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Health Hazard Evaluation Determination Report 77-42-4522 Cleaning House at the Wire Mill, Bethlehem Steel Corporation, Johnstown, Pennsylvania

National Inst for Occupational Safety & Health, Cincinnati, OH

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 77-42-452

CLEANING HOUSE AT THE WIRE MILL
BETHLEHEM STEEL CORPORATION
JOHNSTOWN, PENNSYLVANIA

DECEMBER 1977

I. TOXICITY DETERMINATION

Exposures of the employees in the Wire Cleaning House to hydrogen chloride and hydrochloric and sulfuric acid mists were found to exceed accepted exposure limits by NIOSH Health Hazard Evaluation personnel during the survey dates of February 9-10 and June 22-23, 1977. The exposures observed during this evaluation are not expected to result in serious or irreversible disease. However, workers have experienced respiratory irritation and probably tooth erosion as a result of exposures to sulfuric acid and hydrogen chloride. Worker exposures to carbon monoxide potentially exceed accepted limits when gasoline powered equipment is used in the area. Worker exposures to phosphoric acid were within acceptable levels. These determinations are based upon inspection of the work areas and materials used, medical interview of exposed workers, review of the medical records for a worker with lung disease, measurements of worker exposures to airborne contaminants, and review of the current knowledge of the materials used.

Medical interviews with workers at the wire cleaning operation elicited symptomatology suggesting chronic pulmonary disease in the majority of crane operators and picklers, but its incidence correlated more closely with the individual's smoking history than his occupational exposure to acid mists and/or gases. One-third of the cranemen and picklers described premature tooth erosion and loss. Forty-four percent of the picklers and cranemen reported skin problems probably related to skin contact with the materials in use. Medical records for a worker with documented pulmonary disease were reviewed. This individual's condition is not judged to be related to work exposures to sulfuric acid or hydrochloric acid. Recommendations for medical surveillance of the crane operators, picklers, and mobile operators are made in the report which follows.

Air sampling on June 22-23, 1977 found that the operator of crane cab No. 305 was exposed to as high as 2.94 mg/M^3 of sulfuric acid mist. This concentration of sulfuric acid exceeds the OSHA Standard of 1.0 mg/M^3 for "Ceiling" exposures. All air samples on June 22-23, 1977 failed to detect sulfuric acid, however, this appears to be because of analytical difficulties. Air samples for hydrogen chloride (by the impinger method) found concentrations as high as 2.7 mg/M^3 (2 ppm) on the crane cab No. 308. Again, analytical problems were experienced with some samples.

Detector tube measurements for hydrogen chloride gas found concentrations as high as 8 ppm (11.2 mg/M^3) in crane cab No. 308, and 8 ppm (11.2 mg/M^3) on the catwalk. The OSHA Standard for "Ceiling" exposures to hydrogen chloride is 7.0 mg/M^3 (5 ppm). Workers reported that the acid contamination of the work air was not as great on the survey dates as is sometimes experienced.

Details relating to the conduct, findings and conclusions of this investigation are contained in this report. A discussion of the toxic effects of the materials in use at this operation is also in this report. Recommendations for reducing worker exposures are included.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office at the Cincinnati address.

Copies of this report have been sent to:

a) Bethlehem Steel Corporation, Johnstown, Pennsylvania
b) Authorized Representative of Employees - Local Union 2634, United Steel Workers of America
c) United Steel Workers of America, Pittsburgh, Pennsylvania
d) NIOSH, Region III
e) U.S. Department of Labor, Region III

For the purpose of informing the approximately 28 affected employees, the employers shall post the Determination Report for a period of 30 days in a prominent place(s) near where exposed employees work.

III. INTRODUCTION

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

The National Institute for Occupational Safety and Health (NIOSH) received such a Request from an authorized representative of employees concerning employee exposures to hydrochloric acid, sulfuric acid, borax-lime, and Betha-lube® at the Cleaning House of the Wire Mill at Bethlehem Steel Corporation in Johnstown, Pennsylvania. It was stated on the Request that an employee has been treated for a lung condition and that other employees had visited their physicians due to congestion in their chests, throats, and lungs.

IV. HEALTH HAZARD EVALUATION

A. Evaluation Chronology

NIOSH industrial hygienists and a medical officer visited the Wire Mill operations on February 9-10, 1977 to investigate the alleged health hazards. A walk-through survey of the Wire Mill was performed by these NIOSH investigators to observe the work activities and collect information on the materials in use. Air sampling was performed for possible air contaminants. The NIOSH medical officer interviewed workers concerning their health problems. NIOSH industrial hygienists returned on June 22-23, 1977 to perform additional air sampling and observe work conditions.

The flooding of Johnstown, Pennsylvania in July of 1977 did not affect the Wire Mill operations except for a temporary disruption of work.

