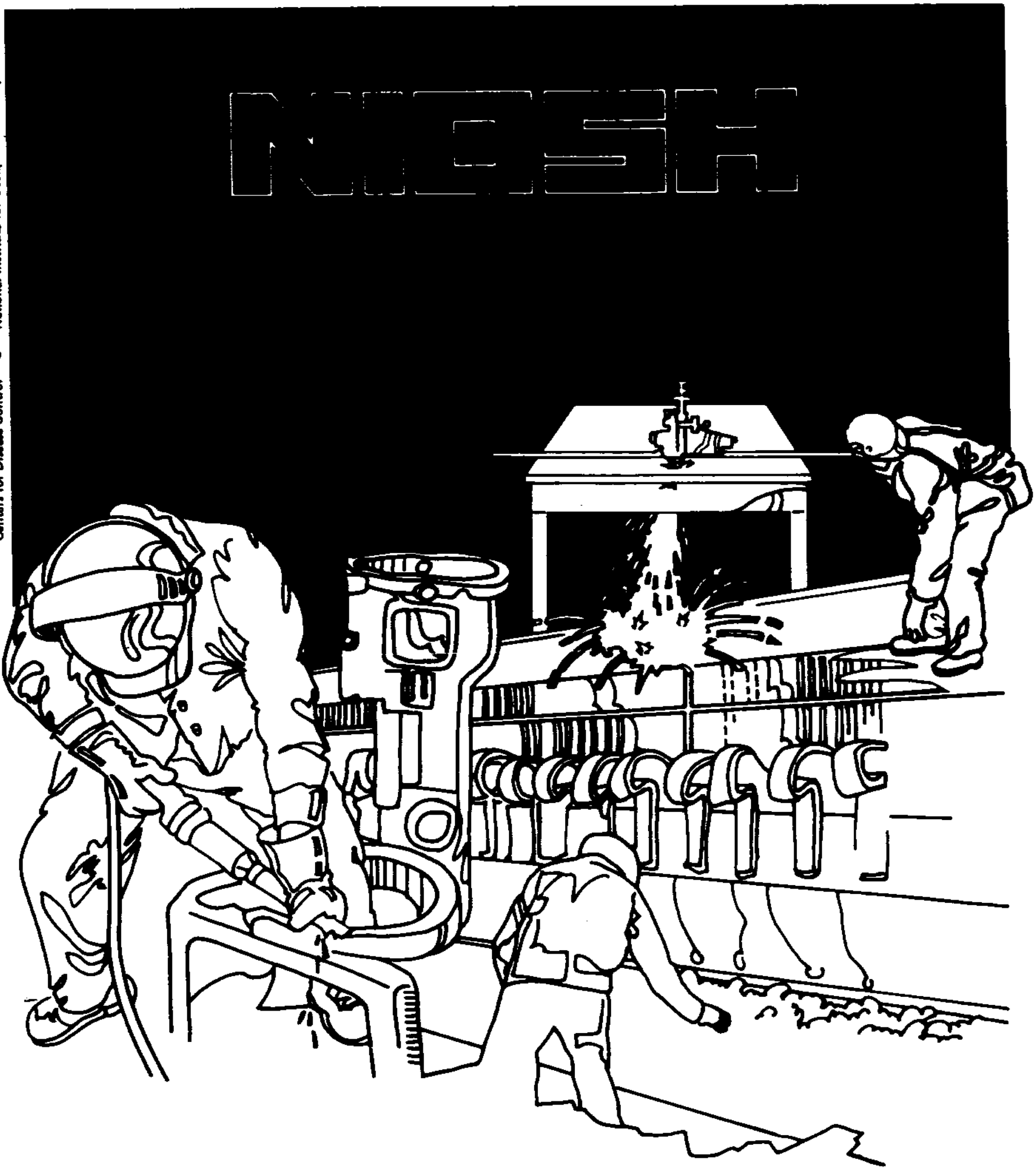
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 86-284-1914
H.B. SMITH COMPANY, INC.
WESTFIELD, MASSACHUSETTS

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 86-284-1914
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H.B. SMITH COMPANY, INC.
WESTFIELD, MASSACHUSETTS

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I. SUMMARY

In April, 1986 the National Institute for Occupational Safety and Health (NIOSH) received a request from the Molders and Allied Workers Union, Local 95, to evaluate employee exposures to chemicals used in the foundry operations at H.B. Smith Company, Inc., Westfield, Massachusetts. The request concerned employees' reported symptoms of breathing difficulties throughout the foundry.

Between August 31 and September 3, 1987 environmental monitoring was done using both personal breathing-zone and area air samples to characterize workers' exposure to chemicals in the foundry. Employee medical records were reviewed and private employee interviews conducted to determine the scope of employee medical complaints. Results of X-rays on 47 foundry workers with a duration of employment greater than 7 years had previously been interpreted by a NIOSH certified B-reader.

Environmental sampling revealed the following airborne concentration ranges which are compared to their respective environmental exposure criteria (EC). Dimethylethylamine (DMEA): 0.9 - 10.4 mg/m^3 (EC-6 mg/m^3-NIOSH Alert), petroleum distillates: 19.4 - 32.3 mg/m^3 (EC-2,000 mg/m^3-OSHA), respirable free silica: ND - 0.54 mg/m^3 (EC-0.05 mg/m^3-NIOSH), carbon monoxide: 0.3 - 95 ppm (EC-35 ppm - NIOSH), naphthalene: ND - 0.2 mg/m^3 (EC-50 mg/m^3-OSHA). No detectable airborne concentrations of acrolein were found.

