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JOHNSON BROTHERS COMPANY
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I. SUMMARY

In July 1993, the National Institute for Occupational Safety and Health (NIOSH) received a request from management at Johnson Brothers Company, Pittsburgh, Pennsylvania, to conduct a health hazard evaluation (HHE) of steel-plate (water-tank) sandblasting and painting operations. On October 5-6, 1993, a team of NIOSH investigators surveyed two job sites located in Pike County and Cranberry Township (Beaver County), Pennsylvania, where sandblasting and spray painting were being conducted.

Workers were found to be overexposed to crystalline silica during tank interior sandblasting and shoveling operations at the Pike County site. Airborne concentrations of respirable silica during sandblasting exceeded the NIOSH recommended exposure limit (REL) by a factor of 300-540 while an abrasive blasting hood with an assigned protection factor (APF) of only 25 was used. During sand shoveling operations the NIOSH REL was exceeded by a factor of 94 while a respirator with an APF of only 10 was used.

Deficiencies in the respiratory protection and hearing conservation programs were noted at the Pike County job site. Specific findings included: use of insufficiently protective air-supplied respirators during sandblasting operations; a disconnected in-line carbon monoxide alarm; improper hookup of a compressed airline (compressed air went to a manifold that supplied both a spray paint gun and airline respirators, a potential cross connection); use of air purifying respirators (instead of supplied air respirators) while spray painting in confined spaces; use of respirators requiring a tight face fit by employees with beards; and inadequate training/health and safety knowledge for workers involved in potentially immediately dangerous to life and health (IDLH) situations.

Medical testing was conducted at the same two job sites on October 17-18, 1993. Eleven of the 13 employees at these sites participated in the medical evaluation, which included a medical and occupational history questionnaire, chest x-ray, spirometry testing, and determination of blood lead level. None of the examined workers had radiographic changes suggestive of silicosis. Three had abnormal spirometry test results. An obstructive pattern of abnormality was noted in all three, who had between 7 and 12 years of sandblasting experience and substantial smoking histories, as well. All blood lead levels were at or below 15 µg/dl (micrograms per deciliter).

Based on the results of this investigation, the NIOSH investigators conclude that during the time of this evaluation, a health hazard existed at work sites operated by Johnson Brothers Company due to employee exposure to respirable crystalline silica. NIOSH recommendations include implementation of effective respiratory protection, hearing conservation, and medical surveillance programs, and the substitution of a less toxic alternative for silica sand as an abrasive blasting material.

KEYWORDS: SIC (Painting and Paper Hanging, 1721; Structural Steel Erection, 1791) Silica, Crystalline silica, Pneumoconiosis, Silicosis, Tuberculosis, Respirable Quartz, Sandblasting, Construction, Elemental Metals, Abrasive Blasting, Respirator, Steel-Plate Fabrication, Painting Contractor, Abrasive Blasting Contractor, Water Tank, Noise

II. INTRODUCTION

In April 1993, the National Institute for Occupational Safety and Health (NIOSH) was notified by a physician of a case of silicosis and active tuberculosis (TB) in a sandblaster employed by Johnson Brothers Company in Pittsburgh, Pennsylvania. This sandblaster reported that his usual work had consisted of abrasive blasting of metal surfaces to remove old paint or to burnish the surface of new metal to prepare it for painting. Most of his work involved using silica sand as an abrasive. He reported that among five other coworkers whom he knew well, one had culture-confirmed active TB, one had suspected active TB (based on a positive tuberculin skin test and an otherwise unexplained 40-pound weight loss), and three had positive tuberculin skin tests discovered when the local health department screened close contacts (including some coworkers) of the workers with TB.

In June 1993, NIOSH representatives initiated contact with the owner of Johnson Brothers Company, Pittsburgh, Pennsylvania. The NIOSH team discussed concerns about the risk of silicosis and tuberculosis among other employees. In July 1993, NIOSH received a request from an employer representative to investigate exposures of sandblasters/painters at remote job sites of this company and to conduct medical evaluations. A conference to discuss plans of the investigation was held on September 7, 1993.

On October 5-6, 1993, a team of NIOSH investigators performed environmental sampling at two Johnson Brothers job sites with ongoing sandblasting and painting operations; one in Cranberry Township, Pennsylvania, and the other in Pike County, Pennsylvania. On October 7, 1993, NIOSH notified Johnson Brothers Management and the Occupational Safety and Health Administration (OSHA) of working conditions at the Pike County job site that represented a possible imminent danger. Medical testing of employees at the job sites was conducted on October 17-18, 1993.

III. PROCESS DESCRIPTION

Johnson Brothers Company specializes in the surface preparation (abrasive blasting) and painting of steel-plate water tanks. Most jobs are performed for municipalities located throughout the eastern United States. The abrasive blasting operation involves forcefully projecting a stream of abrasive particles (sand) onto a steel plate surface with compressed air to rid the surface of impurities and provide for better paint adhesion.

As with most construction operations, the number of workers employed at any given time is a function of workload. At the time of this survey, Johnson Brothers employed 21 active hourly employees who worked at multiple sites. NIOSH investigators evaluated two job sites. Because of difficulties associated with the painting of steel structures in cold weather, these were to be the last jobs to be performed until the spring.

The Pike County job consisted of sandblasting and painting the interior and exterior of a 750,000 gallon water tank and a 200-foot-tall supporting structure. Seven workers (two sandblasters, two laborers, two painters, and a foreman) were responsible for sandblasting and painting the interior of the supporting structure and tank during the environmental portion of the survey. (An additional three workers were present during the medical examinations, which were conducted later.) The laborers served as "pot tenders," replenishing sand to the hopper and servicing the air compressor. All employees were involved in cleanup operations, such as the shoveling of spent sand that accumulates on catwalks.

At the Cranberry Township job, three workers (two sandblasters/painters and one foreman/tender) were engaged in sandblasting and painting the exterior welds of a steel plate tank.