B. Process Description

The operation of concern at this facility involves the batch pickling of steel and alloy wire coils. The coils of wire are sequentially dipped in tanks for cleaning (or pickling), and coating by two overhead cranes. There are two lines of tanks; each line is serviced by a crane operator who spends the majority of the work time seated in the crane cab. The pickling of the wire coils is by dipping them in tanks containing either sulfuric acid (heated to about 160°F with an acid concentration ranging from 7.3 percent to 13.4 percent) or hydrochloric acid (at temperatures ranging from ambient to 125°F, with an acid concentration ranging from 4.7 percent to 11.9 percent) - or a combination of the two acids. Alloy wire is cleaned by dipping into both the hydrochloric acid and sulfuric acid tanks. The low and high carbon steel wire is cleaned in the sulfuric acid tanks only. The coils are then placed into tanks of various coating solutions: Bonder-lube® (phosphate), caustic/permanganate, Borax, and/or lime. There are several ovens ("Ross Baker") for drying the finished wire. The wire is then transferred to the wire drawing operations, which are physically adjacent to the wire cleaning area, or shipped out to buyers. There is a great deal of activity and material transport in the wire pickling area: lift trucks bring in and out the coils of wire, the two cranes are continually running along the two lines of tanks as the coils of wire are sequentially cleaned and coated, and there is considerable foot and motor-lift traffic from the adjacent rod mill and wire drawing operations.

The wire cleaning and coating operations are performed during three 8-hour shifts each day. At each shift, there are two crane operators and the pickler (he is responsible for adding acid or chemicals to the tanks, and other duties in close proximity to the tanks). Additionally, two fork lift ("mobile") operators enter the cleaning house to deliver and remove coils of wire.

C. Evaluation Methods

1. Medical

Private medical interviews were conducted with six of the crane operators, three of the picklers, and four of the truck operators ("Mobile Operators"). This represented workers from all three shifts. Medical histories were taken and correlations between symptoms and working conditions were explored. A meeting was held with the chief of the medical staff at the Bethlehem Steel Johnstown Clinic to discuss reported illnesses and injuries (OSHA Form 102) and the employees' complaints. The medical records of one employee with documented lung disease was reviewed and outside hospital records obtained.

2. Environmental

The industrial hygiene survey included 1) observation of work practices, 2) interview with employees regarding work at this operation, any work related health problems, and possible means of controlling exposures, and 3) air sampling to determine employee exposures.

Air sampling was conducted during the first and second work shifts of February 9, 1977, and during the first work shift on February 10, 1977. Air sampling was performed during the second site visit during the afternoon of June 22, 1977 and the first shift on June 23, 1977.

The following air sampling and analysis methods were used to estimate worker exposures to air contaminants:

Sulfuric and Hydrochloric Acid -

Sampling units were attached to the crane cabs to estimate the crane operators' exposures to sulfuric and hydrochloric acid. Area samplers were also placed on the catwalk for the purpose of comparing various sampling methods for sulfuric acid. The primary method of sampling and analysis involved using MSA Model G pumps to draw air at a rate of 1-1.5 liters per minute through an 0.8 um, 37-mm cellulose membrane filter (AA) in a three-piece cassette, followed by a midget impinger containing 10 ml distilled water (on the February 9-10, 1977 survey) or 10 ml of 0.5 N sodium acetate (during the June 22-23, 1977 survey). The AA filters from the February 9-10, 1977 survey were analyzed for sulfuric acid by the sulfate titration method (NIOSH Method S174). The AA filters from the June 22-23, 1977 survey were analyzed by NIOSH Cincinnati Laboratories by the ion chromatography method (P&CAM Method 268). The impinger samples for hydrochloric acid were analyzed by the chloride ion specific electrode method (NIOSH Method S246). Concurrent air samples (...at the same location during the same period.) for sulfuric acid were obtained. These methods included analysis of Whatman 40 filter samples (a method under developmental consideration by NIOSH), and analysis of glass fiber filter (impregnated with perimidyl ammonium bromide) samples according to

R. L. Thomas, et al (Anal. Chem., Vol. 48, p. 639-642 (1976). Analysis results for the Whatman 40 filter and glass fiber filter samples were not considered reliable upon subsequent evaluation.

Draeger colorimetric gas detector units also were used to measure hydrogen chloride and carbon monoxide. The hydrogen chloride units are not certified for accuracy. The carbon monoxide units are NIOSH certified to have an accuracy of ±35 percent at one-half the exposure limit and an accuracy of ±25 percent at one to five times the exposure limit.

D. Evaluation Criteria

1. Toxic Effects[1-5]

Hydrogen Chloride - Hydrogen chloride and hydrochloric acid mist exposures can cause irritation of the membranes of the eyes and upper respiratory tract, and prolonged exposure to low concentrations can cause erosion of the teeth. Severe exposures can result in pulmonary edema and laryngeal spasm, both of which can be fatal. There are no known chronic or acute systemic effects of hydrochloric acid.