Medical interviews revealed few respiratory complaints. The results of the 1986 pulmonary function testing revealed no apparent trends suggestive of either obstructive or restrictive lung disease. Interpretation of X-rays by the B-reader revealed no abnormalities suggestive of pneumoconiosis. However, because of the long time required for such diseases to manifest, such symptoms would likely not be detected in a cross sectional study. Furthermore, radiographic changes occur comparatively late in the course of disease and the absence of X-ray evidence does not imply a limited worker risk. The relationship between the exposures and diseases has been well established in the medical literature, and it should be emphasized that the medical surveillance program should not be a replacement for adherence to strict industrial hygiene standards and good work practices.

Based on the results of this investigation, NIOSH investigators determined that health hazards exist due to employee overexposure to respirable free silica, DMEA and carbon monoxide. Recommendations are found in Section VIII of this report to reduce employee exposures in the foundry.

KEYWORDS: Sic: 3565 (Industrial Patterns: Foundry Cores), 3321 (Grey Iron Foundries), coremakers, core machines, dimethylethylamine, DMEA, Isocure, no-bake binders, silica, carbon monoxide.

II. INTRODUCTION

In April, 1986 the National Institute for Occupational Safety and Health (NIOSH) received a request from the Molders and Allied Workers Union, Local 95, to evaluate employee exposures to chemicals used in the foundry operations at H.B. Smith Company, Inc., Westfield, Massachusetts. The request concerned employees' reported symptoms of breathing difficulties throughout the foundry.

Initial contact with company officials was made on September 22, 1986, at which time it was learned that the policy of the company is to require a warrant in order to gain entry. On August 31, 1987, NIOSH investigators obtained a warrant to conduct an investigation; presented a copy of the warrant to company officials; held an opening conference with management and employee representatives; conducted an initial walkthrough of the plant; and began environmental monitoring and medical records review. Between August 31 and September 3, 1987, NIOSH investigators conducted an environmental and medical survey.

On September 24, 1987 a letter summarizing the environmental/medical activities conducted during the survey was distributed to plant management and union representatives. An interim report was distributed in February, 1988.

III. BACKGROUND

The H.B. Smith Company, Inc., which has been operational since 1853, employs approximately 400 workers in the manufacture of cast iron boilers. Of this number, approximately 200 work in the foundry, 60 in the machine shop and 140 in sales and administrative support. The number of workers has been fairly constant since the addition of second shift production in 1984. Prior to that time all production was limited to the day shift. Work hours are staggered so that melters and molders arrive for work before pourers, shake-out and knock-out workers. Production hours are normally 6:30 AM to 12:30 AM, five days per week. However, mechanical breakdowns may cause interruptions in work schedules. At the time of this survey the average length of seniority for first shift workers was 11.1 years, and for second shift workers, 2.1 years.

A. Coremaking

Coremaking operations run on both shifts, five to seven days per week depending upon production schedules. During the NIOSH survey, each shift employed 1 core machine operator and 2 helpers (core finishers). Laborers were used to haul cores to the core storage area. Three additional workers make small cores by hand in a separate building. A total of 11 workers are assigned to coremaking.

Eighty-five percent of the cores are made using the Isocure (TM) sand binder system (phenolic urethane gas-cured no-bake) and the remaining cores are produced either by the Pep-Set (TM) (phenolic urethane liquid cured no-bake) or, as in the hand made cores, a bake system. The Ashland Isocure (TM) binder process used in the coreroom consists of three parts:

Part I, a liquid phenolic resin (phenol-formaldehyde resin with organic solvents), designated as Isocure (TM) 308;

Part II, a liquid diisocyanate (methylene bisphenyl isocyanate (MDI) with solvents), designated as Isocure (TM) 606; and

Part III, an amine gas catalyst (dimethylethylamine (DMEA)) designated as Isocure (TM) 702.

Above the core machine, accessed via a catwalk, the phenolic resin and isocyanate components are added to, and mixed in approximately equal amounts (1-1.5% each by weight of the total sand mix) with silica sand in a screw muller, which also transports the mixture to the core machine. Resin and isocyanate are stored in tanks outside the coreroom. The core sand is pneumatically fed to the muller from an outside storage silo. Mixed sand from the muller is transported to a hopper above the vertical press-type core machine and is pneumatically forced into the corebox.

Once in the metallic corebox mold, the sand mixture is gassed with DMEA under pressure. When the amine gas contacts the binder coated sand it produces an instantaneous curing or hardening at room temperature, thus eliminating the need for the cores to be "baked". Liquid DMEA is stored outside the coreroom and is converted to gas (using nitrogen as a carrier) in generators attached to the core machine.

After the solidified cores are automatically removed from the corebox, they are manually placed on pallets for finishing and storage. After each core is removed, a solvent based release agent is automatically sprayed into the corebox to prevent the sand from sticking to the corebox mold. Core helpers (finishers) work adjacent to the core machine installing plugs and filing away irregularities.

From the coreroom, the finished cores, which are solid reproductions of the hollow spaces desired within the finished casting, are transported to the core storage room where they continue to cure for two to three days.

B. Mold making

Green-sand molds are used at this foundry for pouring castings. Large molds are formed around a pattern using sand slings which deposit the mold-sand in the mold area. Smaller molds are made using a "squeeze-jolt" machine which continually bounces (creating a jolt) to compact the sand in the mold. There are three sand slings and two squeeze-jolt machines in the foundry. Each machine requires an operator (molder) and at least one laborer.

