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Abrasive Blasters
Parma and Akron, Ohio

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PREFACE

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Rita Washko, M.D., and Joe Cocalis, P.E., CIH, of the Respiratory Disease Hazard Evaluations and Technical Assistance Program, Division of Respiratory Disease Studies (DRDS), Clinical Investigations Branch. Desktop publishing by Pamela Hixon.

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Health Hazard Evaluation Report 95-0225-2596
Abrasive Blasters
Parma and Akron, Ohio
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SUMMARY

On April 7, 1995, the National Institute for Occupational Safety and Health (NIOSH) received a technical assistance request from the Ohio Department of Health (ODH) to conduct medical screening of Cleveland area workers involved in or around abrasive blasting activities. This request was a follow-up to an ODH investigation of a worksite where an employee who worked as an abrasive blaster had died with accelerated silicosis in 1992. The investigation identified overexposures to crystalline silica and deficiencies in the respiratory protection program. The purpose of the screening is to determine if additional silicosis and/or work practices that may result in silicosis are occurring in the Cleveland area. Given the fact that abrasive blasting may also result in exposure to lead, ODH requested in July 1995 that NIOSH expand the scope of the technical assistance to include blood-lead screening.

NIOSH investigators conducted medical screening from August 7-11, 1995, in Parma, Ohio, and from August 21-25, 1995, in Akron, Ohio. Screening consisted of a work history and medical questionnaire, chest x-ray, and blood lead test. A total of 170 were screened, including workers whose primary occupations were abrasive blasters, painters, tapers (drywall finishers), general laborers, and foremen.

Results from the two sites were combined for the purpose of analysis and reporting. All of the 170 participants from both sites had chest x-rays, and 96 (56%) participated in blood-lead screening. Eight (5%) of the 170 participants had chest x-rays that were classified as being consistent with pneumoconiosis (dust disease of the lungs). All eight had worked as abrasive blasters. Only one of these eight had previously known that his chest x-ray was consistent with this diagnosis. None of the participants had blood lead levels (BLL) that exceeded the limits or action levels specified in the Occupational Safety and Health Administration (OSHA) standard for lead in construction. The median BLL was 5 micrograms per deciliter (µg/dl) with a range of 2-30 µg/dl.

Questionnaire results indicated deficiencies in knowledge of proper use of respirators (e.g., only 1/3 were fit tested and 18% had facial hair that may interfere with respirator seal) and of NIOSH recommendations to prevent silicosis (e.g., use of silica substitute abrasives).

This medical screening of workers from the Cleveland area who were exposed to abrasive blasting found that 8 (5%) of 170 participants had chest x-rays consistent with pneumoconiosis. All eight had worked as abrasive blasters. The questionnaire results indicate a need for better training and education in the proper use of respiratory protection and in silicosis prevention among workers engaged in or around abrasive blasting operations.

Keywords: SIC (Painting and Paper Hanging, 1721; Structural Steel Erection, 1791) Silica, Crystalline silica, Pneumoconiosis, Silicosis, Respirable Quartz, Sandblasting, Construction, Lead, Abrasive Blasting, Respirator, Steel-Plate Fabrication, Painting Contractor, Abrasive Blasting Contractor.

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INTRODUCTION

In April 1995, the Ohio Department of Health (ODH) requested that the National Institute for Occupational Safety and Health (NIOSH) provide technical assistance in screening Cleveland area workers involved in or around abrasive blasting operations to determine if silicosis, or conditions conducive to the development of silicosis, were present among these workers or worksites, respectively. Since abrasive blasting of lead-containing paints may result in overexposures to lead, ODH requested in July 1995 that blood lead testing be included in the evaluation.

In July 1995, ODH and NIOSH representatives met with representatives of the Occupational Safety and Health Administration (OSHA), Cleveland Area Office to discuss the project. At the meeting, OSHA agreed to support the screening effort by distributing literature on reducing exposures to silica and lead and by providing information to workers on-site during the screening activities.

Participants were recruited from the membership rosters of the International Brotherhood of Painters (IBP) union, through the ODH, and through media advertisements. NIOSH investigators conducted medical screening from August 7-11, 1995, in Parma, Ohio, and from August 21-25, 1995, in Akron, Ohio. Screening consisted of a work history and medical questionnaire, chest x-rays, and blood lead tests. All study participants received written notification of their individual chest x-ray results and BLLs.