Inhalation of high concentrations of hydrogen chloride can cause coughing and choking as well as inflammation and ulceration of the upper respiratory tract. Acid mists may cause bleeding of nose or gums and skin irritation. No organic damage is reported at levels of 5 ppm (7 mg/M^3). Irritation of mucous membrane occurs at 10 ppm (15 mg/M^3) although workers accustomed to hydrochloric acid may work undisturbed at this concentration, some researchers have viewed a level of 5 ppm as a borderline of significant irritation. Work becomes difficult in the range of 15 to 75 mg/M^3, and irritation of the throat membranes has been reported at exposures of 50 mg/M^3. Exposure levels above 75 mg/M^3 cannot be tolerated for longer than one hour. Intoxication from inhalation is rare, as the acid is highly irritating in low concentrations. There are reports of a higher evidence of chronic bronchitis and gastritis among hydrochloric acid-exposed workers. The American Conference of Governmental Industrial Hygienists (ACGIH) TLV of 5 ppm (7 mg/M^3) is believed to be sufficiently low to prevent toxic injury, but on the borderline of severe irritation. The odor threshold values reported vary from below 1 ppm to 10 ppm, the odor itself being pungent and subjectively irritating. The acid mists are not as dangerous as the hydrogen chloride gas because the acid has no strong dehydrating effect on the tissues.

Sulfuric Acid Mist - Surfuric acid mist is an aerosol of droplets of varying diameter of aqueous sulfuric acid solutions. The occupational hazard results not from the sulfate ion, but from either the hygroscopic (dehydrating) nature of the acid or its oxidizing potential. Concentrated solutions may char the skin, but mists of more dilute solutions can irritate the skin and mucous membranes as well as cause a dermatitis. Chronic exposures to sulfuric acid which are generally tolerated by workers has not been associated with serious or irreversible health effects. However, exposure to sulfuric acid has been claimed to result in conjunctivitis, frequent respiratory infections, emphysema and digestive disturbances.

Exposures from 0.8 to 17 mg/M^3 cause, first etching of the dental enamel, then erosion of enamel and denture with loss of tooth substance. This has little effect on dental caries. Inhalation of acid mist in high enough concentrations causes irritation of nose and throat, sneezing and coughing. At levels below these causing these effects, sulfuric acid causes a reflex increase in rate and the depth of respiration with reflex broncho constriction. Higher levels may result in bronchitic symptoms, nasal discharge and nose bleeds.

In controlled laboratory studies of symptoms correlated with various concentrations, it was found that at 1.1 to 2.4 mg/M^3 all subjects noticed considerable irritation at the base of the esophagus, and forty percent of the subjects noticed eye irritation. At 2.4 - 6.0 mg/M^3 all subjects experienced acute irritation of the mucous membranes and pronounced cough. No respiratory changes were elicited by exposures of less than 1.0 mg/M^3.

Particle size along with temperature and humidity appears to influence the toxic effects, large particles exerting their effects on the middle respiratory tract and smaller particles producing reflex broncho constriction. Lower concentrations under conditions of high humidity have been found to be more irritating than higher doses under less humid conditions. Interpretations of exposure-effect are thereby made difficult. In addition, human susceptability differs widely. Because of the many uncertainties present in the reported environmental sulfuric acid levels, it is not possible to estimate an exposure level to sulfuric acid mist which would eliminate the occurrence of dental etching and erosion.

A recent NIOSH Health Hazard Evaluation[6] by Price evaluated employee exposures to sulfuric acid and other air contaminants at a pickling operation of steel billets and blooms. Twelve of the 38 employees at this operation attributed symptoms to acid mist exposure from the pickling tanks: dental anomalies, sinus problems, head colds and irritation of the eyes, nose and throat. Worker exposures to sulfuric acid during this study ranged from below detectable limits to 0.48 mg/M^3. The method of analysis was the Barium-thorium Titration Method.[7] Samples were also analyzed by ion chromatography and colorimetric methods under development by NIOSH. No other air contaminants were found in levels which would have produced this type of symptomatology.

The effects of combined exposure to sulfuric acid and hydrogen chloride should be considered additive. The irritant properties of these acids are similar, and probably additive, due to their dehydrating effects on tissue. There are no reported studies on the possible additive or potentiated effects from sulfuric acid and hydrogen chloride exposures.