Mold sand is "conditioned" by the addition of sea coal, wood flour, corn flour, and clay for moldability. Mold sand is also reused after re-conditioning.

Molds are made in two halves. The bottom half is placed on a conveyor and the core is inserted into the shaped mold. The top half is placed over the bottom half and secured in place. The finished molds are the manually pushed along the conveyor to the pouring station.

C. Casting

The casting of metal boiler sections involves the melting and pouring of the iron metal. There is one melter assigned to each shift, along with four laborers for charging the cupola (outside) and at least two pourers and one crane operator (inside).

The coal fired cupola is charged by the addition of coke, pig iron, foundry scrap iron, purchased scrap iron and limestone. The charging crew works outside and manually transports materials in wheelbarrows.

After the metal is melted in the cupola, it is tapped into a holding ladle. When a sufficient number of molds have arrived at the pouring station, the pourers tranfer the molten metal from the holding ladle to the pouring ladle. The pouring ladle is transported by overhead crane to the pouring station where the molten metal is poured into the molds. Any left-over metal or metal that has cooled beyond the optimum pouring temperature is poured into pig boxes and allowed to solidify. This metal will be reused in the charging process at a later time.

After pouring, the molds are allowed to cool and are transported to the shake-out area where the casting will be removed from the mold.

D. Shake-out

There are three shake-out machines in the foundry: one at the end of each line (see Figure 1). The lines are numbered 2, 3, and 4. The shake-out operation involves the removal of the top half of the mold by crane, placing it on a vibrating metal platform which vibrates the sand from the mold, and then placing it back on the conveyor for transport back to the molding area. The operation is repeated for the bottom half of the mold. What is left is the metal casting on the shake-out platform. The casting is transported by crane to another conveyor to proceed to the sand blast area where the castings are automatically sandblasted using black beauty to remove any debris. Two employees operate the automatic sand blasting machine.

Line 4 requires two workers to attach the molds to the crane hooks, one crane operator, and one worker on the platform of the shake-out machine. This line produces the largest castings.

Line 3 shake-out is performed by one worker using a hand operated crane. This line produces the smaller castings.

Line 2 shake-out is usually a two man operation: the operator and a laborer. This line produces various sized castings.

E. Knockout

The knockout operation is where the core sand is removed from inside the casting. Six employees work in this area each shift. The operation consists of vibrating the castings either using contact vibrators which are attached to the casting, or by placing the casting on a vibrating surface. The castings are positioned by the operator so their openings face downward and the core sand empties through the opening.

Once the castings leave the foundry area they are transported to the machine shop where various drilling, threading and grinding operations take place prior to assembly.

IV. EVALUATION DESIGN AND METHODS

Between August 31 and September 3, 1987 environmental monitoring was conducted on all foundry operations to characterize employee exposures to various chemicals. In addition, during this time employee medical records were reviewed and private employee interviews were conducted to determine the extent of employee medical problems.

Personal Protective Equipment

All employees in the foundry wore safety shoes, hard hats and safety glasses. Pourers wore additional fire retardant clothing (coats and gloves) and full face shields. Molders, shakeout and knockout workers wore single use, disposable, paper dust masks (3M-8710).

Environmental

The environmental evaluation used both personal breathing-zone and area air samples to characterize workers' exposures to chemicals in the foundry. The sampling and analytical methodologies for the substances sampled, including collection media, flow rate and referenced analytical procedures, are presented in the following Table.

Substance	Collection Device	Flow Rate	Analysis	Reference
Dimethylethylamine (DMEA) (modified)	Silica Gel Tube	.05-.2 LPM	GC-N-P detector	NIOSH P&CAM 221
Petroleum Distillates	Charcoal Tube	.05 LPM	GC-FID	NIOSH 1550
Acrolein	ORBO 23 Tube	.05 LPM	GC-FID	NIOSH 2501
Carbon monoxide	Detector Tubes	.02 LPM	Direct Read	
Coal Tar Pitch Volatiles (Benzene soluble)	37mm Teflon Filter +XAD-2 Tube	1.7 LPM	GC-FID, Gravimetric	NIOSH 5515 NIOSH 5023
Silica (crystalline)	Tared PVC Filter	1.7 LPM	X-Ray Dif	NIOSH 7500
Metals	MCEF (AA) Filter	1.7 LPM	ICP	NIOSH 7300
Beryllium	Bulk	N/A	Atomic Absorption	EPA 7090

GC-FID = Gas Chromatography with Flame Ionizing Detector
ICP = Inductively Coupled Plasma emission spectrometer
GC-N-P = Gas Chromatography with Nitrogen-Phosphorus Detector

Core Making

Employee exposure to DMEA was evaluated during the core making operation. Eight (8) personal breathing-zone air samples and four (4) stationary long term area air samples were collected for DMEA analysis. Personal samples were collected on the core machine operator and both helpers to determine their exposure to DMEA while working near the core machine. Area samples were collected in the core storage room to determine the potential for exposure to DMEA for workers who frequent this area.

Four (4) personal breathing-zone air samples were collected during the Pep Set (TM) production of pig boxes for determination of employee exposure to petroleum distillates. However, two of these samples (912330, 912327) were not indicative of employee exposure, as the operation experienced a break down before it got started, and the samples were removed when it became apparent that the operation would not take place on that shift.

Molding

Employee exposure to crystalline silica was evaluated on all three lines and during the mold making operation and also at the muller station where mold sand is mixed. Ten (10) full shift, personal breathing-zone air samples and one (1) bulk sample of the mold sand were collected to determine the silica exposures in the molding areas of the foundry. Seven of the ten personal samples were collected for respirable silica, and three for total dust containing silica.