BACKGROUND

In January 1992, ODH received a physician's report of the death of a 55 year-old worker with accelerated silicosis and associated *Mycobacterium kansasii* infection. The man was a Cleveland-area abrasive blaster (sandblaster) with 10 years of sandblasting experience. On March 4, 1992, NIOSH, at the request of ODH, conducted a health hazard evaluation at the worksite and found overexposures to crystalline silica and deficiencies in the respiratory protection program [NIOSH 1992a].

In April 1995, ODH asked NIOSH for assistance in screening workers from the Cleveland area who are involved in abrasive blasting operations. In addition to workers who perform the abrasive blasting, those who work in the immediate vicinity of such activities may be at risk of the same exposures. Typically, workers who perform abrasive blasting and related duties also work as painters, tapers (drywall finishers), and pot tenders (abrasive blasters' helper); unionized workers from these groups belong to the IBP. Given this, participants in this study included those with job titles of painters, pot tenders, and tapers in addition to those who were designated as abrasive blasters.

METHODS

Study Objectives

The primary objectives of this study were to identify workers with silicosis and to identify those with elevated blood lead levels. Additional goals of the study were to provide an assessment of the workers' knowledge of proper use of respiratory protection and of appropriate industrial hygiene practices for the prevention of exposures to lead and silica.

Study Population

Participants were recruited from the membership rosters of the IBP by letter followed up by telephone contact, directly through the ODH (from referrals through the sentinel event notification or SENSOR program), and through media advertisements. Any unionized or non-unionized worker in the Cleveland/Akron, Ohio, area who was/is exposed to abrasive blasting operations was encouraged to participate. The invitations to participate included workers who were currently working as abrasive blasters or around abrasive blasting operations, those who previously had such exposures, and those who were retired, disabled, or currently unemployed.

Data Collection

Questionnaire

Trained NIOSH interviewers asked participants about their occupational histories and selected medical information (Attachment 1). Occupational questions focused on work practices and knowledge of hazards associated with silica and lead. Participants were also asked about the current availability and use of respirators. Displays of the various types of respirators were used to aid in the identification of respirator type(s) used. Those who responded that they used a particular respirator were asked if fit-testing had been performed. Interviewers were instructed to record whether or not the participant had interfering facial hair (facial hair that lies along the sealing area of a respirator). Questions pertaining to the types of and cumulative exposure to materials used as abrasive blasting agents were also asked.

Participants were asked if their current employer 1) informed them of the health hazards of silica dust and lead; 2) provided training regarding use of respirators; and 3) provided shower facilities.

Medical questions focused on respiratory illnesses, company medical monitoring practices, and use of tobacco products. Current smokers were defined as those who currently smoke cigarettes; persons who smoked five or more packs of cigarettes during their entire life, but who were not currently smoking cigarettes, were defined as ex-smokers.

Chest X-rays

A single-view, posteroanterior (PA) chest x-ray was taken by NIOSH on a full-size (14 x 17 inch) film. X-rays were reviewed on-site by the attending NIOSH medical officer to determine if immediate notifications of findings were necessary. Clinical readings were subsequently performed at NIOSH by a pulmonary specialist and any urgent notifications were made as appropriate. These notifications consisted of an immediate telephone call to the participant followed by written notification.

X-rays were then sent for independent readings by two NIOSH-certified B Readers (physicians trained and certified in the classification of chest x-rays for pneumoconioses) who, without knowledge of the participant's age, occupation, or smoking history, classified the films according to the current international classification system for pneumoconiosis [ILO 1980]. The International Labor Organization (ILO) classification method is used for epidemiological research, for the surveillance of workers in dusty occupations, and for clinical purposes. This method recognizes two major categories of parenchymal (lung tissue) opacity size, small and large [Morgan 1986].

The profusion (i.e., number) of small opacities denotes the relative number of opacities per unit area of lung and is recorded using a graduated 12-point scale within four major categories (0,1,2,3) [Wagner et al. 1993]. A major profusion category of 0 indicates no apparent abnormality, while 3 indicates severe abnormality. Film classification is achieved by comparing the subject film with the appearance of ILO "standard films" which define small opacity profusion. In classifying small opacity profusion, the final determination of major category is listed first. If a higher or lower major category has also been seriously considered, this category is also listed after a slash mark. If there is no question as to major category, the two listed numbers are identical [ILO 1980; Morgan 1986]. Thus, the small opacity profusion scale is as follows: 0/-, 0/0, 0/1,1/0, 1/1,1/2, 2/1, 2/2, 2/3, 3/2, 3/3, 3/+.

