U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 77-31-432

INLAND STEEL CORPORATION
EAST CHICAGO, INDIANA 46312

OCTOBER 1977

## I. TOXICITY DETERMINATION

The National Institute for Occupational Safety and Health conducted a health hazard evaluation January 17-20, and May 25-26, 1977, in Plant #2 (P.C. Dock) at the Inland Steel Corporation, East Chicago, Indiana. The following determinations are based upon environmental sampling, medical evaluation by interviews, observations of work practices, engineering controls, and a review of pertinent literature.

Personal and area samples were collected over 8-hour work shifts to determine the airborne concentrations of free crystalline silica (quartz and cristobalite), total particulate, sulfuric acid, iron oxide, lead, copper, manganese, nickel, chromium, zirconium, and hafnium. Short-term measurements were taken for phenol and formaldehyde.

An over-exposure to lead existed when billets and blooms containing lead were cut with an oxy-acetylene torch. The Scrap Burner sampled on May 26, 1977, was exposed to 0.27 mg/$M^3$ of lead, which exceeded the existing OSHA Standard of 0.2 mg/$M^3$, as well as the NIOSH Recommended Standard of 0.1 mg/$M^3$ and the TLV of 0.15 mg/$M^3$. The airborne concentrations of all other contaminants sampled were not potentially toxic under the conditions which existed during this evaluation. This is supported by the lack of complaints and symptoms reported for the days visited.

While air sampling results indicated that worker exposures to airborne sulfuric acid were within acceptable limits, review of the medical questionnaires revealed previous symptomatic conditions common to sulfuric acid exposure. These symptoms included upper respiratory tract irritation, eye irritation, dermatitis, and dental anomalies.

Recommendations are included in the report in the interest of maintaining a safe and healthful work environment.

## 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. Inland Steel Corporation, East Chicago, Indiana
b. Authorized Representative of Local 1010, United Steelworkers of America
c. United Steelworkers of America, Pittsburgh, Pa.
d. U.S. Department of Labor - Region V
e. NIOSH - Region V

For the purpose of informing the approximately 70 "affected employees" the employer shall promptly "post" for a period of 30 calendar days the Determination Report 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 in the place of employment might have potentially toxic effects as it is used or may be found.

The National Institute for Occupational Safety and Health received such a request from an authorized representative of Local 1010, United Steelworkers of America, regarding exposures of workers to free crystalline silica, lead, sulfuric acid, and contaminants released from the abrasive grinding of steel billets and blooms. Also, it was alleged that employees were eating in open areas where an exposure to these contaminants may occur.

## IV. HEALTH HAZARD EVALUATION

### A. Process Description

The work force at the Pickling and Chipping Dock (P.C. Dock) is comprised of approximately 70 production personnel over four turns. The process is located in about 100,000 square feet of building space with a ceiling height ranging from 40-60 feet. Equipment housed in the building included four cranes (3 in operation), four grinders (3 in operation), two pickling tanks, and one Magna-Glo machine.

The basic function of the P.C. Dock is the removal of defects from the steel billets and blooms before they are processed in a rolling mill. Billets are pieces of steel ranging in size from 3 7/8 to 7 1/4 inches square with lengths varying from 14 to 41 feet. Blooms have a larger cross-sectional area than billets, with such dimensions as 8 1/2 x 7 1/2 inches and lengths up to 14 feet. Steel billets and blooms are brought in from the primary mill and prepared for inspection by either a descaling process employing sulfuric acid (Pickling) or a Magna-Glo process. Inspection of the steel is performed to determine if any cracks or splits are present which would propagate upon further processing.

The actual cleaning is done by first immersing the steel into a sulfuric acid bath at heated temperatures, then into a rinsing tank containing water. Under normal operating conditions the acid is heated to approximately 170 F.

In preparation for pickling the blooms are gathered into groups of six and the billets into groups of seven by an overhead crane; these groups are referred to as lifts. During pickling, two lifts of blooms are immersed in each of the two pickling tanks, giving a total of 24 blooms; or three lifts of billets are placed in each tank, giving a total of 21 billets. The "pickle-hooker" and his assistant work in the general area of the tanks where they chain and unchain the lifts in the tanks. These employees are also involved with the addition of ingredients to the tanks.

The acid for the tanks is stored outside the building and pumped in when necessary. A chemist analyzes the tanks several times daily for salts, temperature, and percent by weight of sulfuric acid. When the acid concentration is too low or the salt concentration too high, the tank contents are pumped out into underground holding areas, then removed by truck.

After the scale has been removed, an inspector examines the lifts to mark any defects that are present. Depending on the number of defects, the type of steel, and operation time available, the steel is sent either to the chippers or to the grinders for further processing. Surface defects are generally removed by hand in the Chipping Area using pneumatic hammers. Those defects which are deeper into the steel are removed through abrasive grinding. Each grinding machine is equipped with a cab to house the operator and with a 110 pound abrasive wheel which rotates at 900 rpm. This equipment is mounted on tracks in order that the grinding wheel can be moved along the steel to be ground. Each operator services 2-3 tables (total of 8 tables) where the billets and blooms are positioned during processing. The finished billets and blooms are then loaded by crane onto railcars to be moved to a rolling mill.