Carbon Monoxide - Excessive carbon monoxide exposure can result in adverse health effects due to the blood's reduced ability to transport oxygen to the tissues. Hemoglobin, the blood's oxygen carrying protein, will preferentially bind carbon monoxide and have a reduced oxygen carrying capacity. Such an oxygen deficiency to the tissues is first observed

as a headache, nausea and mental impairment. In extreme exposure conditions, unconsciousness and death can occur. Carbon monoxide in the blood can be reduced by removing the affected person to uncontaminated air or administering oxygen. Employees in the Wire Cleaning area could potentially be exposed to carbon monoxide as a result of the operation of a faulty fork lift, gasoline powered engines, and the smoking of cigarettes. Heavy cigarette smokers commonly have levels of carbon monoxide in their blood which are comparable to occupational over-exposure.

2. Environmental Criteria

Airborne exposure limits intended to protect the health of workers have been recommended or promulgated by several sources. These limits are established at levels designed to protect workers occupationally exposed to a substance on an 8-hour per day, 40-hour per week basis over a normal working lifetime. For this investigation, the criteria used to assess the degree of health hazards to workers were selected from three sources:

a. NIOSH Recommended Standards - airborne limits which NIOSH has recommended to OSHA for occupational health standards,

b. Threshold Limit Values (TLV's) - guidelines for airborne exposures recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) for 1977,

c. OSHA Standards - the air contaminant standards enforced by the U.S. Department of Labor as found in Federal Register, Vol. 39, 23540-23543, June 27, 1974.

The criteria used in this investigation to assess potential health hazards from airborne exposures are listed below:

Source	Substance	8-hour Time Weighted Average Concentrations
OSHA Standard	Surfuric Acid	1.0 mg/M^3*
NIOSH Criteria Document	Sulfuric Acid	1.0 mg/M^3
OSHA Standard C*	Hydrogen Chloride	7.0 mg/M^3 (5 ppm*)
1977 TLV, C*	Hydrogen Chloride	7.0 mg/M^3 (5 ppm)
OSHA Standard	Carbon Monoxide	50 ppm
1977 TLV	Carbon Monoxide	50 ppm
1977 TLV, Tentative STEL*	Carbon Monoxide	400 ppm
NIOSH Criteria Document	Carbon Monoxide	35 ppm
NIOSH Criteria Document, C	Carbon Monoxide	200 ppm
OSHA Standard	Phosphoric Acid	1 mg/M^3

mg/M^3* = approximate milligrams of contaminant per cubic meter of air.
ppm* = parts of contaminant per million parts of contaminated air by volume.
C* = ceiling value, that level of exposure which can not be exceeded at any time.
Tentative STEL* = a maximal allowable concentration, or absolute ceiling, not to be exceeded at any time. An ACGIH 1977 Threshold Limit Value (TLV).

NIOSH Recommended Standards and TLV's are only recommended exposure limits whereas the OSHA Standards are those promulgated and enforced by the U.S. Department of Labor (OSHA).

E. Results and Discussion

1. Medical

Thirteen employees were interviewed during the medical evaluation, all males. The mean age was 51 years with a range from 32 to 56 years. The symptoms elicited are listed in Table I. Two groups are designated according to their exposure to the acid gases and mists; Group 1 consists of the two crane operators and one pickler worker for each shift, and Group 2 consists of the mobile operators, four of whom were interviewed. To assess the possible role of occupational exposure to the symptoms described, the following correlations are useful.

a. Proximity - Of the crane operators and picklers, seven of nine felt they had a work-related health problem. Among the mobile operators, two of four answered similarly. None of the workers were experiencing symptoms during the interview and there was general agreement that the acid mists on the day of the interview were not overly bothersome.

b. Length of Exposure - The pickling operation has a very low worker turnover rate, the average time on their job of Group 1 workers being 15 years, with a range of eight months to 30 years. In this group, the two individuals who felt they had no medical problem related to work had only three years and less than one year of full-time work in the plant. Each person with longer exposure than this claimed to have a work-related medical problem. In Group 2 workers, the average occupational exposure was 13 years, the range being from three to 27 years. No correlation between exposure time and symptoms was noted in this small sample.

c. Smoking History - There was a high correlation between positive smoking history and respiratory complaints. Of the 13 individuals sampled, eight reported smoking cigarettes, the average duration being 28.7 pack years. One individual smoked cigars, approximately four per day, for about ten years. All of the smokers complained of significant cough except for one individual who complained of only occasional cough. Most of the coughs were productive of significant quantities of sputum. No non-smokers in either group complained of a significant cough, but two non-smokers did complain of slight shortness of breath while on the job.

A meeting was held with the chief of the medical staff of the Bethlehem Steel Medical Clinic in Johnstown. The case history and medical records of one individual with documented significant lung disease was reviewed and hospital records were obtained. The Chief stated that among those workers involved in the pickling operation, there was no higher evidence of upper respiratory complaints or skin rashes. He had no knowledge of increased incidence of tooth erosion among these workers. The workers did not report a high incidence of seeking medical help outside the plant facility, but outside medical records were not obtained with the exception of the case to be discussed.