A chest x-ray was defined as consistent with pneumoconiosis if both of the B Readers classified small opacity profusion as 1/0 or greater or, in the case of three readings, if the median profusion was 1/0 or greater. In the event of disagreement between the two readers on small opacity profusion (i.e., a disagreement on major category determination), the film was sent to a third B Reader who independently classified the chest x-ray and the median of the three readings was accepted as the final result.

Size and shape of the small opacities are also classified, both being differentiated using the letters of the alphabet. Two letters are used to record size (in millimeters, mm) and shape, the first listed letter indicating the predominant type of small opacity [ILO 1980; Morgan 1986]. Classification conforms to the following scheme:

Shape	Size		
	Up to 1.5 mm	1.5-3.0 mm	3-10 mm
Round	p	q	r
Irregular	s	t	u

Large opacities are >1 cm in size and are designated as A, B, or C opacities. Category A is specified as an opacity >1 cm but <5 cm, or several opacities >1 cm whose combined diameters are <5 cm; Category B is one or more opacities >5 cm whose combined area is less than the equivalent area of the right upper lung zone; and Category C is one or more opacities whose combined area is greater than the equivalent area of the right upper lung zone [ILO 1980; Morgan 1986].

Blood Lead Levels

Blood for lead analysis was obtained by venipuncture using aseptic technique and was stored on ice. The contract medical laboratory, which is CDC licensed for blood lead testing, provided transport of specimens to their facility for analysis. Blood lead concentrations were measured in micrograms of lead per deciliter of blood (µg/dl).

EVALUATION CRITERIA

Evaluation Criteria

Questionnaire -- Respiratory Protection

Responses to questions about respirator use and availability were used to evaluate the worker's knowledge and the adequacy of respiratory protection programs. Evaluation was based on the NIOSH Respirator Decision Logic [NIOSH 1987] and OSHA regulations.[29 CFR 1926.103].

Blood Lead

Interpretation of blood lead levels and concomitant actions taken vary according to the purpose for collecting the data. For example, surveillance case definitions of elevated blood lead levels may differ from those established by the regulatory agency in charge of monitoring blood lead levels.

Under the OSHA standard regulating lead exposure in construction, the permissible exposure limit (PEL) is 0.05 milligrams per cubic meter (mg/m^3) as an 8-hour time-weighted average (TWA) [29 CFR 1926.62]. Employers covered by the construction standard are required to determine if any employee may be exposed to lead at or above the action level of 0.03 mg/m^3 as an 8-hour TWA. Medical surveillance is required for employees exposed to airborne lead at levels at or above the action level. This includes monitoring of an employee's blood lead and zinc protoporphyrin levels at least every 2 months for the first 6 months in the exposed job and every 6 months thereafter. The employer is required to notify each employee in writing of his or her blood level within 5 working days after the receipt of biological monitoring results.

OSHA recommended actions based on blood lead levels are as follows:

Blood lead level	Action
< 40 µg/dl	retest in 6 months
40-50 µg/dl	retest every 2 months until two consecutive tests show blood lead < 40 µg/dl
> 50 µg/dl	retest within 2 weeks; if confirmatory test result is > 50 µg/dl, medical removal mandated

The employer is required to remove employees with confirmed blood lead levels above 50 µg/dl from work having an exposure to lead at or above the 0.03 mg/m^3 action level. Such employees may return to their former job status when two consecutive blood lead levels are at or below 40 µg/dl.

The OSHA standard also lists certain lead-related tasks/operations in which there is presumed overexposure to lead and for which appropriate protective measures are required until exposure assessment indicates that there is no overexposure. For abrasive blasting on steel structures where lead-containing coatings or paint are present, the employer must treat the employee as if the employee were exposed to lead in excess of 2,500 µg/m^3 of air unless exposure assessment demonstrates lower exposure levels [29 CFR 1926.62].

NIOSH's Adult Blood Lead Epidemiology and Surveillance program (ABLES) monitors elevated blood lead levels among adults in the United States for the purpose of documenting occupational trends of work-related lead exposures [CDC 1992; CDC 1996]. The surveillance case definition used for this program defines an elevated BLL as 25 µg/dl or greater. Also, in recognition of the health risks associated with exposure to lead, a goal for reducing occupational exposure was specified in *Healthy People 2000,* a recent statement of national consensus and U.S. Public Health Service policy for health promotion and disease prevention. The goal for workers exposed to lead is to eliminate, by the year 2000, all exposures that result in blood lead levels greater than 25 µg/dl [DHHS 1990].

Given the above information, participants with blood lead levels that were elevated according to OSHA's construction standard were to have had the appropriate action taken as specified above. Those with blood lead levels 25 µg/dl or greater, but who did not meet OSHA's definition of an elevated level, were informed in writing of an "elevated" BLL and were given suggestions regarding ways of reducing exposures to lead. Additionally, they were advised to follow-up with their personal physicians.