B. Environmental Controls

Sulfuric acid generation from the pickling operation is controlled through means of dilution ventilation, natural air movement, and the addition of a surface tension liquid to retard production of acid mist. The general ventilation system consists of 5 wall fans mounted approximately 40 feet above the tanks. Each fan has a capacity of 19,400 cubic feet per minute (CFM). The surface tension liquid (Activol 1834) is added to the acid to enhance the descaling process and to control excessive hydrogen evolution. The vendor of Activol 1834 reports[1]. that the "aerosol effect" created by the bursting of hydrogen bubbles at the surface of the tank is reduced, thus lowering the amount of acid mists released into the atmosphere.

Grinder operators are enclosed in cabs equipped with a filtration system for the air. When grinding, the abrasive wheel throws the metal filings into a ventilated booth approximately 10 feet from the wheel. For every two tables, one motor operates the ventilation system. Each table consists of three hoods which are connected to a common plenum. The designed exhaust capacity for the total system is 120,000 CFM.

C. Evaluation Design and Methods

The initial environmental and medical survey was performed January 17-20, 1977. During the visit a walk-through survey of the facility was conducted, persons working in the plant were privately interviewed regarding possible health problems, and air sampling was performed. A second visit was made May 25-26, 1977, to complete the medical evaluation and the environmental sampling.

1. Air Sampling

Personal sampling and area sampling was performed to evaluate employee exposure. The personal sampler was attached on the lapel of the employee in order to collect an air sample representative of his breathing zone. Area samplers were positioned at specific locations in the working environment and generally within a distance of 0.5 to 3 feet from the workers' breathing zone. Each of the sampling data tables (Tables I-VI) includes information denoting the types of samples collected and their location.

a. Crystalline Silica: Personal and high volume area respirable dust samples were collected using two stage cyclone size - selective samplers. The sampling train for the personal samples consisted of a Mine Safety Appliance* (MSA) vacuum pump operating at a flow rate of 1.7 liters per minute (lpm), in conjunction with a 10 millimeter (mm) nylon cyclonic separator containing a pre-weighed 5.0 micron (u) pore size FWS-B filter. The high volume samples were collected using a pre-weighed 5.0 u FWS-B filter mounted in a three piece cassette, a 1/2 inch steel cyclone, and a Gast pump equipped with a critical orifice to regulate the flow rate at 9.0 lpm. The filters were analyzed gravimetrically to determine total milligrams of dust and subsequently analyzed by x-ray diffraction to identify and quantitate the various polymorphs of crystalline silica present. The lower limits of analytical detection using x-ray diffraction for quartz and cristobalite were 30 micrograms (ug) and 40 ug, respectively.

b. Lead, Iron, Manganese, Copper, Nickel, and Chromium: These metals were concurrently collected on a pre-weighed 5.0 u pore size VM-1 filter mounted in a 3 piece closed face cassette. The samples were collected at a flow

*Mention of commerical names or products does not constitute endorsement by NIOSH.

rate of 1.5 lpm using an MSA vacuum pump. The metals were analyzed by digesting and solubilizing the filter in a nitric acid solution and then aspirating the analyte into an atomic absorption spectrophotometer. Prior to digestion of the filters, a total dust determination was performed gravimetrically. The lower limit of detection as reported in milligrams (mg) per sample for the analyses were as follows: (1) lead, 0.013; (2) iron, 0.0094; (3) copper, 0.0008; (4) manganese, 0.0025; (5) nickel, 0.0067; and (6) chromium, 0.0008.

c. Lead, Iron, Copper, Chromium, Zirconium and Hafnium: During the follow-up survey lead, iron, copper, and chromium were again sampled and analyzed using the same methodology previously described for these metals, with the exception that 0.8 u mixed cellulose ester membrane filters were employed as the collection media. Zirconium and hafnium were collected on the initial survey using the same type filters and analyzed by x-ray fluorescence. The lower limits of detection as reported in milligrams per sample were as follows: (1) lead, 0.006; (2) iron, 0.002; (3) copper, 0.001; (4) chromium, 0.0009; (5) zirconium, 0.005; and (6) hafnium, 0.005.

d. Sulfuric Acid: Samples were collected for sulfuric acid on 0.8 u mixed cellulose membrane filters and Whatman #40 filters mounted in separate 3 piece closed face cassettes; air was drawn through the samplers at a flow rate of 1.5 lpm for four hours using vacuum pumps. Sulfuric acid collected on the mixed cellulose mbrane filters was extracted with distilled water and isopropyl alcohol. The .tract was analyzed by ion chromatography and/or by Barium-Thorin Titration (0.005 M barium perchlorate with Thorin used as the indicator). Prior to titration, the extract was passed through an ion exchange column for removal of any interference metals. Samples collected on Whatman 40 filters were analyzed by heating the filters in an oven to 120 C for 48 hours, producing a color change. The color change was then compared to standard filters. (This method was recently developed by NIOSH.)

The lower limits of detection reported in milligrams per sample for the methods were as follows: (1) ion chromatography, 0.01; (2) Barium-Thorin Titration, 0.01-0.06; and (3) NIOSH method using Whatman Filters, 0.02.

e. Formaldehyde and Phenol: The presence of these substances was monitored using direct reading Drager detector tubes. The lower ranges of measurement for the formaldehyde and phenol detector tubes were 0.5 and 5.0 parts per million (ppm), respectively.

2. Medical Evaluation

During the January 17-20, and May 25-26, 1977, field investigations, medical questionnaires were completed on 38 of approximately 70 employees affected by the alleged health hazards. A non-directed medical questionnaire was used to elicit any symptoms or medical problems which were immediately apparent to the employee. The interviews included the employee's work history, symptoms experienced on the job, and any aggravating or alleviating factors.