Melting/Pouring

The melting and pouring operation was evaluated to determine employee exposure to carbon monoxide, acrolein, coal tar pitch volatiles (benzene soluble fraction (CTPV)), DMEA and metal fume. Ten (10) full shift, personal breathing-zone air samples were collected to determine carbon monoxide exposure levels of melters, pourers, and crane operators. Additional instantaneous carbon monoxide readings were obtained in the areas between molding lines 3 and 4 during pouring operations.

Three (3) each, stationary long term area air samples were collected to determine potential exposures to acrolein and CTPV. The area samples were positioned: in the overhead crane, in the area of line 3 and in the area of line 4. In addition, one (1) each, stationary area sample was positioned in the overhead crane to determine the presence of DMEA and metal fume.

Shakeout, Knockout and Sandblast

Employee exposure to crystalline silica was evaluated in the shakeout, knockout and sandblast areas of the foundry. Seven (7) full shift, personal breathing-zone air samples were collected to determine employee exposure to silica during shakeout. Seven (7) full shift, personal breathing-zone air samples were collected to determine employee exposure to respirable free silica during knockout. Four (4) full shift, personal breathing-zone air samples were collected to determine employee exposure to respirable free silica during sandblasting. In addition, a bulk sample of the "black beauty" used for sandblasting was obtained for beryllium analysis.

Medical

Personal interviews were conducted with foundry workers and OSHA 200 logs and current employee medical records were reviewed. NIOSH requested the results of chest X-rays on 47 foundry workers with a duration of employment greater than 7 years. The company had these x-rays taken in October 1987 and had the films interpreted by a NIOSH-certified B-reader using the standard international system for describing pneumocoiosis.[17]

V. EVALUATION 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 of workers may experience adverse health effects because of individual susceptibility, a pre-existing medical condition and/or by 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 considered for this study were: 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) federal 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 exposure limits, 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 standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8-10 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.

Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless gas, slightly lighter than air. It is produced in the presence of incomplete combustion of carbon-containing compounds, such as in the sand binder system. The combination of incomplete combustion and inadequate venting often results in overexposure.[1,2]

The danger of this gas derives from its affinity for the hemoglobin (Hb) of red blood cells, which is 300 times that of oxygen. The hazard of exposure to CO is compounded by the insidiousness with which high concentrations of CO-Hb can be attained without marked symptoms. Intermittent exposures are not cumulative in effect and, in general, symptoms occur more acutely with higher concentrations of CO.[3] The myocardium is more sensitive than any other muscle tissue to the decreased amount of available oxygen in blood, as is caused by exposure to CO. Not surprisingly, therefore, there is substantial evidence of an association between exposure to CO and disturbances of the cardiovascular system,[4] including some limited evidence of an increased risk of myocardial infarction among persons living in environments with high CO levels.[5]

The OSHA standard, as well as the ACGIH TLV, for CO is 50 ppm, averaged over an 8-hour workshift.[6] NIOSH recommends an 8-hour TWA exposure limit of 35 ppm, with a ceiling level of 200 ppm.[7]

Crystalline Silica

The crystalline forms of silica can cause severe tissue damage when inhaled. Silicosis is a form of pulmonary fibrosis caused by the deposition of fine particles of crystalline silica in the lungs. Symptoms usually develop insidiously, with cough, shortness of breath, chest pain, weakness, wheezing, and nonspecific chest illnesses. Silicosis usually occurs after years of exposure, but may appear in a shorter time if exposure concentrations are very high. This latter form is referred to as rapidly-developing silicosis, and its etiology and pathology are not as well understood. Silicosis is usually diagnosed through chest x-rays, occupational exposure histories, and pulmonary function tests. The manner in which silica affects pulmonary tissue is not fully understood, and theories have been proposed based on the physical shape of the crystals, their solubility, toxicity to macrophages in the lungs, or their crystalline structure. There is evidence that cristobalite and tridymite, which have a different crystalline form from that of quartz, have a greater capacity to produce silicosis.[8]

NIOSH, in its recommendion for a free silica standard, has proposed that exposures to all forms of respirable free crystalline silica be controlled so that no worker is exposed to airborne concentrations greater than 0.05 mg/m^3, averaged over a 10-hour working day, 40-hour work week. This recommendation was designed to protect workers from silicosis. 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 contained in the NIOSH criteria document, "Occupational Exposure to Crystalline Silica".[8]

The current federal OSHA PEL[6] for respirable free silica exposure is an 8-hour time-weighted average based upon the 1968 ACGIH TLV formula of 10 mg/m^3 divided by the sum of the percent SiO_2 and 2 (for quartz). One-half this amount was established as the limit for cristobalite and tridymite. As can be seen from this calculation, the OSHA regulation is based on the percentage of free silica contained in the respirable particulate exposure, whereas the NIOSH REL applies directly to the airborne concentration of respirable free silica.

Dimethylethylamine (DMEA)

Dimethylethylamine is a clear, colorless, volatile liquid with a high vapor pressure of 414 mm Hg at 68°F (20°C), and a suffocating ammonia-like odor.[9,10] This tertiary aliphatic amine is an extremely flammable liquid that has a flashpoint of -36°C. It is soluble in water and many organic solvents.