Previous NIOSH work concerning workers performing abrasive blasting removal of lead-based paint had demonstrated that a comprehensive worker protection program, including engineering controls, good work practices, worker training, personal protective equipment, personal hygiene facilities and practices, and medical surveillance is technically feasible and protective to workers in the construction industry [NIOSH 1992b].

Silica

NIOSH recommends an exposure limit for respirable crystalline silica of 0.05 mg/m^3, expressed as a time-weighted average (TWA) [NIOSH 1974]. The OSHA TWA permissible exposure limit (PEL) for crystalline silica (as respirable quartz) in general, maritime, and construction industries is 0.1 mg/m^3 [OSHA Memorandum for Regional Administrators, Special Emphasis Program (SEP) for SILICOSIS; Appendix Establishing a Permissible Exposure Limit for Construction and Maritime, April 5, 1996]. The ACGIH TWA 1995-1996 TLV for crystalline silica is 0.1 mg/m^3 (as respirable quartz) [ACGIH 1995].

The use of sand for abrasive blasting typically results in the fracturing of the sand into fine particles which become airborne. This freshly fractured crystalline

Toxicology

Silica

silica appears to be more fibrogenic than aged silica[Vallyathan et al. 1988]. When workers inhale the crystalline silica, the lung tissue reacts by developing fibrotic nodules and scarring around the trapped silica particles. This fibrotic condition of the lung is called silicosis.

Workers can develop three types of silicosis, acute, accelerated, or chronic silicosis, depending on the airborne concentration of, and the duration of exposure to, crystalline silica. Chronic silicosis typically occurs after many years (usually 10 or more) of relatively low exposure to silica, but may occur in an accelerated fashion with exposure to higher concentrations of silica as soon as 5 years after the initial exposure. Acute silicosis, which is caused by exposure to very high concentrations of crystalline silica, develops as soon as a few weeks after the initial exposure [Parkes 1982]. Accelerated and chronic silicosis manifest as scarring of the lung tissue as a result of a fibrogenic reaction to the inhaled silica particles, which deposit in the alveoli. The scarring can limit the ability of the lungs to transfer oxygen and can decrease lung volumes. Acute silicosis, which occurs when the lung is overwhelmed by exposure to silica, is associated with fluid accumulation in the lungs as a reaction to the inhaled silica dust. Death from acute silicosis commonly occurs within months and is associated with very little of the scarring that is typical of the more chronic forms.

Abrasive blasters who use sand are at risk of developing acute or accelerated silicosis because they are potentially exposed to very high concentrations of freshly fractured silica dust [NIOSH 1992c; Vallyathan et al. 1988]. Silicosis victims who are/become infected with *M. tuberculosis* are at high risk of developing active tuberculosis (TB) [Bailey et al. 1974]. This is believed to be due to the reduced ability of silica-filled macrophages to kill organisms [Allison and Hart 1968]. Fungal infections may also complicate silicosis and, like TB, can be fatal [Bailey et al. 1974].

Because of the risk of silicosis associated with abrasive blasting in which sand is used (i.e., sandblasting), and the difficulty in controlling the exposure, the use of crystalline silica for blast cleaning operations was restricted in Great Britain in 1950 [Factories Act 1948], and in other European countries in 1966. In 1974, NIOSH recommended that silica sand (or other substances containing >1% free silica) be prohibited as an abrasive blasting material [NIOSH 1974]. Evidence now indicates that crystalline silica is a potential occupational carcinogen [DHHS 1991; IARC 1987; NIOSH 1988].

Lead

Inhalation (breathing) of lead-contaminated dust or fumes and ingestion (swallowing) of lead-contaminated mucus or lead from hand-to-mouth contact with lead-contaminated objects are the major routes of worker exposure to lead. The latter route of contamination can occur when a worker has been exposed to lead and then smokes or eats without previously washing his/her hands and face. Once absorbed, lead accumulates in the soft tissues and bones, with the highest accumulation initially in the liver and kidneys [NIOSH 1981]. Lead is stored in the bones for decades and may cause toxic effects as it is slowly released over time. This is particularly true for persons with a large body burden of lead. For those with lower body burdens of lead, an increased rate of release due to stresses such as disease, injury, or pregnancy is a potential problem. Overexposure to lead results in damage to the kidneys, gastrointestinal tract, peripheral and central nervous systems, and the blood-forming organs (bone marrow). The frequency and severity of symptoms associated with lead exposure increase with increasing blood lead levels. Health effects of lead intoxication include weakness, excessive tiredness, constipation, anorexia, abdominal pain, anemia, high blood pressure, irritability or anxiety, fine tremors, pigmentation of the gums ("lead line"), and weakness of the extensor muscle groups ("wrist drop" or "foot drop") [Hernberg et al. 1988;

Landrigan et al. 1985; Proctor et al. 1988].