D. Evaluation Study Criteria

1. Toxicological Effects

Only those substances in which the airborne concentrations exceeded one-third of the applied exposure limits will be discussed in this section.

a. Sulfuric Acid: Sulfuric acid is classified as a primary irritant.[2] When introduced into the body in liquid or vapor form, it causes intense irritation and chemical burns of the mucous membranes of the respiratory and digestive tract, eyes, skin, and teeth. On contact with the skin, sulfuric acid causes dehydration and releases heat in sufficient quantities to produce burns. The depth of the lesions depends on the concentration of the acid and the length of contact.[3] Splash juries to the eyes are in practice the most serious adverse effect of sulfuric id in industry. Contact with concentrated acid of any magnitude is capable of producing irreparable corneal damage resulting in blindness.[4] Dental lesions are also common; they affect mainly the incisors[3] through the softening of the dentine.[2]

Inhalation of sulfuric acid vapors produces the following symptoms: nasal secretion, sneezing, a burning feeling in the throat and retrosternal region; these are followed by cough, respiratory distress, sometimes accompanied by spasm of the vocal cords, a burning sensation in the eyes with lachrymation and conjunctival congestion.[3]

b. Lead: Lead poisoning may occur through the inhalation and/or ingestion of lead fumes or dust. This results in the deposition of lead in the bones and tissue of the body and alterations in normal physiological function. No single sign or symptom may be considered diagnostic of lead poisoning. Lead poisoning may present such symptoms as a metallic taste in the mouth, loss of appetite, indigestion, nausea, vomiting, constipation, abdominal cramps, nervousness, insomnia, colic and also loss of kidney function which may be irreversible.[5]

Many of the sources of lead poisoning are industrial, but man also absorbs lead in small amounts from his food and water, and from the air. These sources lead to the "normal" body burden of lead, not normally leading to poisoning. Goldwater and Hoover have reported a worldwide blood lead mean of 0.017 milligrams of lead per 100 milliliters of whole blood (0.017 mg/100 ml).[6] The National Institute for Occupational Safety and Health defines the unacceptable level of lead to be 60 'crograms of lead per 100 milliliters (60 ug/100 ml) of whole blood or greater,[7] at levels of 0.20 mg of lead per liter of urine or greater.[8]

2. Environmental Evaluation Criteria

Airborne exposure limits intended to protect the health of workers have been recommended or promulgated by several sources. These limits represent conditions under which it is believed that nearly all workers may be repeatedly exposed to a substance on an 8-hour per day, 40-hour per week basis without adverse effects. For this investigation, the criteria used to assess the degree of health hazards to workers were selected from three sources: (1) airborne exposure limits which NIOSH has recommended to OSHA for occupational health standards, (2) Threshold Limit Values (TLV's) for 1976 and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH), and (3) Occupational Health Standards as promulgated by the U.S. Department of Labor (Federal Register, 29CFR1910, pp. 506-509, January 1, 1976). The exposure limits applicable to the principal chemical substances of this evaluation are as follows:

| | EXPOSURE LIMITS ($mg/M^3$)* | | |
|---|---|---|---|
| Contaminant | NIOSH | TLV's | OSHA |
| Chromium | | 1 | 1 |
| Copper | | 0.2(Fume)<br>1 (Dust) | 0.1 (Fume)<br>1 (Dust) |
| Formaldehyde | 1.2(c)** | 3 (C) | 4 |
| Vanadium | | 0.5 | 0.5 |
| Iron Oxide Fume | | 5 | 10 |
| Lead | 0.10*** | 0.15 | 0.2*** |
| Manganese | | 5 (C) | 5 (C) |
| Nickel | 0.015 | 1 | 1 |
| Phenol | 20 | 19 | 19 |
| Silica (Respirable) | 0.05**** | 10 $mg/M^3$ / % quartz +2 | 10 $mg/M^3$ / % quartz +2 |
| Sulfuric Acid | 1 | 1 | 1 |
| Zirconium | | 5 | 5 |
| Total Particulate | | 10 | 15 |

*$mg/M^3$ - milligrams of contaminant per cubic meter of air.
**"C" - designated a ceiling value which should not be exceeded for an interval of 30 minutes or less. All other values presented in the table are permissable exposure levels based on an 8-hour time weighted average.
***OSHA has proposed a standard for lead of 0.10 $mg/M^3$ as of October, 1975. NIOSH presented testimony March, 1977, supporting the proposed standard.
****Applies to all polymorphs of free crystalline silica.

The NIOSH Recommended Standards and the TLV's are given prominence in this evaluation since they are the most current criteria. If the three sources cite criteria values which differ for the same contaminant, the most stringent value will be used to assess the hazard. Federal standards are the legal standards and enforcement is a responsibility of the U.S. Department of Labor, OSHA.

E. Evaluation Results and Discussion

1. Environmental

a. Results of the Initial Survey

Results of the air sampling conducted January 18-19, 1977, for sulfuric acid, iron oxide, lead, copper, manganese, nickel, chromium, zirconium, hafnium, silica, phenol, and formaldehyde were all within the acceptable limits (Tables I, III, V and VI). The only exposure that exceeded one-half the applied standard was Crane Operator "O". An exposure of 0.08 $mg/M^3$ of lead was determined for this employee (NIOSH recommended level is 0.1 $mg/M^3$).

Airborne concentrations of various contaminants were monitored at the lunch table located near the Chipping Area. The concentrations reported in $mg/M^3$ were as follows: (1) sulfuric acid, 0.18-0.24; (2) lead, 0.02; and (3) iron oxide, 0.36. Analyses did not indicate the presence of copper, manganese, nickel, chromium, or silica (quartz and cristobalite).