Exposure to vapors of volatile aliphatic amines may produce irritation of the mucous membranes of the nose and throat, and lung irritation with cough and respiratory distress.[11] Many studies have shown that exposure to amines may induce bronchial asthma.[12,13] Some aliphatic amines may cause the liberation of histamine, and histamine can bring about a decrease in blood pressure, tachycardia (rapid heartrate), itching, erythema (reddening of the skin), urticaria (hives) and facial edema (swelling).[11] Specifically, exposure to DMEA vapor can cause dizziness, weakness, fatigue, headache and nausea.[14] These systemic symptoms (those affecting the body generally, due to exposure via the lungs or skin, or from ingestion, followed by absorption and a toxic effect of the chemical) may be related to the pharmacologic action of the amines. Skin contact with DMEA can result in irritation, burns and dermatitis.[14] The ethyleneamines have been shown to cause cutaneous sensitization.[11]

Although there are no occupational exposure standards for exposure to DMEA, NIOSH has recently published an Alert (dated December, 1987, a copy of which was included with the Interim Report) pertaining to DMEA exposure. The conclusions of the NIOSH Alert indicate that vision disturbances and systemic effects (e.g., faintness, chest and abdominal pain, headache, nausea and increased heart rate) have occurred in workers exposed to DMEA at an 8-hour TWA concentration of 6 mg/m^3 (2 ppm) or greater.

Acrolein

Acrolein is a severe eye and respiratory system irritant. The principal site of chemical effects is the mucous membranes of the upper respiratory tract. Acrolein is toxic by all routes of administration. It has not been shown to be carcinogenic or embryotoxic. It is the major contributor to the irritant properties of cigarette smoke.[15] The OSHA PEL for acrolein is a TWA of 0.25 mg/m^3 (0.1 ppm).[6] The ACGIH TLV of 0.25 mg/m^3 (0.1 ppm) is considered sufficiently low to minimize, but not entirely prevent, irritation among all exposed individuals.[16]

VI. RESULTS

Environmental

Results of the environmental sampling, tabulated at the end of this report, are summarized in the following paragraphs. The calculated OSHA permissible exposure limit (PEL) for silica is included in the tables since they are based on the percent of crystalline free silica in each sample.

Core Making

Of the three core machine operators sampled, two were exposed to DMEA at concentrations above 6 mg/m^3 (which NIOSH considers to be the level at which adverse health effects become evidenced). The operators TWA exposures ranged from 1.1 - 10.4 mg/m^3.

The DMEA exposures for the four core machine helpers ranged from TWA's of 1.2 - 7.7 mg/m^3, with only one employee's exposure exceeding the Alert level.

The four area samples in the core storage area indicated DMEA concentrations of between 0.9 and 4.4 mg/m^3, with the highest level occurring amid the day-old cores in storage.

The Pep Set (TM) production of pig boxes exposed employees to 19.4 and 32.3 mg/m^3 of petroleum distillates. The OSHA permissible exposure level (PEL) is 2,000 mg/m^3.

Mold Making

Of the seven respirable dust personal samples collected in the mold making department, five employee's exposures exceeded the NIOSH Recommended Exposure Limit (REL) of .05 mg/m^3 respirable free silica, although only two employee's exposures exceeded the OSHA PEL for silica (Unit 2 molder and muller operator).

Three of three total dust personal samples collected in the mold making area exceeded the OSHA PEL for employee exposure to total dust containing silica (6.17, 6.21 and 3.28 mg/m^3).

Melting/Pouring

Results of carbon monoxide sampling in the melting and pouring areas indicated that two of the three crane operators sampled had exposures that exceeded the NIOSH REL of 35 ppm (14, 48 and 95 ppm). One of the three exposures exceeded the OSHA PEL of 50 ppm.

Four of the five iron pourers sampled had exposures that exceeded the NIOSH REL for carbon monoxide, with three of those four above the OSHA standard. (0.3, 46, 55, 56, and 64 ppm)

One of the two melters sampled had an exposure which exceeded both the NIOSH REL and the OSHA PEL for carbon monoxide exposure. (20 and 56 ppm).

Acrolein and DMEA were not detected on any of the area samples in the pouring area. Metal fumes (aluminum, iron, magnesium, calcium, manganese and zinc) were detected in the crane area but at levels well within applicable exposure criteria.

Coal tar pitch volatiles were detected on two of the three area samples in the pouring area (.25 and .18 mg/m^3). However, 95% of the total sample was identified as naphthalene, which has an OSHA PEL of 50 mg/m^3.

Shakeout

Silica results in the shakeout area indicate that five of the seven workers sampled were exposed in excess of the NIOSH REL (.05 mg/m^3), although only two were exposed to levels greater than the OSHA PEL. The concentration of respirable free silica ranged from none detected (N.D.) to .11 mg/m^3.

Sandblast

All four sandblast workers' exposures exceeded both the NIOSH REL and the OSHA PEL for silica. Respirable free silica ranged from .09 to .31 mg/m^3.

The bulk sample of the "black beauty" used in sandblasting was found to contain 4.5 ppm beryllium by weight.

Knockout

Seven of seven knockout workers had exposures in excess of both the NIOSH REL and the OSHA PEL for silica. Respirable free silica ranged from .08 to .54 mg/m^3.

Medical

There was no evidence of silicotic lung disease among current foundry workers with a duration of employment greater than 7 years indicated on the 42 DHHS reporting forms. No cases of silicosis were detected by the review of company medical records or employee interviews. This finding must be viewed with caution. First, only current employees were included in the study. Records of former workers, retirees, disabled workers, transferred workers, and deceased workers were not examined. Secondly, the relatively high turnover rate among employees may be responsible for the short average duration of employment. Since several studies suggest that the time required for foundry workers to show evidence of silicosis is approximately 20 years, this study may not reflect the true risk of lung disease in the foundry workforce at the H.B. Smith Co. Furthermore, radiographic changes occur comparatively late in the course of disease and the absence of X-ray evidence does not imply a limited worker risk. The relationship between the exposures and diseases has been well established in the medical literature, and it should be emphasized that the medical surveillance program should not be a replacement for adherence to strict industrial hygiene standards and good work practices.