Overt symptoms of lead poisoning in adults generally begin at blood lead levels above 60 µg/dl, but a number of studies have found neurological symptoms in workers with blood lead levels of 40 to 60 µg/dl. The World Health Organization has recommended an upper limit of 40 µg/dl for occupationally exposed adult males [WHO 1980]. For 1995-1996, ACGIH has adopted a biological exposure index (BEI) of 30 µg/dl for blood lead. These occupational exposure criteria, while providing guidelines for the evaluation of potential health hazards, are not protective for all the known health effects of lead.

RESULTS

Questionnaire

Occupational

A total of 170 persons participated in screening activities. One hundred twenty two (72%) were currently employed and 48 (28%) were unemployed (includes those who were retired or disabled). Of the 122 current workers, 11 (9%) performed blasting only, 13 (11%) were pot tenders, and 23 (19%) performed both blasting and pot tending duties. Thus, 47 (39%) of those currently employed were performing blasting, pot tending, or both duties at the time of this screening. Most of the 170 participants were male (166 or 98%), Caucasian (160 or 94%), and Non-Hispanic (166 or 98%). The median age was 48 years (range 24 to 78 years). Forty-nine (29%) participants did not complete a high school education. The prevalence of current smoking was 37%; 42% were ex-smokers.

Participants were asked about their usual job title during their working life. One hundred six (62%) were painters, 22 (13%) were tapers, and 14 (8%) performed abrasive blasting (referred to as "blasting" in remainder of report). The remaining 28 (16%) stated that their usual job title was general laborer or foreman. When asked if they had **ever** performed blasting during their working life, 80 (47%) responded that they had. The median number of years that this group had performed blasting duties was 11 (range 1 to 45 years). Actual blasting time was estimated to be more than 40 hours per week by 12 (15%), 21 to 40 hours weekly by 50 (63%), 10 to 20 hours weekly by 11 (14%), and less than 10 hours weekly by 7 (9%) of these 80 participants. Thirty-four (43%) of those who ever blasted were currently blasting.

Participants were also asked if they had ever been employed as a pot tender or worked around an abrasive blasting operation; 96 (56%) responded that they had. The median number of years that this group had worked around abrasive blasting was eight; 80 (83%) had worked around an abrasive blasting operation for at least 21 hours per week. Thirty-six (38%) of these 96 were currently working around an abrasive blasting operation.

Respirators -- Current Workers

Among the 122 who were **currently employed**, 112 (92%) used one or more respirators at their job. Eighty-five (76%) of these 112 used a replaceable-cartridge air-purifying respirator, 84 (75%) used a dust mask, 29 (26%) used an air-supplied hood without a tight-fitting face seal, 16 (14%) used an air-supplied hood with a tight-fitting face seal, 3 (3%) used a powered air-purifying respirator, and 2 (2%) used both an air-supplied hood without a tight-fitting face seal with an replaceable cartridge air-purifying respirator (these two respirators were used at the same time). NIOSH interviewers noted that 20 (18%) of these 112 workers who used a respirator at their current job had facial hair in the face-to-respirator seal area.

Respirators -- Current Blasters, Pot Tenders, and Workers Performing Both Blasting and Pot Tending

Forty-seven (39%) of the 122 participants who were **currently employed** were performing **blasting, pot tending, or both** duties. Two (4%) of these 47 stated that respirators were not required at their current jobs; one worked as a pot tender, one as a blaster and pot tender. All except one employer provided respirators for these 47 workers. Forty-three (92%) of these workers used a respirator while performing their duties. Among the four who did not use a respirator, two worked as pot tenders and two as blasters. All except 5 (12%) of these 43 used more than one type of respirator. The most frequently worn respirator type was the replaceable cartridge air-purifying respirator; 37 (86%) of 43 current blasters, pot tenders, or both used this respirator. Less than one-third (12/37, 32%) of this group was fit-tested for this respirator. Table 1 presents information pertaining to types of respirators worn by these current blasters, pot tenders, or workers who performed both duties.