Except for the temperatures of the pickling tanks, the process observed during the initial survey appeared representative of normal conditions. Some concern was expressed relative to the amount of leaded steel which was processed during the survey. It was believed by some employees that less than normal amounts of leaded steel were being ground. When reviewing the production levels for January through December 1976, approximately 34% of the time leaded steel was ground, as compared to approximately 50% at the time of the survey.

b. Results of Follow-up Survey

Due to the frigid ambient conditions during the initial visit the temperatures of the pickling tanks were lower than normal, ranging from 104-142 F. To sample for sulfuric acid under representative conditions a follow-up survey was conducted in May, at which time the temperatures of the tanks ranged from 162-182 F.

All sulfuric acid samples collected on the follow-up were analyzed by Ion Chromatography and by the NIOSH method using Whatman Filters. One sample was analyzed by Barium-Thorin Titration. Additional samples could not be analyzed by this method since the concentration of sulfate was not sufficient to allow the analyte to be divided. When comparing data, the samples analyzed by Ion Chromatography generally produced the highest results. (Table II). The highest concentrations detected were in Crane Cabs 1 and 2 in which the ambient levels approached one-half the standard of 1.0 $mg/M^3$.

Simultaneous samples were collected for iron, chromium, copper, and lead in order to determine metallic interferences with the Barium-Thorin Titration method. Although the airborne concentrations of these metals were below the recommended health standards, the data (Table IV) has been supplemented as additional information to the reader.

Production during the initial survey did not include cutting of the leaded billets and blooms with an oxy-acetylene torch. On the follow-up, the Scrap Burner involved with this process was sampled to evaluate lead exposure. The results presented in Table IV illustrate that the employee exposed on 5/26/77 exceeded both the NIOSH recommended standard of 0.10 $mg/M^3$ and the existing OSHA standard of 0.2 $mg/M^3$. It should be noted that the Scrap Burner on 5/25/77 did not cut any leaded steel; whereas, the Scrap Burner on 5/26/77 did cut leaded steel for about 1.5 hours.

2. Medical

Medical questionnaires were completed for all production personnel assigned to the first and second shifts. Questioning was carried out in a non-directed manner to elicit complaints and/or symptoms believed by the employee to be job related. A total of 38 men (males constituted 100% of the P.C. Dock's population) were interviewed representing approximately 50% of the 70 person work force. The average age for those interviewed was 35 years, with a median age of 32 years and a range of 18-59 years. The average duration of employment at Inland Steel was 9 years, with a median of 9 years, and a range of 6 months to 25 years.

Table VII and VIII summarizes the pertinent points of the employee interviews. The most frequent health complaints associated with contaminant exposures were mucous membrane irritation resulting from work performed near the pickling tanks. Of the 38 employees interviewed 12 had symptoms which they attributed to sulfuric acid exposure. The symptomatology included dental anomalies, dermatitis, sinus problems, head colds and tissue irritation of the eyes, nose and throat. Three employees also mentioned that the dusts and fumes generated by abrasive grinding and burning of scrap have caused occasional discomfort (headaches and sinus congestion).

As anticipated from administering a non-directed medical questionnaire, a variety of other complaints and symptoms of medical conditions were elicited. Four employees complained of back pains or soreness due to turning the billets by hand; one employee complained of earaches resulting from noise produced in the adjacent mill; and four employees mentioned various conditions (i.e., arthritis, stiffness in joints) which were attributed to or aggravated by the cold and damp environment.

F. Conclusions and Summary

Based on environmental sampling it was concluded that an excessive airborne concentration of lead was produced when billets and blooms containing lead were burned with an oxy-acetylene torch. The Scrap Burner monitored on 5/26/77 was exposed to 0.27 mg/M$^3$ of lead. The operation was not equipped with mechanical ventilation nor was respiratory protection used by the employee.

All other sampling conducted during the survey failed to detect excessive levels of silica, iron oxide, copper, manganese, nickel, chromium, zirconium, hafnium, phenol, formaldehyde, and sulfuric acid. These results are supported by the lack of symptoms and complaints reported by the employees during the days sampled. However, worker complaints (in the past) of dermatitis, dental problems, and irritation of the eyes, nose, and throat suggested that excessive exposure to sulfuric acid mist has previously occurred.

Area sampling conducted at the lunch table detected the presence of sulfuric acid, lead, and iron oxide. The concentrations of these contaminants were less than 25% of the occupational exposure standards.

## V. RECOMMENDATIONS

Several of the recommendations cited below are contained in the NIOSH criteria documents relative to lead[8] and sulfuric acid[9] exposure.

A. Lead

1. It is recommended that the Scrap Burning operation be adequately ventilated to preclude excess lead exposure.

2. Inland Steel should continue their biological monitoring program for lead. Biological monitoring should be made available to all workers subject to lead exposure equal to or above one-half the recommended environmental limit of 0.1 mg/M$^3$. The frequency at which biological monitoring is conducted depends upon the type of biological media used (blood or urine) and the ambient

concentration of lead. As recommended by NIOSH, when urine is used as the sampling media, each worker should be offered biological monitoring semi-annually. If blood is used, half of the workers subject to lead exposure should be monitored every 6 months, so that each worker is monitored yearly. When environmental sampling indicates ambient lead concentrations at or greater than the standard, the interval of biological monitoring should be reduced one-half. This increased frequency should be continued for at least 6 months after the high environmental level has been shown.