The hazard evaluation request specifically cited one worker who had developed pulmonary disease while working at the pickling operation. It was the worker's belief, shared by some of his colleagues, that his disease was occupationally caused. A routine chest X-ray revealed bilateral upper lobe infiltrates with hilar adenopathy, especially on the right side. Diagnostic workup revealed a non-caseating granulomatous inflammation. It is unlikely that this is occupationally related.

2. Environmental

The site visits on February 9-10 and June 22-23, 1977 enabled NIOSH industrial hygienists to observe work activities and conditions. Production conditions and activities were generally considered to be "typical or normal" for these time periods. The temperatures at the worksite during the February visit were about 40°F and more mist from the acid and coating tanks was noticeable than during the June visit. The temperature ranged from about 70-80°F with about 70-80 percent humidity during the June visit. There were construction related activities occurring during the June visit.

A slightly noticeable acid "odor" or "irritation of the nose" was minimally noticeable to the NIOSH investigators in all areas of the Wire Cleaning House. The irritation of the nose and throat becomes progressively more noticeable as the tanks of acid are approached. Irritation of the nose and throat was very apparent to the NIOSH industrial hygienists at times when riding on the crane cabs and while on the catwalk. There were occasional moments when the NIOSH industrial hygienists could not tolerate the acid mists (one occasion was just after adding sulfuric acid to a tank). Informal interviews with the picklers and crane operators disclosed that they experience mild to moderate irritation of the throat and nose as well as other symptoms. It was stated that the acid in the air sometimes was almost intolerable. The crane operators and picklers generally expressed concern about the acid contamination of the air because of 1) the obvious presence of acid in the air, 2) the corroded structural steel of the building, and 3) their fellow worker with a lung condition.

Observation of the work activities and location of the acid tanks indicated that the pickler and crane operators would be most exposed. The mobile operators had significantly lower exposures due to the

limited time spent near the wire cleaning operation. Adjacent work areas, the wire drawing and patent oven areas, reportedly are contaminated by acid mists from the wire cleaning operations. These areas would be expected to have significantly lower levels of acid air contamination than the wire cleaning area.

Tables II - IV summarize the results of air sampling on February 9-10 and June 22-23, 1977 for acid mists and gases. Table II shows that air concentrations of hydrogen chloride on February 9-10, 1977 ranged from below detectable levels to 2.72 mg/M^3. The OSHA Standard for Ceiling exposures is 7.0 mg/M^3 (5 ppm). All of the air samples taken in the crane cabs approximated the crane cab operators breathing zone concentrations. Table III shows detector tube measurements of hydrogen chloride ranging from less than 0.5 mg/M^3 to 10 mg/M^3. These "grab samples" represent levels of hydrogen chloride which workers could be exposed to at specific locations. The air sampling results for hydrogen chloride are of questionable reliability: 1) only the air samples collected in 0.1 N sodium hydroxide showed measurable levels of hydrogen chloride, concurrent samples collected in 0.5 N sodium acetate did not show detectable levels, 2) air samples for hydrogen chloride using sodium acetate collecting media on June 22-23, 1977 were all below detectable analytical limits (less than 0.026 milligram per sample where air sample volumes ranged from 79 to 135 liters), 3) impinger air samples for hydrogen chloride on the catwalk (a location expected to have high hydrogen chloride levels) did not detect any, and 4) air samples for hydrogen chloride using Draeger detector tubes are not NIOSH certified for accuracy, this method does not measure hydrochloric acid mist. The air sampling results for hydrogen chloride should be considered to underestimate, rather than overestimate, the actual hydrogen chloride and hydrochloric acid mist concentrations. Table IV shows that air concentrations of sulfuric acid mist ranged from below detectable limits to 2.43 mg/M^3. The OSHA Standard for Ceiling exposures is 1.0 mg/M^3. The air samples in Table IV were analyzed by the ion chromatography method (P&CAM Method 268) considered to be the most reliable and accurate method of analysis for sulfuric acid. All sixteen air samples taken for sulfuric acid on February 9-10, 1977 were analyzed by NIOSH Method S174 and were reported to be below detectable limits of sulfuric acid (the analytic lower limit of detection is 0.01 milligrams per sample and air sample volumes ranged from 39 to 164 liters). The air sample analysis results for sulfuric acid from all of the February 9-10, 1977 samples, and the June 22-23, 1977 samples with the Whatman 40 and glass fiber filters were not considered correct because of the metal ions present which interferred with analysis. Table V shows that phosphoric acid air concentrations ranged from 0.02 to 0.05 mg/M^3. The OSHA Standard is 1.0 mg/M^3. Table VI shows the results of air sampling for carbon monoxide at selected locations and times. Concentrations of carbon monoxide in the work area were generally less than 10 ppm, however, a fork lift unit and a gasoline powered compressor unit (involved in construction activities in an adjacent area on June 23, 1977) were identified as emitting hazardous quantities of carbon monoxide.