IV. METHODS AND MATERIALS

A. ENVIRONMENTAL

During the period October 5-6, 1993, environmental samples were collected during typical work shifts in an attempt to evaluate worker exposures to respirable crystalline silica, elemental metals, hydrocarbons, and noise. The amount of sampling equipment that could be safely worn by painters and sandblasters working on elevated platforms was limited. Therefore, some area samples were taken. For elevated areas on the interior of tanks, area samples were placed within 15 feet of the sandblaster/painter on the railing of a catwalk. When working on exterior areas of tanks, area samples were placed within 10 feet of the sandblaster scaffold railing. The methods used are as follows.

Respirable crystalline silica

Dust-laden air was passed through a 10-mm nylon cyclone pre-separator at a flow rate of 1.7 liters per minute (lpm) and the respirable fraction was deposited on a 37-mm diameter, 5-micron pore size polyvinyl chloride (PVC) filter. The

dust collected on the filters was analyzed by x-ray diffraction for crystalline silica using NIOSH Analytical Method 7500.[1]

Lead and other elemental metals

Area samples for the estimation of exposure to elemental metals were collected on 37-mm diameter, 0.8 micron pore size, cellulose ester membrane filters mounted in closed face cassettes. Air was drawn through the filters at a flow rate of 1.7 lpm. The samples were analyzed by NIOSH Method 7300.[1]

Hydrocarbons

Samples for the estimation of exposure to hydrocarbons were collected on charcoal adsorbent tubes at the Pike County site. Air was drawn through the tubes at a flow rate of 100 cubic centimeters per minute. One sample was analyzed by gas chromatography/mass spectrophotometry to qualitatively identify individual compounds. Using a combination of NIOSH Methods 1300[1]and 1501[1], the remaining samples were quantitatively analyzed (each charcoal tube sample was desorbed in carbon disulfide, followed by gas chromatography analysis using a flame-ionization detector).

Noise

One area sample for noise exposure was taken (in the vicinity of a sandblaster) using a General Radio Model 1954 noise dosimeter at the Pike County site.

B. MEDICAL

The 13 current employees working at the Cranberry Township and Pike County locations were offered on-site medical testing, consisting of an occupational and medical history questionnaire, a posteroanterior chest x-ray, spirometry testing, and a blood lead test. NIOSH personnel performed this testing on-site on October 17-18, 1993. In November 1993, all current Johnson Brothers Company employees who were not tested on-site were mailed a letter informing them that they were eligible for this medical testing at an occupational health clinic located near the company headquarters. However, no workers chose to take advantage of this offer, and in March 1994, NIOSH staff notified the eligible workers that the clinic contract for medical testing had been discontinued.

Questionnaire

Respiratory symptoms were assessed by questionnaire. Chronic cough was defined as cough occurring on most days for 3 or more months during the year for 2 years or longer. Chronic phlegm was defined similarly. Grade I dyspnea

was defined as shortness of breath when hurrying on level ground or walking up a slight hill. Grade II dyspnea was defined as shortness of breath while walking on level ground with people of one's own age, and Grade III was defined as having to stop for breath when walking at one's own pace on level ground. Individuals who reported currently smoking cigarettes were defined as current smokers. Individuals who reported having smoked five or more packs of cigarettes during their entire life, but not currently smoking cigarettes, were classified as ex-smokers.

Spirometry

Spirometry testing was performed in conformance with American Thoracic Society guidelines.[2] Predicted values were based on published reference equations.[3] Predicted values for blacks were determined by multiplying the value predicted by the reference equations by 0.85.[4] Forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) were the parameters selected for analysis. Each participant's FVC and FEV_1/FVC ratio were compared to the 95th percentile lower limit of normal (LLN) values obtained from the reference population. Results below the LLN values were considered abnormal. (About five percent of a normal population would be expected to have test results that fall below the LLN).

Obstructive and restrictive spirometric patterns were defined as:

Obstructive: Observed FEV_1/FVC% below the LLN.
Restrictive: Observed FVC below the LLN; and
FEV_1/FVC% above the LLN.

AND

Severity levels for obstructive and restrictive patterns were defined as:

	Obstructive (FEV_1/FVC x 100)	Restrictive (% Predicted FVC)
Mild	> 60	> 65
Moderate	$\geq$ 45 to $\leq$ 60	$\geq$ 51 to $\leq$ 65
Severe	< 45	< 51

Posteroanterior (PA) Chest Radiographs

Each PA chest radiograph was taken on a full size (14 x 17-inch) film and read independently by two NIOSH-certified B Readers who, without knowledge of the participant's age, occupation, or smoking history, classified the films according to the current international classification system for pneumoconiosis.[5] A chest radiograph was defined as consistent with pneumoconiosis if each of the two B Readers classified small opacity profusion as 1/0 or greater. In the event of disagreement between the two readers on small opacity profusion, the chest radiograph was defined as consistent with pneumoconiosis if a third B Reader independently classified small opacity profusion as 1/0 or greater.

Blood Lead Levels

Blood for lead analysis was obtained by venipuncture using aseptic technique, stored on ice, and hand-carried to a contract medical laboratory for analysis.

V. EVALUATION CRITERIA AND TOXICOLOGY

A. CRITERIA

As a guide to the evaluation of the hazard posed by workplace exposures, NIOSH field investigators 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 8-10 hours per day, 40-hours per week for a working lifetime without experiencing irreversible adverse health effects. It is important to understand these criteria are guidelines, not absolute limits between safe and dangerous levels of exposure. Not all workers will be protected from adverse health effects even 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 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 occupational exposures are controlled at levels described in the evaluation criterion. These combined effects are not considered in the evaluation criterion. Also, some substances are absorbed by direct contact with the skin and mucous membranes which may increase the overall exposure beyond that resulting from inhalation. Finally, evaluation criteria may change over time 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 (TLVs)[6]; and (3) OSHA Occupational Health Standards.[7] OSHA standards take into account the feasibility of controlling exposures in the various industries where the agents are used. The NIOSH Recommended Exposure Limits (RELs), by contrast, are based primarily on concerns relating to the prevention of occupational disease. The employer 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 workday. Some substances have recommended short term exposure limits (STEL) or ceiling (C) values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures. The environmental exposure criteria for some substances monitored during this investigation are shown in Table I.