Among 34 workers directly involved in blasting activities (blasters only and those who were both blasters and pot tenders), 23 (68%) used a dust mask. Six (26%) of these 23 used a dust mask while operating blasting equipment, 12 (52%) used this mask when working around blasters, and an ever greater proportion (17/23, 74%) used a dust mask when cleaning up.

Characteristics of Exposures

All participants were asked about the type of abrasives used in blasting operations "in which you have been directly involved." Among 113 who had **ever** blasted and/or pot tended, 108 (96%) had used silica sand, 62 (55%) had used coal slag, and 39 (35%) had used steel shot. The average years that these materials were used was 10, 5, and 4 years for silica sand, coal slag, and steel shot, respectively. When asked which material they had used most often in their working lifetime, 62 (83%) of 75 workers who responded to this question stated they most often used silica sand, 8 (11%) used coal slag, 4 (5%) used an other material, and 1 (1%) used steel shot.

Participants who were **currently** working as blasters and/or pot tenders were also asked about their use of abrasives in blasting operations. Among these 47, 45 (96%) had used silica sand, 31 (66%) had used coal slag, and 21 (45%) had used steel shot. The average years that these materials were used was 12, 5, and 5 years for silica sand, coal slag, and steel shot respectively. Silica sand was the most-often used abrasive among these workers; among 34 responding, 29 (85%) used this material most often. Three (9%) and 2 (6%) of these 34 stated that coal slag and an "other" material, respectively were the most often used abrasives. Table 2 presents information pertaining to use of abrasive materials by those who "ever" were blasters, pot tenders, or both, and those who were current blasters, pot tenders, or both.

Current blasters were asked if they ever blast in a booth, other enclosure (such as a bridge), or a tank. Among the 34 current blasters, 22 (65%) reported blasting in a tank, 19 (56%) reported blasting in an enclosure, and 7 (21%) reported blasting in a booth.

Other Occupational Exposures

Occupational exposures other than those related to abrasive blasting and pot tending were explored. Thirty (18%) of the 170 participants had worked in "other" construction, 19 (11%) had worked in a foundry, and 12 (7%) had worked on road construction. The average years worked at these occupations were 16, 4, and 5 years for those who worked in "other" construction, in a foundry, or on road construction, respectively. These data are presented in Table 3.

Employer-Provided Training

Only those who were currently working were asked about employer-provided training. Sixty-six (54%) of 122 current workers were informed of the health hazards of lead and 61 (50%) were informed of the health hazards of sand or silica dust by their employers. Sixty (49%) stated that their current employer had given them training regarding use of a respirator.

Medical

History of Respiratory Illness

Questions about respiratory diseases were asked, but patient-reported information was not confirmed by physician report or medical record review. One participant reported being diagnosed with silicosis at the age of 52 years. None reported a history of tuberculosis. Because of difficulties in patient interpretation of personal medical information, these data could not be further analyzed.

Personal Activities

Current workers were asked about personal activities that may affect their exposures to lead. Fifty-six (46%) stated that they use tobacco products at work; only 14 (25%) washed their hands before using tobacco products at work. Almost half (58, or 48%) ate their lunches in the work area; 46 (38%) ate in a non-working area designated for eating and drinking only; 13 (11%) ate away from the worksite; 2 (2%) ate in their personal vehicles at the worksite; 2 (2%) ate at "other" places; and 1 (1%) did not respond. Eighty-nine percent (108) of the workers stated that they washed their hands before they ate meals at work.

Employer-Provided Testing

Three-fourths (128) of all participants responded that they have had a chest x-ray at sometime in their life. When asked if, in the past five years, any of their employers had provided them with a chest x-ray, 28 (16%) said yes, 137 (81%) said no, and 1 (<1%) did not know; 3 (2%) were not employed during the past five years. One person did not respond to this question.

Only 22 (13%) of all participants responded that, within the past five years, an employer had provided them with a blood lead test. Participants were also asked if they had ever been told that they had an abnormal blood lead test; four said yes.

Chest x-rays

Eight (5%) of 170 participants had chest x-rays that were classified as being consistent with pneumoconiosis. All eight were major profusion category 1. All were male and had a median age of 63 years (range 41 to 71 years). Two (25%) of the eight were current smokers and three (38%) were ex-smokers. Only one of these eight had known that his chest x-ray was consistent with pneumoconiosis. None of the participants, including these eight who had chest x-rays that were consistent with pneumoconiosis, had large opacities.