The tanks of acids and coatings are not mechanically ventilated. Several portable air moving fans are in the coating area and are used to blow excessive wet coatings off of the wire. Clouds of steam and acid mist could be visually observed to travel up and out of the louvers in the ceiling some of the time. Much of the mist cloud disperses in the work area, especially during particular climatic conditions.

D. Conclusions

1. Based on the medical histories elicited, there was evidence of chronic pulmonary disease in a majority of the crane operators and picklers, but its incidence correlated more closely with the individual's smoking history than his occupational exposure to acid mists and/or gases.

2. The irritant effects upon the respiratory tract which were experienced vary significantly depending upon temperature, humidity, and acid concentrations. With certain combinations of the above factors, almost all the workers experienced difficulty breathing, quite likely the result of reversible bronchoconstriction superimposed upon whatever chronic obstructive disease is present.

3. One-third of the cranemen and picklers described premature tooth erosion and loss. Each of these men had at least 21 years occupational exposure in their present job. This is quite likely related to long-term acid mist exposures.

4. Forty-four percent of the picklers and cranemen reported skin problems. These were felt to be primarily contact related and preventable by proper precautions such as wearing gloves and keeping their feet dry, not using some of the chemicals to clean their hands, etc.

5. In the one worker with documented pulmonary disease, the presumptive diagnosis appeared to be warranted from a brief review of the medical records.

6. The operator of crane cab No. 305 had exposures to sulfuric acid mist exceeding the OSHA ceiling value of 1.0 mg/M^3 on June 22 and 23, 1977. Detector tube measurements for hydrogen chloride indicated that worker exposures could exceed the OSHA ceiling limit in the crane cabs and on the catwalk area at times. Worker exposures to phosphoric acid and other potential air contaminants were not found to exceed accepted limits. Analysis of these filter samples for sulfuric acid by NIOSH Method S174 is not appropriate due to the interferences caused by metal ions present in the air.

7. Air concentrations of carbon monoxide can approach or exceed accepted limits when gasoline powered machinery is used or if fork lift units are not properly maintained.

8. Worker exposures to acid gases and mists from the wire cleaning operations are currently controlled by regulating the concentration and temperature of the acid baths and by maintaining a top layer of a mist-suppressing foam product. Natural ventilation is depended upon to clear the air of accumulated acids but is only partially effective. Workers in the area reported that the accumulation of acid gases and mists was much more noticeable at times, probably due to climatic conditions.

V. RECOMMENDATIONS

1. Worker exposures to acid gases and mists should be reduced to prevent dental errosion and irritation of the respiratory tract. There is no documented evidence that exposure levels which were measured during the study dates would result in serious or permanent health effects. The most cost-effective means of reducing worker exposures is probably by the more frequent addition of mist-suppressing foams and careful regulation of the temperature and acid concentrations of the acid tanks. If possible, workers should avoid areas where high acid mists are detected by irritation to the eyes or throat. For example, workers should physically distance themselves from tanks during "topping" operations. Enclosure of the crane cabs and supplying them with purified air would significantly reduce exposures. The most effective reduction of worker exposures to acid mists and gases (in the wire cleaning and other adjacent areas) would probably be accomplished by utilizing a system of lateral exhaust hoods at the tank edges. The NIOSH publication, Recommended Industrial Ventilation Guidelines (pp. 205-223, 311-313)[8], provides guidelines for designing appropriate ventilation systems. Respirators should not be considered as a means of controlling exposures because of the facial irritation which occurs at the points of facepiece contact.

2. Workers should continue to prevent skin contact with materials by the use of gloves, long sleeved shirts and other protective clothing. The use of barrier creams should be accelerated when the possibility of skin contact with the materials exists.

3. Air sampling for sulfuric acid and hydrogen chloride should be conducted during periods when workers feel that air contamination is great. The wire cleaning and coating operations should be re-evaluated if any process changes occur.

4. The present maintenance practices for the fork lift units should be continued to insure that excessive carbon monoxide accumulations do not occur in the workplace. Gasoline powered equipment should not be used in enclosed areas unless the exhaust is appropriately vented.

5. The Company should perform medical surveillance of the crane operators, picklers, and "mobile" operators at the wire cleaning operation. Comprehensive preplacement and annual medical examinations should be directed toward, but not limited to, the teeth, eyes, skin, and the cardiopulmonary system. Particular attention should be focused on dental

erosion and complaints of mucous membrane irritation and cough. These medical records should be maintained for at least twenty years after the individual's employment is terminated.