SILICA

Because of the extremely high risk of silicosis associated with sandblasting, and the difficulty in controlling exposure to respirable silica during sandblasting operations, the use of crystalline silica for abrasive blasting cleaning operations was restricted in Great Britain in 1950,[8] 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.[9] In addition to causing silicosis, evidence now indicates that crystalline silica is a potential occupational carcinogen.[10,11,12]

NIOSH recommends an exposure limit for respirable crystalline silica of 0.05 mg/m^3, expressed as a TWA. The 1995-1996 ACGIH TLV for respirable crystalline silica (as quartz) is 0.1 mg/m^3. For construction operations (including the Johnson Brothers Company operations investigated), the OSHA permissible exposure limit (PEL) for crystalline silica (as respirable quartz) is 250 million particles per cubic foot divided by "% SiO_2 + 5." This is based on a 1970 ACGIH TLV. For other industries, the OSHA PEL for crystalline silica (as respirable quartz) is 10 mg/m^3 divided by the value "% SiO_2 + 2."

LEAD

A goal for reducing occupational exposure was specified in *Healthy People 2000*, a 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 (BLLs) greater than 25 ug/dl.[13]

Previous NIOSH work concerning workers performing abrasive blasting removal of lead-based paint has 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 for workers in the construction industry.[14]

Under the OSHA standard regulating lead exposure in construction,[15] the PEL is 0.05 mg/m^3 as an 8-hour TWA. Employers covered by this 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 exposed employee's blood lead and zinc protoporphyrin (ZPP) levels at least every 2 months for the first 6 months in the job and at least 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 the results.

Actions based on blood lead levels are as follows:

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

The employer is required to remove an employee from work having an exposure to lead at or above the action level if the employee has a blood lead level above 50 ug/dl. Removed employees may return to their former job status when two consecutive blood lead levels are at or below 40 ug/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 ug/m^3 unless exposure assessment demonstrates lower exposure levels.[15]

NOISE

The OSHA standard for occupational noise exposure in construction specifies a PEL of 90 db(A)-slow response for a duration of 8 hours per day.[16] The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship. This means that in order for a person to be exposed to noise levels of 95 dB(A), the amount of time allowed at this exposure level must be cut in half to be within the PEL. Conversely, a person exposed to 85 dB(A) is allowed twice as much time at this level (16 hours) to remain within the daily PEL. Both NIOSH and ACGIH recommend an exposure limit of 85 dB(A) for 8 hours, 5 dB less than the OSHA standard. Also, the NIOSH and ACGIH criteria both use a 3 dB time/intensity trading relationship in calculating exposure limits. Time-weighted average noise limits, as a function of exposure duration, are shown as follows:

Duration of Exposure (hrs/day)	Sound Level [dB(A)] ACGIH[6]	NIOSH[17]	OSHA[16]
16	82	82	
8	85	85	90
4	88	88	95
2	91	91	100
1	94	94	105
.5	97	97	110
.25	100	100	115*
.125	103	103	**

* No exposure to continuous or intermittent noise in excess of 115 dB(A).
** Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

When employees are subjected to sound levels exceeding the OSHA criteria, feasible administrative or engineering controls are required. If such controls do not reduce sound levels to acceptable levels, personal protective equipment is required. When sound levels exceed the permissible levels, a continuing, effective hearing conservation program is required.

B. TOXICOLOGY

SILICA

Depending on the intensity and duration of exposure to airborne crystalline silica, exposed workers may develop one of two types of silicosis. Nodular silicosis typically occurs after many years (usually 15 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. Nodular silicosis manifests 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 is caused by exposure to very high concentrations of crystalline silica, develops as soon as a few weeks after the initial exposure.[18] 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, sometimes with very little of the scarring that is typical of nodular silicosis.

The use of sand for abrasive blasting typically results in the fracturing of the sand into fine airborne particles which can be inhaled. This freshly fractured crystalline silica appears to be more toxic to the lung than aged silica.[19] Sandblasters are at high risk of developing acute or accelerated silicosis because they are potentially exposed to very high concentrations of freshly fractured silica dust.[20,21] Mycobacterial infections often complicate silicosis and can be fatal.[22] These infections are believed to be due to the reduced ability of silica-filled macrophages to kill organisms.[23]

LEAD

Inhalation of lead-contaminated dust and 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. Once absorbed, lead accumulates in the soft tissues and bones, with the highest accumulation initially in the liver and kidneys.[24] Lead is stored in the bones for decades and may cause toxic effects as it is slowly released over time. Overexposure to lead results in damage to the kidneys, gastrointestinal tract, peripheral and central nervous systems, and the blood-forming organs (bone marrow). Long-term overexposure to lead may also cause infertility in both sexes and fetal damage.

The likelihood and severity of symptoms associated with lead exposure increase with increasing blood lead levels (BLLs). Health effects of lead intoxication include weakness, excessive tiredness, constipation, anorexia, abdominal pain, anemia, high blood pressure, irritability or anxiety, fine tremors, pigmentation on the gums ("lead line"), and weakness of the extensor muscle groups ("wrist drop" or "foot drop").[25,26,27]

Overt symptoms of lead poisoning in adults generally begin at BLLs above 60, but a number of studies have found neurological symptoms in workers with BLLs of 40 to 60 ug/dl. The World Health Organization has recommended an upper limit of 40 ug/dl for occupationally exposed adult males.[28] The current OSHA standards for both construction and general industry mandate medical removal for workers with BLLs greater than 50 ug/dl.[15,29] Recent studies suggest that there are adverse health effects at BLLs below the current evaluation criteria for occupational exposure.[30]

An increase in an individual worker's BLL can mean that the worker is being overexposed to lead. While the BLL is a good indication of recent exposure to lead, it is not a reliable indicator of the total body burden of lead.[31] Lead can accumulate in the body over time and produce health effects long after exposure has stopped.