3. Each employee who absorbs unacceptable amounts of lead as indicated by biological monitoring should be examined as soon as practicable after such absorption is demonstrated and confirmed, and at least every 3 months thereafter until his blood or urine lead levels have returned to normal.

4. Personal air monitoring should be conducted semiannually for those employees occupationally exposed to lead, except as otherwise indicated by a professional industrial hygiene survey. If environmental levels of lead are at or above the standard, personal monitoring should be increased to every 3 months.

5. The company should initiate a respirator program, meeting the requirements outlined in the Occupational Safety and Health Standards, 29 CFR 1910.134(b)(1)-(11). Respiratory protection should be considered for use at the Scrap Burning operation as an interim measure until the proper engineering controls can be implemented.

a. The company should provide respirators in accordance with Table IX and should insure the employees use the respirators in a proper manner. Only respirators approved by NIOSH or the Mining Enforcement and Safety Administration should be used. The standard for approval is specified in 30 CFR 11. The company should insure that respirators are properly cleaned, maintained, and stored when not in use.

b. Employees should not be assigned to tasks requiring use of respirators unless it has been medically determined that they are physically able to perform the work and use the equipment.

6. Workers should receive periodic instructions on proper personal hygiene practices when exposed to lead. Instructions should include such points as: (1) wearing and changing of protective clothing, (2) washing exposed areas of the skin before eating, and (3) problems associated with eating, drinking, and smoking in areas where lead may be present.

B. Sulfuric Acid

1. It is recommended that Inland Steel conduct environmental sampling of the pickling operation at least semiannually. This is especially true since past symptomatology indicated possible over exposure to sulfuric acid mist.

2. An annual medical examination should be provided to exposed personnel if environmental sampling indicates airborne sulfuric acid concentrations equal to or above one-half the recommended standard of 1.0 $mg/M^3$. The examination should be directed toward, but not limited to, the teeth, eyes, skin, and cardiopulmonary system. Particular attention should be focused on dental erosion and complaints of mucous membrane irritation and cough.

3. Impervious protective clothing, such as rubber gloves, aprons, suits, hoods, and boots should be used when skin contact with sulfuric acid is likely. When there is a danger of sulfuric acid eye contact appropriate eye protection should be worn.

4. The emergency shower and eye wash at the pickling tanks was inoperative and thus should be repaired.

C. General

1. Employees should not consume food or beverages in any area exposed to toxic materials. It is recommended that management discourage future use of the lunch table located near the Chipping Area. Such contaminants as lead, sulfuric acid, and iron oxide were present at this location.

2. It is recommended that Inland Steel assess the employee complaints concerning back problems from turning billets manually.

3. The fogging created by condensation of moisture from the pickling tanks significantly reduced the visibility on the catwalk leading to the cranes. This condition was observed to be worse during the initial survey on January 17-20, 1977 than during the follow-up survey conducted May 25-26, 1977. The extremely cold ambient temperatures produced extensive fogging that not only affected visibility above the tanks where the operators entered the cranes, but also the visibility was reduced throughout the area. It is recommended that Inland Steel evaluate the conditions and implement any necessary corrections.

4. A continuing educational program should be instituted to ensure that all workers have current knowledge of job hazards, proper hygiene practices, and that they know how to correctly use personal protective equipment.

5. Many health and safety problems can be corrected through joint efforts between labor and management. Should any potential problems arise, fast action from both parties to determine their existence will promote future cooperation while providing for a safe and healthful workplace.

## VI. AUTHORSHIP AND ACKNOWLEDGEMENTS

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2. Hygienic Information Guide No. 14 - Sulfuric Acid: Commonwealth of Pennsylvania, Department of Health, Division of Occupational Health, 1964.

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4. Fasullo, OT: Sulfuric Acid Use and Handling, McGraw-Hill, N.Y., 1965.

5. Hygienic Information Guide No. 8 - Lead: Commonwealth of Pennsylvania, Department of Health, Division of Occupational Health, 1969.

6. Goldwater, I., and Hoover, A.: An International Study of "Normal" Levels of Lead in Blood and Urine. Arch. Environ. Health 15:60-63, 1967.

7. Statement of Edward J. Baier, Deputy Director for the National Institute for Occupational Safety and Health, Before the Department of Labor (OSHA) Public Hearing on Occupational Lead Standard, March 1977.

8. Criteria for a Recommended Standard..Occupational Exposure to Lead, NIOSH, HEW, Washington, D.C. 1972.

9. Criteria for a Recommended Standard..Occupational Exposure to Sulfuric Acid, NIOSH, HEW, Washington, D.C. 1974.

TABLE I

Summary of Air Sampling For Sulfuric Acid[1]

Inland Steel Corporation
East Chicago, Indiana

January 18-19, 1977

| Date | Location | Job Classification | Sample Type | Sampling Period | Sampling Volume ($M^3$)[2] | Concentration ($mg/M^3$)[3] |
|---|---|---|---|---|---|---|
| 1/18/77 | Crane No. 1 | Craneman | P[4] | 0812-1158 | 0.34 | 0.29 |
| | | | | 1159-1555 | 0.35 | 0.15 |
| | Crane No. 2 | Craneman | P | 0813-1158 | 0.34 | 0.29 |
| | | | | 1159-1555 | 0.35 | 0.18 |
| | Pickle Tanks | Pickle Hooker | P | 0814-1133 | 0.29 | 0.25 |
| | | | | 1133-1537 | 0.37 | 0.07 |
| | Pickle Tanks | Asst. Pickle Hooker | P | 0815-1130 | 0.29 | 0.48 |
| | | | | 1130-1541 | 0.38 | <0.03 |
| | Lunch Table | | A[5] | 0840-1147 | 0.28 | 0.24 |
| | | | | 1147-1550 | 0.36 | 0.18 |
| 1/19/77 | Crane No. 1 | | A | 0805-1602 | 0.71 | 0.18 |
| | Crane No. 2 | | A | 0810-1602 | 0.70 | 0.01 |
| | Pickle Tanks | Pickle Hooker | P | 0821-1540 | 0.66 | 0.14 |