6. Worker education regarding the real and potential dangers of exposures as well as misconceptions should be attempted.

VI. REFERENCES

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7. Part II Standards Completion Program Validated Methods, S-174, DHEW (NIOSH) Publication No. 77-157-C, Cincinnati, Ohio, 1977.

8. NIOSH 1976, Recommended Industrial Ventilation Guidelines. pp. 205-223, 311-313, HEW Publication No. (NIOSH) 76-162. Single copies are available from the Division of Technical Services, Publications, NIOSH, 4676 Columbia Parkway, Cincinnati, Ohio 45226.

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TABLE I

SYMPTOMS ELICITED IN WORKERS AT THE WIRE CLEANING HOUSE

BETHLEHEM STEEL CORPORATION
JOHNSTOWN, PENNSYLVANIA

FEBRUARY 1977

	GROUP 1		GROUP 2	
	Crane Operators and Picklers (9)		Mobile Operators (4)	
SYMPTOMS	# POSITIVE RESPONDERS	PERCENT	#POSITIVE RESPONDERS	PERCENT
Cough	6	67	1	25
Shortness of breath	4	44	2	50
Chest pain, tightness	3	33		
Sore throat	1	11	1	25
Nose or gum bleeding	1	11		
Headaches	1	11		
Chronic eye irritation	1	11	1	25
Skin rash	4	44	2	50
Accelerated tooth loss	3	33		
Tooth discoloration	1	11	2	50
Hemoptosis	1	11		
History of previous lung disease	2*	22		
Smoking History	7**	78	2	50
Symptoms while at work during hot, humid days				
Eye burning	6	67	2	50
Cough	5	55		
Difficult breathing, throat burning	9	100	2	50
Dizziness or headache	2	22		
Skin irritation	1	11		
"Do you feel you have a work related health problem"	7	78	1	25

* One episode acute bronchitis, one worker with pulmonary opacity on chest X-ray, told later this had cleared on repeat chest X-ray.

** Includes one cigar smoker.

TABLE II

SUMMARY OF AIR SAMPLING FOR HYDROGEN CHLORIDE*

BETHLEHEM STEEL CORPORATION
JOHNSTOWN, PENNSYLVANIA

February 9-10, 1977

Sample Location	Sample Period	Collecting Media	Concentration of HCl mg/M^3**
	2/9/77		
Cab #308	12:30 - 3:34 PM	Sodium acetate	N.D.[a]
Cab #308	12:30 - 3:34 PM	Sodium hydroxide	2.26
Cab #305	12:25 - 3:41 PM	Sodium acetate	N.D.***
Cab #305	12:25 - 3:41 PM	Sodium hydroxide	N.D.[a]
Cab #305	3:41 - 6:24 PM	Sodium acetate	N.D.
Cab #305	3:41 - 6:24 PM	Sodium hydroxide	N.D.
Cab #308	3:40 - 6:15 PM	Sodium acetate	N.D.
Cab #308	3:40 - 6:15 PM	Sodium hydroxide	2.72
	2/10/77		
Cab #308	8:25 - 11:35 AM	Sodium acetate	N.D.
Cab #305	8:20 - 11:33 AM	Sodium acetate	N.D.
On Catwalk	8:30 - 11:35 AM	Sodium acetate	N.D.
On Catwalk	8:30 - 11:35 AM	Sodium acetate	N.D.

* OSHA Standard for ceiling exposures - 7 mg/M^3 (5ppm).

** mg/M^3 - approximate milligrams of sulfuric acid per cubic meter of air.

*** N.D. - none detected.

[a]N.D. - none detected where the analytic lower limit of detection was 0.15 milligram per sample, air sample volumes ranged from 39 to 195 liters.

TABLE III

SUMMARY OF DRAGER* DETECTOR TUBE MEASUREMENTS FOR HYDROGEN CHLORIDE*

BETHLEHEM STEEL CORPORATION
JOHNSTOWN, PENNSYLVANIA

Sample Location	Sample Period	Concentration of hydrogen chloride, ppm[a]
In Cab #308 - at unloading area	2/10/77[b]	N.D.[c]
In Cab #308 - at Bonderlube tank	2/10/77[b]	N.D.
In Cab #308 - at heated HCl tank	2/10/77[b]	N.D.
Adjacent to heated HCl tank	2/10/77[b]	10
In Cab #308 - at heated HCl tank	2/10/77[b]	8
In Cab #308 - at heated HCl tank	2/10/77[b]	N.D.
	6/22/77	
Breathing zone of operator, Cab #305	2:45 PM	1
Breathing zone of operator, Cab #305	2:55 PM	0.5
Breathing zone of operator, Cab #305	4:42 PM	1.5
Adjacent to hydrogen chloride tank on the Cab #305 side	4:52 PM	2.5
On catwalk	4:55 PM	8.0
Breathing zone of operator, Cab #308	5:10 PM	1.0

* Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

** OSHA Standard for ceiling exposures - 5 ppm (7 mg/M^3).

a - ppm - parts of hydrogen chloride per million parts of contaminated air by volume.

b - These samples were taken sequentially at about 2:00 PM, just after the addition of acid and other chemicals.

c - N.D. - None detected where the lower limit of measurement is about 0.5 ppm.