ALUMINUM

Metallic aluminum dust is considered a relatively benign “inert dust.”

ARSENIC

Exposure to inorganic arsenic can produce dermatitis (skin inflammation), keratoses (horny growths on the skin), peripheral neuropathies (diseases of the nerves of the extremities), peripheral vascular diseases (diseases of the arteries and veins of the extremities), and cancer of the skin, liver, and lungs. Arsenic is absorbed primarily via inhalation and ingestion. Oral ingestion from contaminated hands may result in absorption of toxicologically significant amounts of arsenic.[32]

Inorganic arsenic is eliminated from the body through metabolism and urinary excretion. The total amount excreted in urine accounts for about 60% of the absorbed amount. Inorganic arsenic metabolites appear in urine shortly after the start of exposure. The concentration rises slowly during the first days of the exposure, and then levels off. If a worker’s exposure on following days is similar, the arsenic concentration in urine remains more or less the same.

BERYLLIUM

Beryllium and its compounds are highly toxic substances. The chronic form of beryllium disease is manifest primarily by respiratory symptoms, weakness, fatigue, and weight loss (without cough or dyspnea at the onset), followed by a non-productive cough and shortness of breath.

IRON

Inhalation of iron oxide dust may cause a benign pneumoconiosis called siderosis.

HYDROCARBONS

Inhalation is the primary route of occupational exposure to organic solvents, although most organic solvents are also absorbed through the skin to some degree following direct contact. Almost all volatile lipid-soluble organic solvents cause general, nonspecific depression of the central nervous system. The symptoms of acute intoxication range from headache, nausea and vomiting, dizziness, lightheadedness, vertigo, disequilibrium, slurred speech, disorientation, and confusion to loss of consciousness and death from respiratory depression. Chronic exposure to organic solvents can cause adverse neurobehavioral effects, including changes in personality or mood, and impaired intellectual function as assessed by neurobehavioral testing. Many common organic solvents may cause or contribute to peripheral neuropathies. Typical symptoms of solvent-induced neuropathy are slowly ascending numbness, paresthesia, and weakness.[36] A secondary hazard from these neurological effects is an increased risk of accidents.

The toxic effects of organic solvents are not limited to the neurological system. There are few studies of chronic pulmonary effects from exposure to organic solvents. The principal effect of some organic solvents on the heart is "cardiac sensitization," in which the heart has increased sensitivity to the arrhythmogenic effects of epinephrine. This may result in sudden death due to cardiac arrhythmias in otherwise healthy workers overexposed to certain industrial solvents. The aromatic hydrocarbons, including toluene and xylene, are weakly toxic to the liver (hepatotoxic) at high levels of exposure; solvents may also potentiate the effects of alcohol on the liver.[36]

NOISE

Exposure to high levels of noise may cause temporary or permanent hearing loss. The extent of damage depends primarily upon the intensity of the noise and the duration of the exposure. There is epidemiological and laboratory

evidence that protracted noise exposure above 90 dB(A) causes hearing loss in a portion of the exposed population.[17]

VI. RESULTS AND DISCUSSION

A. ENVIRONMENTAL

As with most construction operations, conditions will vary considerably at different job sites, and care must be taken when using these sample results to determine the degree of health risk at other sites.

Silica

Due to difficulties associated with confined space access and the limited availability of air-supplied respirators, the NIOSH survey team was not able to directly observe the sandblasting operations at the Pike County site.

Half-shift sampling (versus full-shift sampling) was selected at the Pike County site to reduce the chance of filter overloading. At this operation, half-shift sample concentrations are reasonable approximations of full-shift concentrations (2 hours of sandblasting per 4-hour half-shift is similar to 4 hours of sandblasting per 8-hour full-shift). Therefore, half-shift, 4-hour TWA exposures are believed to be reasonable approximations of full-shift, 8-hour TWA exposures.

Ten samples (eight personal, four area) for respirable crystalline silica were collected during sandblasting operations inside a steel structure at the Pike County site and two area samples were collected during sandblasting of the exterior of a steel structure at the Cranberry Township site. Four of the personal samples and two of the area samples were voided due to overloading and/or pump failure. The results are presented in Table II and indicate that all non-voided samples exceeded both the NIOSH REL and the ACGIH TLV for respirable crystalline silica.

Four half-shift respirable crystalline silica personal samples at the Pike County site ranged from 15 to 27 mg/m^3, equivalent to 300 to 540 times the NIOSH REL.[9] The type-CE continuous-flow abrasive-blasting respirator with an assigned protection factor (APF) of 25 in use at this operation is not considered adequately protective at such high concentrations of airborne respirable crystalline silica.[37,38] The results of two area samples (within 15 feet of the sandblaster) show half-shift TWA respirable crystalline silica concentrations to be approximately 7 mg/m^3 at the Pike County site. These concentrations, equivalent to 240 times the NIOSH REL, are somewhat lower than the 15 to 27 mg/m^3 range reported for personal samples, but still indicate the potential for

overexposure.

The results of two area samples (within 10 feet of the sandblaster) taken at the Cranberry Township site show half-shift TWA respirable crystalline silica concentrations to be 0.7 and 0.8 mg/m^3. Both of these concentrations exceeded the NIOSH REL and the ACGIH TLV. (Note that PPE with an APF of 25 was worn).