1. Samples analyzed using Barium - Thorin Titration. Lower limit of detection was 0.01 mg per sample.
2. $M^3$ - cubic meter
3. OSHA Standard - 1 milligram of sulfuric acid per cubic meter of air (1 $mg/M^3$) as measured by an 8-hour time-weighted average exposure.
4. P - Personal sample collected in breathing zone of employee.
5. A - Area sample

TABLE II

Summary of Air Sampling for Sulfuric Acid[1]

Inland Steel Corporation
East Chicago, Indiana

May 25-26, 1977

| Date | Location/Operation | Sample Type | Sampling Period | Sampling Volume ($M^3$)[3] | Concentration ($mg/M^3$)[2] | | |
|---|---|---|---|---|---|---|---|
| | | | | | Ion Chromatography | NIOSH Method Using Whatman Filters | Barium - Thorin Titration |
| 5/25/77 | Crane 1 | A[4] | 1602-2010 | 0.37 | 0.48 | 0.14 | 0.4 |
| | | | 2025-2340 | 0.29 | 0.15 | 0.13 | |
| | Crane 2 | A | 1615-2008 | 0.35 | 0.50 | <0.18 | |
| | | | 2030-2328 | 0.27 | 0.30 | 0.17 | |
| | Pickle Tanks (Pickle Hooker) | P[5] | 1621-1953 | 0.32 | 0.12 | 0.10 | |
| | | | 1953-2335 | 0.33 | 0.18 | 0.13 | |
| | Pickle Tanks (Asst. Pickle Hooker) | P | 1622-1945 | 0.30 | 0.12 | 0.12 | |
| | | | 1945-2330 | 0.34 | 0.19 | 0.12 | |
| 5/26/77 | Crane 1 | A | 0800-1215 | 0.38 | 0.24 | 0.13 | |
| | | | 1230-1532 | 0.27 | 0.18 | 0.16 | |
| | Crane 2 | A | 0805-1210 | 0.37 | 0.36 | 0.09 | |
| | | | 1235-1530 | 0.26 | 0.13 | 0.13 | |
| | Pickle Tanks (Pickle Hooker) | P | 0812-1157 | 0.34 | 0.17 | 0.11 | |
| | | | 1157-1532 | 0.32 | 0.09 | 0.12 | |
| | Pickle Tanks | A | 0820-1200 | 0.33 | 0.27 | 0.10 | |
| | | | 1200-1540 | 0.33 | 0.12 | 0.11 | |

1. Analytical method used:

| | Lower Limits of Detection (mg per sample) |
|---|---|
| Ion Chromatography | 0.01 |
| NIOSH method using Whatman Filters | 0.02 |
| Barium - Thorin Titration | 0.06 |

2. OSHA Standard - 1 milligram of sulfuric acid per cubic meter of air (1 $mg/M^3$) as measured by an 8-hour time-weighted average exposure.
3. $M^3$ - cubic meter
4. A - area sample
5. P - Personal sample collected in breathing zone of employee.

TABLE III

Summary of Air Sampling for Various Metals[1]

Inland Steel Corporation
East Chicago, Indiana

January 18, 1977

| Location | Job Classification | Sample Type | Sampling Period | Sampling Volume ($M^3$)[2] | Concentration ($mg/M^3$)[3] Iron Oxide | Lead | Copper | Manganese | Nickel | Chromium | Zirconium | Hafnium | Total Particulate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crane No. 1 | Crane Operator | P[4] | 0802-1555 | 0.71 | 1.3 | 0.05 | <0.01 | <0.01 | ND[5] | <0.01 | | | 1.9 |
| Crane No. 2 | Crane Operator | P | 0806-1555 | 0.70 | 0.77 | 0.03 | <0.01 | ND | ND | <0.01 | | | 1.9 |
| Crane No. 0 | Crane Operator | P | 0803-1555 | 0.71 | 2.7 | 0.08 | <0.01 | 0.01 | ND | <0.01 | | | 2.6 |
| Grinder No. 1 | Grinder Operator | P | 0808-1553 | 0.70 | 0.62 | 0.02 | <0.01 | ND | ND | ND | ND | ND | 1.0 |
| Grinder No. 2 | Grinder Operator | P | 0811-1549 | 0.69 | 0.52 | 0.02 | ND | ND | ND | <0.01 | ND | ND | 0.9 |
| Grinder No. 3 | Grinder Operator | P | 0815-1557 | 0.69 | 0.55 | ND | ND | ND | ND | <0.01 | ND | ND | 0.9 |
| Chipping | Chipper | P | 0813-1548 | 0.68 | 0.34 | ND | <0.01 | ND | ND | <0.01 | | | 0.6 |
| Pickle Tanks | Asst Pickle Hooker | P | 0822-1545 | 0.66 | 0.74 | 0.02 | <0.01 | ND | ND | <0.01 | | | 1.1 |
| Grinding Area | Recorder | P | 0823-1548 | 0.67 | 0.67 | 0.02 | <0.01 | ND | ND | <0.01 | | | 1.1 |
| Lunch Table | | A[6] | 0833-1544 | 0.65 | 0.36 | 0.02 | ND | ND | ND | ND | | | 0.7 |