Pertinent characteristics of these eight workers are presented in Table 4. All eight had performed blasting during their working lifetime; half were currently employed but only one was currently blasting. Four (50%) had also worked as a pot tender. When asked what their usual job title had been during their working life, four reported being painters, two reported being foremen, one reported being a blaster, and one reported being a blaster and painter. Silica sand was the most commonly used abrasive material by five of the eight workers. All four current employees stated that their employer required the use of a respirator; all used a replaceable-cartridge air-purifying respirator. Only two (50%) had been fit-tested for this respirator.

Lead Levels

Ninety-six (56%) participants had blood drawn for a determination of BLL. The median BLL was 5µg/dl and the range was 2 to 30 µg/dl. Four participants had Blood lead levels between 25 and 30 µg/dl. None of these four had a chest x-ray that was positive for pneumoconiosis.

CONCLUSIONS

This medical screening of abrasive blasters from the Cleveland area found that 8 (5%) of 170 participants had chest x-rays consistent with pneumoconiosis. All eight had worked as abrasive blasters. Deficiencies in knowledge concerning the use of respirators and in silicosis prevention were noted among the eight and also among other study participants. These results indicate a need for better training and education in the proper use of respiratory protection and in silicosis prevention among workers engaged in or around abrasive blasting operations.

RECOMMENDATIONS

A regional silicosis intervention program should be implemented to reduce the risk of silicosis among Cleveland-area abrasive blasters. This issue was discussed with the Cleveland area OSHA office; they planned to include such outreach activities in their silica educational program scheduled during summer 1996. NIOSH has recently published an ALERT requesting assistance in the prevention of death in sandblasters [NIOSH 1992]. Many of the recommendations contained in the ALERT should be disseminated to Cleveland-area painters and businesses engaged in abrasive blasting. They are summarized below:

Environmental

1. Substitute a less hazardous abrasive blasting media that contains less than 1% crystalline silica.

2. Respiratory protection programs should comply with OSHA regulations and guidelines found in the NIOSH Respirator Decision Logic [NIOSH 1987]. These guidelines include recommendations for training and medical surveillance. NIOSH recommendations include:

- ! For situations where sand is used when sandblasting or shoveling in confined spaces, use an approved pressure-demand type CE abrasive-blast supplied-air respirator that contains a tight-fitting face piece and an assigned protection factor (APF) of 2,000.

- ! Facial hair that lies along the sealing area of a respirator, such as beards, sideburns, moustaches, or even a few days growth of stubble should not be permitted on employees who are required to wear respirators that rely on a tight facepiece fit to achieve maximum protection.

3. Employees should be informed of the hazards of exposure to crystalline silica and other occupational hazards. A consistently documented and effective worker awareness program should be developed by OSHA for education and protection. NIOSH recommends that "each employee exposed to free silica shall be apprised at the beginning of his employment or assignment area of the hazards, relevant symptoms, appropriate emergency procedures, and proper conditions and precautions for safe use or exposure" [NIOSH 1974]. OSHA includes this requirement in the Hazard Communications standard [29 CFR 1910.1200].

4. Warning signs should be posted to mark the boundaries of areas where there is potential for exposure to respirable crystalline silica. These signs should warn workers about the hazard of crystalline silica and specify any protective equipment required.

5. Work clothing worn during the process of abrasive blasting should be vacuumed before removal. Vacuum systems with HEPA filters have been shown to be very effective in reducing respirable dust concentrations. Clothes should not be cleaned by blowing or shaking. Personal hygiene is an important element of any program for protecting workers from exposure to silica and other

contaminants during the abrasive blasting operation. All abrasive blasters who use silica sand in blasting operations should wash their hands and faces before eating, drinking, or smoking, and they should not eat, drink, or use tobacco products in the work area.

6. Workers should change into work clothes at the worksite. To minimize the amount of silica dust that may collect in workers' cars, homes, and in other work areas from blasters' dusty clothing, washable coveralls or disposable clothing should be used whenever possible and should be removed before exiting a blasting area. Workers should change back into street clothes after working and before leaving the worksite. Showers should be provided at the worksite (when feasible) for use between clothing changes.

Medical

1. Employers should provide medical examinations for all workers who may have exposure to respirable crystalline silica prior to employee placement and at least once every 3 years thereafter [NIOSH 1988].

Examinations should include, as a minimum:

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

B. A chest x-ray classified according to the 1980 ILO International Classification of x-rays of pneumoconioses [ILO 1980].

C. Spirometry that is performed according to American Thoracic Society guidelines [American Thoracic Society 1995].

D. Annual evaluation for tuberculosis, including intradermal skin testing. Employees with a positive skin test should have appropriate medical evaluation for active tuberculosis and possible treatment.