Two workers at the Pike County site were involved in a 1.4-hour operation involving shoveling sand from an elevated ledge to the bottom of the inside of the tank. Half-mask air-purifying respirators with an APF of 10 were used during the shoveling operation. Three of the four samples collected were voided due to overloading, an indication of excessive exposure. A personal sample showed an 8-hour TWA respirable crystalline silica concentration of 4.7 mg/m^3 (or a 27 mg/m^3 actual concentration for the duration of the operation). The NIOSH REL was exceeded by a factor of 94 (i.e., 4.7 ÷ 0.05). Half-mask air-purifying respirators with an APF of 10 are not considered protective for this exposure.

The results of personal sampling, presented in Table III, show respirable crystalline silica exposures for laborers (outdoor pot tenders) to be within the NIOSH REL on the dates sampled.

Lead (and other elemental metals)

The results of area sampling of the sandblast plumes at both sites showed actual levels of lead in air to be below 0.006 mg/m^3 (0.003 mg/m^3 expressed as a TWA) and below the OSHA action limit of 0.03 mg/m^3 expressed as a TWA.

Time-weighted average (TWA) concentrations from area samples that were above the limit of quantification, based on 4-hours of sandblasting per day were 3.8 mg/m^3 (aluminum), 0.049 mg/m^3 (arsenic), 0.0002 mg/m^3 (beryllium), and 53 mg/m^3 (iron). These results would indicate the potential for overexposure to both arsenic and iron in the absence of adequate respiratory protection. During the sampling period, sandblasters used air supplied respirators with an assigned protection factor of 25, thereby, reducing the potential exposures to individuals to within limits outlined in Table I.

Hydrocarbons

Approximately 50-60 gallons of paint containing approximately 3.3 pounds per gallon (1,500,000 mg/gallon) of volatile organic hydrocarbons were applied per shift in a 750,000 gallon (2838 m^3) capacity tank at the Pike County site. The tank, located over 200 feet above ground level, was naturally ventilated. When relying on natural ventilation (e.g., wind), the contaminant removal rate can be

highly variable. With no dilution, a maximum worst-case concentration of 31,680 mg/m^3 (or 528 mg/m^3 per gallon of paint used) would be expected -- a concentration range that may, under certain circumstances, represent both a toxic and an explosive hazard.

During this survey three samples were taken. One sample was analyzed by gas chromatography/mass spectrophotometry to determine specific components and was found to contain methyl isobutyl ketone (MIBK), toluene, and xylene/ethyl benzene isomers. The other two personal breathing zone samples taken on different days were each analyzed to determine the concentration of the three contaminants. The results are reported in Table IV. They are reported as half-shift TWA exposures. Since painting occurs on both the morning and afternoon work periods, half-shift concentrations are believed to be representative of full-shift 8-hour TWA exposures.

One sample showed approximate MIBK component concentrations of over 55 ppm, which exceeds the NIOSH REL and ACGIH TLV of 50 ppm. (The REL for the mixture was also exceeded.) The high concentrations of organic vapors in the tank resulted in adsorbent tube breakthrough. A sample taken on a different day showed levels to be within the NIOSH REL. As with most construction painting, different areas were painted on each of the days sampled. These results show that natural ventilation (wind) was not always effective in removing hydrocarbon air contaminants from confined spaces such as the interior of tanks.

Respiratory Protection Program

NIOSH noted major deficiencies in the respiratory protection program. NIOSH findings are as follows:

- The type-CE continuous-flow abrasive-blasting respirator with an APF of 25 in use at the Pike County site is not considered protective by NIOSH for sandblasting operations.[21,37,38]

- Air-purifying half-mask respirators equipped with organic vapor cartridges and spray painting prefilters were used during sand shoveling operations. The organic vapor cartridge is not approved for use in atmospheres containing crystalline silica particulate. These respirators have an APF of 10 for respirable dust when used with approved particulate filters. Based on sampling results, respirators with an APF of at least 94 would be necessary to protect workers at this operation, if no other exposure to crystalline silica were to occur during the shift.

- Half-mask air-purifying respirators with organic vapor cartridges and spray

paint prefilters with an APF of 10 were used during spray painting operations, as specified in the material safety data sheets. These air purifying respirators should not be used in confined space situations (such as spray painting the interior of tanks that rely on natural ventilation for contaminant removal) where there is potential for air contaminant buildup to concentrations greater than 10 times the NIOSH REL. The tank was naturally ventilated. Powered ventilation is preferred over natural ventilation to ensure that contaminants do not buildup to immediately dangerous to life or health (IDLH) concentrations.

- The half-mask respirators, which rely on tight face seals, were rendered less effective because of facial hair.

- Poor storage and housekeeping was observed (e.g., respirators hanging on a wall were coated with paint) and training (health and safety knowledge for workers exposed to potential IDLH situations) was deemed inadequate.

- The trap for the compressor supplied air to both the spray paint gun and the abrasive blasting hoods, resulting in a possible cross connection.

- The carbon monoxide alarm to the compressor was disconnected.

- A physician did not determine whether employees were medically capable of wearing respirators.

Noise Exposure and Hearing Conservation Program

The result of the noise measurement, which is believed to approximate worker exposure, showed an 8-hour equivalent exposure of 109.5 dB(A). Although the exposed sandblaster was provided with and wore earplugs, workers had not been provided with audiograms. A literature review indicates a strong association between occupational exposure to noise and abrasive-blasting operations conducted in confined spaces.[39]

B. MEDICAL

Eleven of the 13 workers at the Cranberry Township and Pike County sites participated in the medical testing. One declined to participate and the other was away from work at a meeting on the days of testing. All examined workers were men. They ranged from 20 to 40 years of age, with a median age of 33 years. The prevalence of current smoking was 64%; current smokers had a median of 15.7 pack-years of smoking. Twenty-seven percent of workers were ex-smokers; ex-smokers had smoked a median of 24.0 pack years. Only one worker had never smoked.