TABLE IV

SUMMARY OF AIR SAMPLING RESULTS FOR SULFURIC ACID*
AT THE WIRE CLEANING OPERATION

BETHLEHEM STEEL CORPORATION
JOHNSTOWN, PENNSYLVANIA

June 22-23, 1977

Sample Location	Sample Period	Concentration of H_2SO_4 Mg/M^3**
	6/22/77	
Cab #305	2:20 - 3:48 PM	0.29
Cab #308	2:25 - 4:07 PM	0.11
Cab #305	3:59 - 5:20 PM	2.94
Cab #308	4:22 - 5:15 PM	0.20
Cat Walk,		0.33
Cat Walk (concurrent samples)	2:00 - 3:20 PM	0.35
Cat Walk,	3:27 - 4:50	1.00
Cat Walk (condurrent samples)		0.17
	6/23/77	
Cab #305	7:57 - 9:25 PM	0.39
Cab #308	8:09 - 9:40 PM	0.18
Cat Walk	8:15 - 9:40 PM	0.25
Cab #305	9:30 - 10:35 PM	2.43
Cab #308	9:45 - 11:00 PM	0.17

* - OSHA Standard for ceiling exposures - 1 mg/M^3.

**mg/M^3 - approximate milligrams of sulfuric acid per cubic meter of air.

Table V

SUMMARY OF AIR SAMPLING FOR PHOSPHORIC ACID*

BETHLEHEM STEEL CORPORATION
JOHNSTOWN, PENNSYLVANIA

February 9-10, 1977

Sample Location	Sample Period	Concentration of Phosphoric acid mg/M^3**
	2/9/77	
Cab #305	12:25 - 3:41 PM	0.05
Cab #308	12:30 - 3:34 PM	0.02
	2/10/77	
On the Catwalk	3:24 - 6:03 PM	0.02

* - OSHA Standard - 1.0 mg/M^3

** mg/M^3 - approximate milligrams of phosphoric acid per cubic meter of air.

TABLE VI

SUMMARY OF AIR SAMPLING FOR CARBON MONOXIDE*

BETHLEHEM STEEL CORPORATION
JOHNSTOWN, PENNSYLVANIA

Sample Location	Sample Period	Concentration of Carbon monoxide ppm**
Next to Ross Baker when a fork lift was present	2/10/77	35
Next to Ross Baker -	2/10/77	10
Unloading area for Cab #308	2/10/77	10
	6/23/77	
On Cab #305 side, 25 feet from gasoline-powered compressor	10:00 AM	40 - 50
Wire loading area for Cab #305	10:15 AM	20 - 40

* - OSHA Standard - 50 ppm

**ppm- Parts of carbon monoxide per million parts of contaminated air by volume.

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5. Report Date: *Dec. 1977*

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7. Author(s): *Jack O. Geissert*

8. Performing Organization Rept. No.

9. Performing Organization Name and Address

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13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstracts *A Health Hazard Evaluation investigation was conducted by NIOSH on February 9-10, and June 22-23, 1977, in the Wire Cleaning House of the Bethlehem Steel Corporation in Johnstown, Pennsylvania. The survey was prompted by a request from an authorized employee representative concerning exposure to toxic chemicals and alleging a high incidence of respiratory disorders among the employees. Exposure of employees to hydrochloric acid and sulfuric acid exceeded accepted exposure limits, while exposure to carbon monoxide potentially exceeded accepted limits during the use of gasoline powered equipment. Medical interviews elicited symptomatology suggesting chronic respiratory disease in most of the crane operators and picklers, but its incidence correlated more closely with smoking history than with occupational exposure to acid mists and/or gases. One-third of the cranemen and picklers described premature tooth erosion and loss, while 44% of the workers in this group reported skin problems probably related to skin contact with the materials in use. Recommendations are made for reducing worker exposures.*

17. Key Words and Document Analysis. 17a. Descriptors

Environmental surveys
Industrial hygiene
Industrial atmospheres
Industrial plants
Air pollution
Atmosphere contamination control
Toxicology
Inorganic acids
Iron and steel industry
Chemical cleaning
Carbon monoxide
Exhaust gases
Skin diseases
Dental caries
Respiratory diseases

17b. Identifiers/Open-Ended Terms

Air quality measurement
Exposure limits

17c. COSATI Field/Group *06/J*

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