E. Employees should be informed of any abnormal findings resulting from these medical examinations. Medical records should be kept in a confidential manner. Records should be maintained for at least 30 years following termination of the workers' employment. Current and former employees should be able to obtain information about their work exposures.

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Table 1
Reported respirator use by current abrasive blasters, pot tenders, and workers who performed both blasting and pot tending
Ohio Department of Health
August 1995

					Respirator types worn by workers Number who use it (Number fit-tested for this respirator)			
	Respirator required by employer	Respirator provided by employer	Use respirator	Dust mask	Replaceable cartridge air-purifying respirator	Powered air-purifying respirator	Air-supplied hood with tight-fitting face seal	Air-supplied hood without tight-fitting face seal
Abrasive Blaster only (N=11)	11	10	9	7 (1)	7 (3)	0 (NA)	2 (0)	4 (NA)
Pot Tender only (N=13)	12	13	11	10 (1)	10 (2)	1 (NA)	1 (0)	5 (NA)
Both (N=23)	22	23	23	16 (2)	20 (5)	1 (NA)	9 (2)	13 (NA)
Total (N=47)	45	46	43	33 (4)	37 (10)	2 (NA)	12 (2)	22 (NA)

NA = Not Applicable.

Table 2 Abrasives used by workers who had "ever" performed abrasive blasting or pot tending and by workers currently performing abrasive blasting or pot tending duties Ohio Department of Health August 1995				
	Ever blasters/pot tenders (N=113)		**Current blasters/pot tenders (N-47)**	
	No. (%) who used material	Average number of years used	No. (%) who used material	Average number of years used
Silica sand	108 (96)	10	45 (96)	12
Coal slag	62 (55)	5	31 (66)	5
Steel shot	39 (35)	4	21 (45	5

Table 3
Occupational exposures other than abrasive blasting and/or pot tending
Ohio Department of Health
August 1995

Industry	Number workers	Average years
Other construction	30	16
Foundry	19	4
Road building	12	5
Electrical	9	3
Inorganic pigment manufacturing	9	6
Coal mine	7	5
Plumbing	5	4
Abrasives, abrasive soap manufacturing	2	2
Other mine	2	2
Quarry	2	12
Granite	1	10
Glass production	1	2
Lead battery manufacturing/reclaiming	1	1

Table 4
Characteristics of eight workers with chest x-rays consistent with pneumoconiosis*
Ohio Department of Health
August 1995

Worker	Age	Currently employed	Currently employed as blaster	First year as blaster	Last year as blaster	Years blasted**	Ever pot tender	First year as pot tender	Last year as pot tender	Years pot tender**
1	69	N	N	1951	1088	37	N	NA	NA	NA
2	59	Y	N	1956	1993	10	N	NA	NA	NA
3	41	Y	Y	1982	1995	13	N	NA	NA	NA
4	56	Y	N	1959	1988	29	N	NA	NA	NA
5	66	N	N	1949	1959	10	Y	1949	1969	20
6	59	Y	N	1966	1995	6	Y	1966	1995	10
7	71	N	N	1970	1980	2	Y	1970	1980	2
8	67	N	N	1955	1987	12	Y	1960	1988	6

* Chest x-ray with an ILO reading ≥1/0
**Because many workers were employed intermittently as blasters and/or pot tenders, they were asked to estimate the number of years that they performed such duties.
NA = Not applicable.

Table 4 (cont)
Characteristics of eight workers with chest x-rays consistent with pneumoconiosis
Ohio Department of Health
August 1995

Worker	Use respirator at current job	Use APR	Conditions when used †	Use ASH1	Conditions when used †	Use ASH2	Conditions when used †	Most frequently used Abrasive	Smoking status‡
1	NA	NA	NA	NA	NA	NA	NA	Sand	2
2	Y	Y	4	N	NA	Y	1,2	--	3
3	Y	Y	4	N	NA	Y	1	coal slag	2
4	Y	Y	2,3,4	Y	1,3,4	N	NA	Sand	3
5	NA	NA	NA	NA	NA	NA	NA	Sand	1
6	Y	Y	2	N	NA	N	NA	Sand	1
7	NA	NA	NA	NA	NA	NA	NA	--	3
8	NA	NA	NA	NA	NA	NA	NA	Sand	2

APR = Removable cartridge air-purifying respirator; ASH1 = Air supplied hood with tight-fitting face seal; ASH2 = Air supplied hood without tight-fitting face seal.
NA = Not applicable.
†1 = when operating blasting equipment; 2 = when working around blasters; 3 = when cleaning up; 4 = other.
‡1 = current smoker; 2 = former smoker; 3 = never smoked.