1. Iron Oxide, lead, copper, manganese, nickel and chromium samples collected on 5.0 micron VM-1 filters; zirconium and hafnium collected on 0.8 micron mixed cellulose membrane filters.
2. $M^3$ - cubic meter
3. $mg/M^3$ - milligrams of substance per cubic meter of air
4. Personal sample collected in breathing zone of employee
5. ND - None detected
6. Area sample

| | Limits of Detection (mg per sample) | OSHA Standard for 8-Hour Time Weighted Average Exposures ($mg/M^3$) | |
|---|---|---|---|
| Iron Oxide | 0.0094 | 10 | |
| Lead | 0.013 | 0.2 | |
| Copper | 0.0008 | 0.1 | (Fume) 1.0 (Dusts) |
| Manganese | 0.0025 | 5 | (Ceiling value) |
| Nickel | 0.0067 | 1 | |
| Chromium | 0.0008 | 1 | |
| Zirconium | 0.005 | 5 | |
| Hafnium | 0.005 | 0.5 | |
| Total Particulate | -- | 15 | |

TABLE IV

Summary of Air Sampling for Various Metals[1]

Inland Steel Corporation
East Chicago, Indiana
May 25-26, 1977

| Date | Location/Operation | Sample Type | Sampling Period | Sampling Volume ($M^3$)[2] | Concentration ($mg/M^3$)[3] | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Iron Oxide | Lead | Copper | Chromium |
| 5-25-77 | Crane No. 1 | A[4] | 1602-2340 | 0.66 | 0.2 | <0.01 | <0.01 | <0.01 |
| | Crane No. 2 | A | 1615-2328 | 0.62 | 0.2 | <0.01 | <0.01 | <0.01 |
| | Pickle Tanks (Pickle Hooker) | P[5] | 1621-2335 | 0.65 | 0.22 | <0.01 | <0.01 | <0.01 |
| | Pickle Tanks (Asst Pickle Hooker) | P | 1622-2330 | 0.64 | 0.14 | <0.01 | <0.01 | <0.01 |
| | Chipping (Scrap Burner) | P | 1628-2332 | 0.64 | 0.22 | <0.01 | <0.01 | <0.01 |
| 5-26-77 | Crane 1 | A | 0800-1532 | 0.66 | 1.4 | 0.02 | <0.01 | <0.01 |
| | Crane 2 | A | 0805-1530 | 0.63 | 0.6 | <0.01 | <0.01 | <0.01 |
| | Pickle Tanks (Pickle Hooker) | P | 0812-1157 | 0.66 | 0.3 | <0.01 | <0.01 | <0.01 |
| | Pickle Tanks | A | 0820-1540 | 0.66 | 0.2 | <0.01 | <0.01 | <0.01 |
| | Chipping (Scrap Burner) | P | 0814-1532 | 0.66 | 1.6 | 0.27 | <0.01 | <0.01 |

1. Samples collected on 0.8 micron mixed cellulose membrane filters
2. $M^3$ - cubic meter
3. $mg/M^3$ - milligrams of substance per cubic meter of air
4. A - Area sample
5. P - Personal sample collected in breathing zone of employee

| | Limits of Detection (mg per sample) | OSHA Standard for 8-Hour Time Weighted Average Exposures ($mg/M^3$) | |
|---|---|---|---|
| Iron Oxide | 0.002 | 10 | |
| Lead | 0.006 | 0.2 | |
| Copper | 0.001 | 0.1 (Fume) | 1.0(Dusts) |
| Chromium | 0.0009 | 1 | |

TABLE V

Summary of Air Sampling for Free Crystalline Silica

Inland Steel Corporation
East Chicago, Indiana
January 18-19, 1977

| Date | Location | Job Classification | Sample Type | Sampling Period | Sampling Volume ($M^3$)[1] | Respirable Free Silica ($mg/M^3$)[2] | | Total Particulate ($mg/M^3$,[1] |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Quartz | Cristobalite | (Respirable Fraction) |
| 1-18-77 | Grinding Area | Recorder | P[3] | 0818-1545 | 0.76 | ND[5] | ND | 1.1 |
| | Grinder No. 3 | Grinder Operator | P | 0819-1541 | 0.75 | ND | ND | 1.2 |
| | Grinder No. 1 | Grinder Operator | P | 0821-1545 | 0.76 | ND | ND | 0.5 |
| | Grinder No. 2 | Grinder Operator | P | 0823-1545 | 0.75 | ND | ND | 1.5 |
| | Crane No. 0 | Crane Operator | P | 0824-1552 | 0.76 | ND | ND | 2.1 |
| | Chipping Area | Chipper | P | 0827-1541 | 0.74 | ND | ND | 0.8 |
| | Lunch Table | | A[4] | 0910-1540 | 3.5 | ND | ND | 1.2 |
| | Lunch Table | | A | 0910-1540 | 3.5 | ND | ND | 2.1[6] |
| 1-19-77 | Lunch Table | | A | 0817-1544 | 0.76 | ND | ND | 0.5 |