The median tenure of current employment at Johnson Brothers was just under 3 years. Three individuals indicated that they had worked for Johnson Brothers in the past, all for periods of between 1 and 2 years. Eight individuals had been sandblasters for other employers; tenure with these other employers ranged from 5 months to almost 8 years. The combined tenure at Johnson Brothers and at other sandblasting firms ranged from less than 1 year to just over 12 years, with a median of 5.5 years. The year of first employment in the sandblasting industry ranged from 1980 to 1993.

No radiographs were classified as being consistent with pneumoconiosis or suggestive of tuberculosis. Given the median sandblasting tenure of only 5.5 years and the maximum sandblasting tenure of only 12 years, along with the long period of time over which silicosis typically develops, this negative finding is not necessarily unexpected. These workers will remain at risk for silicosis, particularly if they continue to be inadequately protected during work operations which generate silica dust.

The study participants had a high prevalence of chronic respiratory symptoms. Chronic cough and chronic phlegm were reported by 45% and 54% of study participants, respectively, while 54% had wheezing or whistling noises in the chest. One participant reported that he had experienced attacks of shortness of breath with wheezing. One individual had Grade I dyspnea and one had Grade II dyspnea.

All 11 participants had spirometry testing. Three participants (27%) had tests results that were considered abnormal. One (with 7 years of sandblasting experience and a 24-pack-year smoking history) had a moderately severe obstructive pattern. Two others (one with 9 years of sandblasting experience and a 13-pack-year smoking history, and the other with 12 years of sandblasting experience and a 25 pack-year smoking history) had obstructive patterns of mild severity.

Three participants reported having tuberculin skin tests (TSTs) in the recent past; two had the tests in February 1993 and one could not remember the date of his test. All three reported that their tests were negative. The tests performed in February 1993 were conducted by the County Health Department in Somerset County, Pennsylvania, during contact investigation relating to the Johnson Brothers Company employee who was diagnosed with tuberculosis.

Ten of the 11 participants had a blood lead test. Blood lead levels ranged from 1 µg/dl to 15 µg/dl. This lack of evidence of recent occupational overexposure to lead is consistent with the workers' reports that almost all of their sandblasting jobs during the summer of 1993 had involved removing primer coats that did not contain lead.

VII. CONCLUSIONS AND RECOMMENDATIONS

The environmental results of this evaluation document that a health hazard associated with respirable silica existed at the time of this investigation. Although none of the active workers who were examined had radiographic evidence of silicosis, none of them had more than 12 years of sandblasting experience. (The sandblaster whose physician brought the Johnson Brothers Company to the attention of NIOSH had worked for over 20 years as a sandblaster.) The potential for overexposure to organic vapors, noise, arsenic, and iron were also suggested by limited sampling. The Johnson Brothers Company was not providing an adequate respiratory protection program at the time of this investigation, and the hearing conservation program may also have been inadequate.

A. ENVIRONMENTAL RECOMMENDATIONS

NIOSH has recently published an ALERT requesting assistance in the prevention of death in sandblasters.[21] Many of the recommendations in that ALERT are included in the recommendations that follow. Johnson Brothers Company should provide employees with working environments that protect them against significant occupational hazards, as follows:

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

2. Improve the respiratory protection program to comply with OSHA regulations and guidelines found in the NIOSH Respirator Decision Logic.[37] Some of the recommendations made in these guidelines are:

    ! If silica sand continues to be 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 facepiece 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.

- Continuously monitor spray-painting within confined spaces to ensure that exposures are below immediately dangerous to life and health (IDLH) levels and employ engineering controls (powered ventilation) where potential confined space overexposures exist.

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 for education and protection. NIOSH recommended in 1974 that "each employee exposed to free-silica shall be apprised at the beginning of his employment or assignment to a free-silica exposure area of the hazards, relevant symptoms, appropriate emergency procedures, and proper conditions and precautions for safe use or exposure."[9] OSHA includes this requirement in the Hazard Communications standard.[40]

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 in the area.

5. 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 sandblasting workers 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 work site. To minimize the amount of silica dust and other contaminants 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. Work clothing worn during the process of abrasive blasting should be vacuumed before removal. Clothes should not be cleaned by blowing or shaking. When feasible, showers should be provided at the worksite prior to workers changing back into street clothes before leaving the work site.

7. Implement a hearing conservation program that complies with OSHA requirements contained in 29 CFR 1926.52 and 1910.95.

8. Insure that employees are not overexposed to inorganic arsenic or iron during sandblasting operations.

B. MEDICAL RECOMMENDATIONS

1. Johnson Brothers Company should establish a medical monitoring program in which routine examinations are provided for all workers in jobs with exposure to respirable crystalline silica. These screening examinations should be administered prior to employee placement and at regular intervals thereafter.[10] The medical screening program should be directed and supervised by a physician knowledgeable about silicosis, related medical conditions, and personal respiratory protection equipment and programs.

   Examinations should include, as a minimum:

   A. A medical and occupational history to elicit symptoms of respiratory disease and information regarding worker exposure to silica (at intervals of every three years).

   B. A chest radiograph classified according to the 1980 ILO International Classification of Radiographs of Pneumoconioses[5] (at intervals of every three years).

   C. Spirometry performed according to American Thoracic Society guidelines[2] (at intervals of every three years).

   D. Intradermal skin testing for tuberculosis (annually). (Note: All employees were advised by personal letter from the NIOSH investigator to get a skin test if they had not been tested in the past year).

   Any worker judged by the supervising physician to have medically significant results of any of these screening tests should undergo further medical evaluation. Appropriate medical tests should be conducted to allow the examining physician to determine whether the employee has a medical condition caused or exacerbated by workplace conditions, associated with increased risk of impairment from continued exposure to these conditions, and/or warranting medical treatment.