VII. CONCLUSIONS

Based on the results of this investigation, NIOSH investigators determined that health hazards exist due to employee overexposure to respirable free silica, DMEA and carbon monoxide.

VIII. RECOMMENDATIONS

1. Based on the results of the environmental sampling, it is recommended that a mandatory personal protective equipment policy be established immediately which requires the use of certified respirators in all areas of the foundry.

    A. Respirators suitable for protection against silica should be used in the mold making, shakeout, sandblast, knockout and muller areas.

    B. Full-face respirators with organic vapor cartridges should be worn by core machine operators.

2. It is recommended that administrative controls be implemented immediately to reduce melters', crane operators' and pourers' exposure to carbon monoxide. A plan to limit the amount of time these workers spend in the area should be developed and implemented.

3. It is recommended that engineering controls such as local exhaust ventilation, down draft molding platforms, isolation of areas so that one area does not contaminate another, etc. be thoroughly investigated as a means to reduce employee exposure to silica.

4. It is recommended that engineering controls also be investigated to reduce carbon monoxide exposures in the foundry. One possibility might be to enclose the overhead crane cab and provide positive pressure fresh air ventilation to the cab.

5. It is recommended that a thorough evaluation of the local exhaust system for the core machine be conducted to assure that the capture velocities are adequate and there are no leaks in the system.

6. The present system of pre-employment medical examinations should be continued.

7. Periodic medical examinations of foundry workers should include:

   A. Chest X-rays to be performed every three years and interpreted by a NIOSH certified B-reader and results reported using the standard international system for describing pneumoconiosis. More frequent radiographs should be done as clinically indicated.

   B. Yearly pulmonary function tests, which would include FEV1, FVC and FEV1/FVC ratio. These tests should be interpreted by a physician competent in the diagnosis of lung disease.

8. Since cigarette smoking increases the risk of development of lung disease, employees should be warned of this potential.

9. Emphasis and development of the current occupational health and safety program should be continued. Staff development and training in the areas of occupational health and safety should be encouraged.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. H.B. Smith Company, Inc.
2. International Molders and Allied Workers Union
3. OSHA, Region I

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 - DIMETHYLETHYLAMINE
H.B. SMITH CORE MAKING

TYPE	JOB DESCRIPTION	SAMPLE NUMBER	TIME (MIN)	VOLUME (LITERS)	ANALYTE	RESULT (MG/M^3)	TWA
P	CORE HELPER	911314	320	36.8	DMEA	11.7	10.4
P	CORE HELPER	911314B	206	23.7	DMEA	8.4	
P	CORE HELPER	911329	317	63.4	DMEA	1.7	
P	CORE HELPER	911329B	209	41.8	DMEA	1.9	1.8
P	CORE HELPER	922317	325	16.3	DMEA	1.2	
P	CORE OPERATOR	922301	325	17.9	DMEA	1.1	
P	CORE OPERATOR	911321	327	71.9	DMEA	8.5	7.7
P	CORE OPERATOR	911321B	211	46.4	DMEA	6.5	
A	CORE CONF STAIR	931327	458	22.9	DMEA	0.9	
A	CORE STORAGE	911301	465	81.4	DMEA	0.6	
A	CORE STORAGE	911317	463	57.9	DMEA	0.5	
A	CORE-DAY OLD	931321	460	27.6	DMEA	4.3	

P = PERSONAL SAMPLE, A = AREA SAMPLE
NIOSH ALERT SUGGESTS 6 MG/M^3 AS CAUTION LEVEL FOR DMEA

TABLE 2 - PETROLEUM DISTILLATES
H.B. SMITH PEP SET

TYPE	JOB DESCRIPTION	SAMPLE NUMBER	TIME (MIN)	VOLUME (LITERS)	ANALYTE	RESULT (MG/M^3)
P	PEP SET	921314	310	15.5	CT OV	32.3
P	PEP SET	921329	310	15.5	CT OV	19.4
P	PEP SET OP	912330	210	12.6	SG OV	N.D.
P	PEP SET HELP	912327	210	12.6	SG OV	N.D.

P = PERSONAL SAMPLE, CT OV = CHARCOAL TUBE SAMPLE, SG OV = SILICA GEL SAMPLE
OSHA PEL FOR PETROLEUM DISTILLATES IS 200 MG/M^3

TABLE 3 - ACROLEIN
H.B. SMITH POURING

TYPE	JOB DESCRIPTION	SAMPLE NUMBER	TIME (MIN)	VOLUME (LITERS)	ANALYTE	RESULT (MG/M^3)
A	LINE 4	921315	476	23.8	ACROLEIN	N.D.
A	CRANE - POUR	922322	475	28.5	ACROLEIN	N.D.
A	LINE 3	912322	168	10.1	ACROLEIN	N.D.