   The physician should provide an appropriate written report to the employer and the employer should comply with the physician's recommended limitations on the affected worker's exposure to hazardous agents in the workplace and use of personal respiratory protective devices.

   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 workers' employment. Current and former employees should be able to obtain information about their work exposures.

VIII. REFERENCES

1. NIOSH [1984]. NIOSH manual of analytical methods. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 84-100.

2. American Thoracic Society [1987]. Standardization of spirometry--1987 update. Am Rev Respir Dis 136:1285-1298.

3. Knudson RJ, Lebowitz MD, Holberg CJ, Burrows B [1983]. Changes in the normal maximal expiratory flow-volume curve with growth and aging. Am Rev Respir Dis 127:725-734.

4. Lanese RR, Keller MD, Foley MF, Underwood, EH [1978]. Differences in pulmonary function tests among whites, blacks, and American Indians in a textile company. J Occup Med 20:39-44.

5. ILO. Guidelines for the use of ILO international classification of radiographs of pneumoconioses, 1980 edition. Geneva, International Labour Office, 1980. Occupational Safety and Health Series, No. 22 (rev.).

6. ACGIH [1995]. Threshold limit values for chemical substances and physical agents and biological exposure indices for 1995-1996. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

7. CFR. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register. U.S. Department of Labor, Occupational Safety and Health Administration [29 CFR 1926 and 29 CFR 1910].

8. Factories Act, 1937 and 1948--blasting (casting and other articles) special regulations, [1949]. London, England: Ministry of Labour and National Service, Factory Department, SI 1949, No. 2225, pp. 4331-4335.

9. NIOSH [1974]. NIOSH criteria for a recommended standard: occupational exposure to crystalline silica. Cincinnati, OH: U.S. Department of Health and Human Services, Center for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 75-120.

10. NIOSH [1988a]. NIOSH testimony to the U.S. Department of Labor: statement of the National Institute for Occupational Safety and Health. Presented at the public hearing on OSHA PELs/Crystalline silica, July 1988. NIOSH policy statements. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control, National Institute for Occupational Safety and Health.

11. IARC [1987]. IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans: silica and some silicates. Vol. 42. Lyon, France: World Health Organization, International Agency for Research on Cancer, pp.49, 51, 73-111.

12. DHHS [1991]. Sixth annual report on carcinogens: summary 1991. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Institute of Environmental Health Sciences, pp. 357-364.

13. DHHS [1990]. Health people 2000: national health promotion and disease objectives. Washington, DC: U.S. Department of Health and Human Services, Public Health Service, DHHS (PHS) Publication No. 91-50212.

14. NIOSH [1992]. Hazard evaluation and technical assistance report: Seaway Painting, Inc., Annapolis, MD. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Report No. HHE 91-209-2249.

15. CFR. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office. Office of the Federal Register. U.S. Department of Labor, Occupational Safety and Health Administration [29 CFR 1926. 62].

16. CFR. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office. Office of the Federal Register. U.S. Department of Labor, Occupational Safety and Health Administration [29 CFR 1926.52].

17. Niemeier RW: Memorandum of April 13, 1995, from R.W. Niemeier, Division of Standards Development and Technology Transfer, to NIOSH Division Directors, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Public Health Service, U.S. Department of Health and Human Services, 1995.

18. Parkes WR [1982]. Diseases due to free silica. Occupational Lung Disorders. Second Ed. pp. 134-175.

19. Vallyathan V, Shi X, Dalal NS, Irr W, Castranova V [1988]. Generation of free radicals from freshly fractured silica dust: potential role in acute silica induced lung injury. Am Rev Respir Dis 138:1213-1219.

20. Merewether, ERA [1936]. The risk of silicosis in sandblasters. Tubercle 17:385-391.

21. NIOSH [1992]. NIOSH ALERT - Request for Assistance in Preventing Silicosis and Deaths from Sandblasting. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 92-102.

22. Bailey WC, Brown M, Buechner HA, Weill H, Ichinose H, Ziskind M [1974]. Silico-mycobacterial disease in sandblasters. Am Rev Respir Dis 110:115-125.

23. Allison AC, Hart PD [1968]. Potentiation by silica of the growth of mycobacterium tuberculosis in macrophage cultures. Br J Exp Pathol 49:465-476.

24. NIOSH [1981]. Occupational health guidelines for chemical hazards. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 81-123, and supplements 88-118, 89-104.

25. Hernberg S, et al [1988]. Lead and its compounds. In: Occupational medicine. 2nd ed. Chicago, IL: Year Book Medical Publishers.

26. Landrigan PJ, et al [1985]. Body lead burden: summary of epidemiological data on its relation to environmental sources and toxic effects. In: Dietary and environmental lead: human health effects. Amsterdam: Elsevier Science Publishers.

27. Proctor NH, Hughes JP, Fischman ML [1988]. Lead. In: Chemical hazards of the workplace. 2nd ed. Philadelphia, PA: J.B. Lippincott Company, pp. 294-298.

28. WHO [1980]. Recommended health-based limits in occupational exposure to heavy metals. World Health Organization. Geneva: Technical Report Series 647.

29. CFR. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office. Office of the Federal Register. U.S. Department of Labor, Occupational Safety and Health Administration [29 CFR 1910.1025].

30. ATSDR [1990]. Toxicological profile for lead. Atlanta, GA: U.S. Department of Health and Human Service, Public Health Service, Agency for Toxic Substances and Disease Registry, DHHS (ATSDR) Publication No. TP-88/17.

31. NIOSH [1978]. Occupational exposure to inorganic lead. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-158.

32. Reels H, Bucket J, Truc J, et al [1982]. The possible role of direct ingestion on the overall absorption of cadmium or arsenic in workers exposed to Cd or As_2O_3 dust. Am J Ind Med 3: 53-65.

33. Ishinishi N, Tsuchiya K, Vahter M, Fowler B [1986]. Arsenic. In: Friberg L, Nordberg G, Vouk VB, eds. Handbook on the Toxicology of Metals. New York, NY: Elsevier, pp 43-83.

34. Foa V, Colombi A, Maroni M, Buratti M [1987]. Biological indicators for the assessment of human exposure to industrial chemicals. Arsenic. Luxemburg: Commission of the European Communities.

35. Smith TJ, Crecelius EA, Reading JC [1977]. Airborne arsenic exposure and excretion of methylated arsenic compounds. Environ Health Perspect 19: 89-93.

36. Rosenberg J [1990]. Solvents. In: Occupational Medicine. LaDou J (ed.). Norwalk, CT: Appleton & Lange, pp. 359-386.

37. NIOSH [1987]. NIOSH Respirator Decision Logic. Cincinnati, OH: U.S. DHHS (NIOSH) Publication No. 87-108.

38. NIOSH [1993]. Notice to All Users of Type CE, Abrasive-Blast Supplied-Air Respirators Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health - Appalachian Laboratory for Occupational Safety and Health (ALOSH), 1095 Willowdale Road, Morgantown, WV 26505-2888.

39. NIOSH [1975] Criteria Document: Industrial Health and Safety Criteria for Abrasive Blast Cleaning Operations. HEW (NIOSH) Publication No. 75-122.

40. CFR. Code of Federal Regulations: Washington, DC: U.S. Government Printing Officer, Office of the Federal Register. U.S. Department of Labor, Occupational Safety and Health Administration. [29 CFR 1910.1200].

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Copies of this report have been sent to:

1. Johnson Brothers Company
2. OSHA Area Office, Wilkes-Barre, PA
3. OSHA Area Office, Pittsburgh, PA
4. Pennsylvania Health Department

For the purpose of informing affected employees, copies of this report should be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table I
ENVIRONMENTAL EXPOSURE CRITERIA

Johnson Brothers Company
Pittsburgh, PA
HETA 93-1037

SUBSTANCE	NIOSH REL	OSHA PEL	ACGIH TLV
Crystalline Silica	0.05 mg/m^3*** (Respirable)	250/(% SiO_2 + 5) (mppcf)*	0.1 mg/m^3 (Respirable)
Methyl Isobutyl Ketone	50 ppm 75 ppm STEL	100 ppm	50 ppm
Xylenes/Ethyl Benzene	100 ppm 900 ppm IDLH	100 ppm	100 ppm TWA 125 ppm STEL
Toluene	100 ppm 500 ppm IDLH	200 ppm 300 ppm ceiling	50 ppm TWA
Aluminum	10 mg/m^3 (total dust) 5 mg/m^3 (respirable)	15 mg/m^3 (total dust) 5 mg/m^3 (respirable)	10 mg/m^3 (total dust)
Arsenic	0.002 mg/m^3*** (15 minute ceiling)	0.01mg/m^3	0.01 mg/m^3 confirmed human carcinogen
Beryllium	0.0005 mg/m^3*** ceiling	0.002mg/m^3 0.005 mg/m^3 ceiling	0.002 mg/m^3 suspected human carcinogen
Iron	5 mg/m^3 TWA as Iron Oxide	15 mg/m^3 (total dust)	5 mg/m^3 (total dust as iron oxide)
Lead	0.10 mg/m^3	0.05 mg/m^3**	0.15 mg/m^3 (intended change to 0.05 mg/m^3)

* OSHA construction standard based on 1970 TLV (impinger method for quartz; nuisance dust)
** OSHA has specific standards for lead (29 CFR 1926.62) and arsenic (29 CFR 1910.1018) that are applicable to construction and which contain additional requirements for worker protection.
*** Potential Occupational Carcinogen

Table II
RESPIRABLE CRYSTALLINE SILICA CONCENTRATIONS DURING SANDBLASTING OPERATIONS

Johnson Brothers Company
Pittsburgh, PA
HETA 93-1037

JOB/TYPE SAMPLE	RESPIRABLE DUST (mg/m^3 as a TWA)	RESPIRABLE CRYSTALLINE SILICA (mg/m^3 as a TWA)
Pike County /personal	16	16
Pike County /personal	19	19
Pike County /personal	16	15
Pike County /personal	32	27
Pike County /area	9	7
Pike County /area	11	7
Cranberry Township/area	0.7	0.7
Cranberry Township/area	1.0	0.8

Table III
RESPIRABLE CRYSTALLINE SILICA SAMPLING RESULTS OF POT TENDERS
(PERSONAL SAMPLES)

Johnson Brothers Company
Pittsburgh, PA
HETA 93-1037

JOB SITE	CONCENTRATION (8-HOUR TWA mg/m^3)
Pike County*	0.00
Pike County	0.01
Pike County*	0.00
Cranberry Township*	0.00

* Three filters had less than 0.02 mg of weight change, the limit of detection.

Table IV
SAMPLING RESULTS FOR HYDROCARBONS DURING SPRAY PAINTING OPERATIONS AT THE PIKE COUNTY JOB SITE
(ALL SAMPLES WERE PERSONAL SAMPLES)

Johnson Brothers Company
Pittsburgh, PA
HETA 93-1037

HALF-SHIFT CONCENTRATION (approximates 8-hour TWA)	ANALYTE
>55 ppm sample number 1	MIBK* ***
>31 ppm sample number 1	Toluene** ***
>42 ppm sample number 1	Xylenes/ ethyl-benzene** ***
0.36 ppm sample number 2	MIBK
0.27 ppm sample number 2	Toluene
0.08 ppm sample number 2	Xylenes/ethyl-benzene

* breakthrough occurred, the NIOSH REL for MIBK of 50 ppm was exceeded.

** breakthrough occurred, the NIOSH REL for toluene and ethyl benzene may have been exceeded.

*** the NIOSH REL for the mixture was exceeded; however, the amount of exposure above the REL could not be quantified due to breakthrough.