A = AREA SAMPLE, N.D.= NONE DETECTED

TABLE 4 - CARBON MONOXIDE
H.B. SMITH POURING

TYPE	JOB DESCRIPTION	SAMPLE NUMBER	TIME (MIN)	VOLUME (LITERS)	ANALYTE	RESULT (PPM)
P	CRANE OPERATOR	931L28	250	5.0	CO	95.0
P	CRANE OPERATOR	912L5	182	3.6	CO	13.7
P	CRANE OPERATOR	922L4	313	6.3	CO	47.9
P	IRON POURER	931L4	310	6.2	CO	64.5
P	IRON POURER	921L5	487	9.7	CO	56.5
P	IRON POURER	931L5	435	8.7	CO	55.2
P	IRON POURER	921L4	460	9.2	CO	46.2
P	IRON POURER	921L4	180	3.6	CO	0.3
P	MELTER	921L28	487	9.7	CO	56.5
P	MELTER	912L28	183	3.7	CO	20.5
A	BETWEEN #3-#4	POUR	DIRECT	READ	CO	100.0
A	LINE 2	POUR	DIRECT	READ	CO	30.0

P = PERSONAL SAMPLE, A = AREA SAMPLE
NIOSH RECOMMENDED EXPOSURE LIMIT FOR CARBON MONOXIDE IS 35 PPM
OSHA PEL FOR CARBON MONOXIDE IS 50 PPM

TABLE 5 - NAPHTHALENE
H.B. SMITH POURING

TYPE	JOB DESCRIPTION	SAMPLE NUMBER	TIME (MIN)	VOLUME (LITERS)	ANALYTE	RESULT (MG/M^3)
A	CRANE - POUR	ZF1664	475	807.5	CTPV	0.2.
A	LINE 3	ZF1663	485	824.5	CTPV	0.2.
A	CRANE LINE 4	ZF1659	466	792.2	CTPV	N.D.

A = AREA SAMPLE, N.D.= NONE DETECTED
ANALYSIS FOR COAL TAR PITCH VOLATILES (CTPV) REVEALED ONLY NAPHTHALENE
OSHA PEL FOR NAPHTHALENE IS 50 MG/M^3

TABLE 6 - SILICA
H.B. SMITH SHAKEOUT

TYPE	JOB DESCRIPTION	SAMPLE NUMBER	TIME (MIN)	VOLUME (LITERS)	% SIO2	TWA RESULT (MG/M^3)	CALCULATED OSHA STD (MG/M^3)	QUARTZ (MG/M^3)
P	SHAKEOUT	F53	477	810.9	4.3	1.42	1.58	0.06
P	SHAKEOUT	F45	475	807.5	9.5	1.18	0.87	0.11
P	SHAKEOUT	F49	478	812.6	8.5	1.16	0.95	0.10
P	SHAKEOUT	F43	165	280.5	13.3	0.53	0.65	0.07
P	SHAKEOUT	F40	167	283.9	0.0	0.53	5.00	0.00
P	SHAKEOUT	F54	470	799.0	2.7	0.93	2.13	0.03
P	SHAKEOUT	F52	467	793.9	5.6	0.91	1.32	0.05

P = PERSONAL SAMPLE
NIOSH CRITERIA FOR RESPIRABLE FREE SILICA (QUARTZ) IS 0.5 MG/M^3

TABLE 7 - SILICA
H.B. SMITH SANDBLAST

TYPE	JOB DESCRIPTION	SAMPLE NUMBER	TIME (MIN)	VOLUME (LITERS)	% SIO2	TWA RESULT (MG/M^3)	CALCULATED OSHA STD (MG/M^3)	QUARTZ (MG/M^3)
P	PIT CONVEYOR	FW9874	442	751.4	10.0	0.85	0.77	0.09
P	SANDBLAST	FW9847	422	717.4	15.4	1.99	0.58	0.31
P	END BLAST LINE	FW9877	453	770.1	17.2	0.83	0.52	0.14
P	LWR SCRATCH RM	FW9859	455	773.5	10.0	0.78	0.83	0.08
P	SANDBLAST OP	FW9861	450	765.0	15.3	0.77	0.58	0.12
P	BLAST POKEOUT	FW9867	450	765.0	15.9	0.58	0.56	0.09
B	BLACK BEAUTY	ALSO CONTAINED 4.5 PPM BY WEIGHT BERYLLIUM						

P = PERSONAL SAMPLE, B = BULK SAMPLE
NIOSH CRITERIA FOR RESPIRABLE FREE SILICA (QUARTZ) IS 0.5 MG/M^3

TABLE 8 - SILICA
H.B. SMITH MOLD MAKING

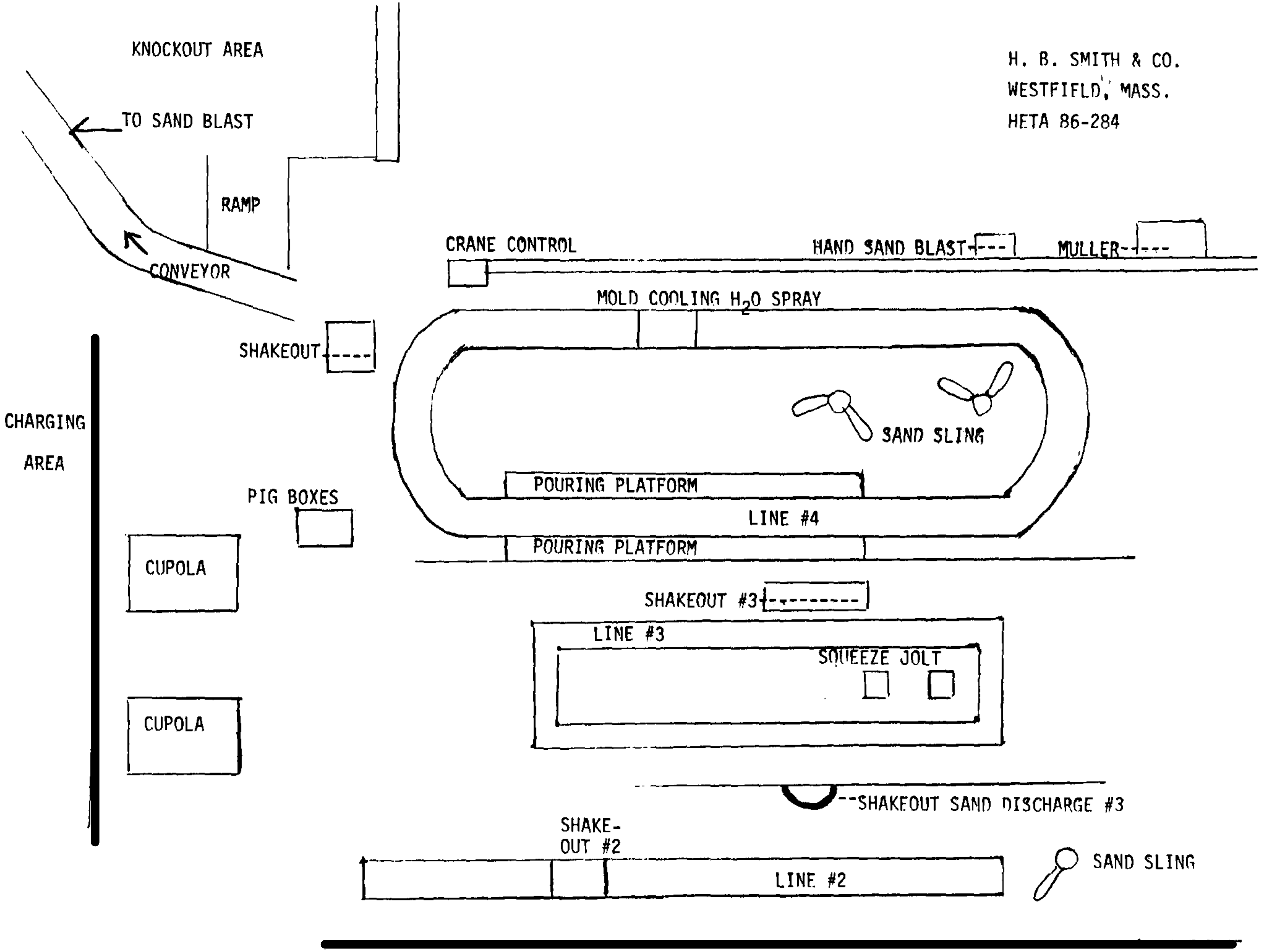
TYPE	JOB DESCRIPTION	SAMPLE NUMBER	TIME (MIN)	VOLUME (LITERS)	% SIO2	TWA RESULT (MG/M^3)	CALCULATED OSHA STD (MG/M^3)	QUARTZ (MG/M^3)
P	MULLER	FW9868	429	729.3	3.4	2.43	1.86	0.08
P	MULLER	FW9855	427	725.9	3.7	1.50	1.76	0.06
P	MOLDER LINE 2	F46	465	790.5	10.3	0.86	0.81	0.09
P	MOLDER - RING	F51	465	790.5	0.0	0.33	5.00	0.00
P	MOLDER LINE 3	F39	169	287.3	66.7	0.10	0.15	0.07
P	LABORER - RING	F44	486	826.2	5.6	0.65	1.32	0.04
P	SQUEEZE JOLT	F50	488	829.6	12.3	0.69	0.70	0.08
P*	LABORER	F48	484	822.8	5.7	6.17	1.30	
P*	MOLDER	F25	486	826.2	7.2	6.21	1.09	
P*	MOLDER LINE 2	F47	445	756.5	14.9	3.28	0.59	

P = PERSONAL SAMPLE, P* = TOTAL DUST SAMPLE
NIOSH CRITERIA FOR RESPIRABLE FREE SILICA (QUARTZ) IS 0.5 MG/M^3

TABLE 9 - SILICA
H.B. SMITH KNOCKOUT

TYPE	JOB DESCRIPTION	SAMPLE NUMBER	TIME (MIN)	VOLUME (LITERS)	% SIO2	TWA RESULT (MG/M^3)	CALCULATED OSHA STD (MG/M^3)	QUARTZ (MG/M^3)
P	KNOCKOUT	FW9871	435	739.5	20.0	2.70	0.45	0.54
P	KNOCKOUT	F56	472	802.4	13.7	0.64	0.64	0.09
P	KNOCKOUT	FW9850	375	637.5	19.0	1.98	0.48	0.38
P	KNOCKOUT	FW9876	455	773.5	16.4	1.89	0.54	0.31
P	KNOCKOUT	F41	191	324.7	15.7	1.57	0.57	0.25
P	KNOCKOUT	FW9865	455	773.5	12.6	1.12	0.68	0.14
P	KNOCKOUT	F42	187	317.9	14.8	0.85	0.59	0.13
B	CORE SAND				94.0			

P = PERSONAL SAMPLE, B = BULK SAMPLE
NIOSH CRITERIA FOR RESPIRABLE FREE SILICA (QUARTZ) IS 0.5 MG/M^3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PIG BOXES
POURING PLATFORM
LINE #4
POURING PLATFORM
CUPOLA
SHAKEOUT #3
LINE #3
SQUEEZE JOLT
CUPOLA
SHAKEOUT SAND DISCHARGE #3
SHAKE-OUT #2
LINE #2
SAND SLING