1. $M^3$ - cubic meter
2. $mg/M^3$ - milligrams of substance per cubic meter of air
3. Personal sample collected in breathing zone of employee
4. Area sample
5. ND - None detected
6. Total silica (respirable + non-respirable)

| | Limits of Detection Per Sample (mg) | OSHA Exposure Standard |
|---|---|---|
| Quartz | 0.03 | $\frac{10\ mg/M^3}{\%\ Si\ O_2 + 2}$ |
| Cristobalite | 0.04 | Use ½ quartz equation |
| Total Particulate (respirable fraction) | -- | 5 $mg/M^3$ |
| Total Particulate (respirable + non-respirable fraction) | -- | 15 $mg/M^3$ |

TABLE VI

Summary of Measurements Taken for Phenol
and Formaldehyde with Drager Indicator Tubes

Inland Steel Corporation
East Chicago, Indiana
January 19, 1977

| Location | Sample Type | Contaminant | Tube Reading |
|---|---|---|---|
| Grinder No. 3 | BZ | Phenol | None |
| | | Formaldehyde | None |
| Grinder No. 3 | A (outside of cab) | Phenol | None |
| | | Formaldehyde | None |

---

BZ - Sample collected in breathing zone of employee

A - Area sample

Lower range of measurement for Indicator Tube:

| | |
|---|---|
| Phenol | 5 ppm* |
| Formaldehyde | 0.5 ppm |

*ppm - Parts of contaminant per million parts of air by volume

TABLE VII

Job Related Medical Problems As Obtained
By Employee Interviews

Inland Steel Corporation
East Chicago, Indiana
January 18-19 and May 25-26, 1977

| Case Number | Complaints | Source of Problem Cited |
|---|---|---|
| 1 | Constant Colds (Sinus and Head) | Pickling Tanks |
| | Eye Irritation | Pickling Tanks |
| | Face Irritation | Pickling Tanks |
| 2 | None | |
| 3 | None | |
| 4 | Head Cold | Pickling Tanks |
| | Sinus Problems | Pickling Tanks |
| | Lacrimation | Pickling Tanks |
| | Dental Problems | Pickling Tanks |
| 5 | Back Strain | Turning Billets by Hand |
| 6 | Rash on Hands, Forehead, and Neck | Pickling Tank |
| | Occasional Headaches | Dust From Grinding |
| 7 | Sinus Problems | Acid and Dust |
| | Stiffness in Joints | |
| | Headaches | |
| 8 | Stiffness and Soreness in Bones | Exposure to Cold |
| 9 | None | |
| 10 | Occasional Eye Irritation | Pickling Tanks |
| 11 | Dry Throat | |
| | Knees Ache | Arthritis (Condition Worsening from Cold) |
| | Dental Problems | Pickling Tank |
| | Eye Irritation | Pickling Tank |
| | Chokes on Fumes | |
| 12 | None | |
| 13 | None | |
| 14 | Tooth Decay | Pickling Tanks |
| | Cold Feet | Cold Work Environment |
| 15 | Nasal Irritation | Pickling Tanks |
| 16 | None | |
| 17 | Eyes, Nose, and Throat Irritation | Pickling Tanks |
| | Tiredness | |
| | Earaches | Noise from Mill |
| | Soreness in Back | Turning Billets |
| 18 | Joints Hurt | Cold Work Environment |
| | Pain in Legs | |
| | Soreness in Back | Turning Lifts |
| 19 | None | |
| 20 | None | |
| 21 | None | |

TABLE VII (Cont'd)

| Case Number | Complaints | Source of Problem Cited |
|---|---|---|
| 22 | Slight Cold | |
| 23 | None | |
| 24 | None | |
| 25 | None | |
| 26 | Irritation From Fumes | Burning Scrap (Has not noticed problem since respirators were issued) |
| 27 | None | |
| 28 | None | |
| 29 | Sore Back | Lifting Billets |
| | Eye Irritation | Pickling Tanks |
| 30 | None | |
| 31 | None | |
| 32 | None | |
| 33 | None | |
| 34 | None | |
| 35 | Face and Nasal Irritation | Pickling Tanks |
| 36 | Heartburn | |
| 37 | None | |
| 38 | Sinus and Eye Irritation | Pickling Tanks (Also when grinding certain steels) |

TABLE VIII

Summary of Medical Complaints Mentioned
During Employee Interviews

Inland Steel Corporation
East Chicago, Indiana
January 18-19 and May 25-26, 1977

| Complaints | Workers Mentioning Problem* |
|---|---|
| Colds | 3 |
| Eye Irritation | 7 |
| Face Irritation | 2 |
| Sinus Problems | 6 |
| Dental Problems | 3 |
| Back Problems | 4 |
| Dermatitis | 1 |
| Headaches | 2 |
| Stiffness and Pains in Joints | 3 |
| Pain in Legs | 1 |
| Throat Irritation | 2 |
| Irritation From Fumes | 2 |
| Tiredness | 1 |
| Earaches | 1 |
| Cold Feet | 1 |
| Heartburn | 1 |

* Thirty-eight (38) employees were interviewed

TABLE IX

REQUIREMENTS FOR RESPIRATOR USAGE
AT CONCENTRATIONS ABOVE THE STANDARD[7]

| EXPOSURE | 8 Hour TWA $mg/M^3$ | | *RESPIRATOR TYPE |
|---|---|---|---|
| Inorganic lead dust | less than | 1.5 | A,B |
| | less than | 15.0 | C |
| | greater than | 15.0 | D |
| Inorganic lead fume | less than | 1.5 | E |
| | less than | 15.0 | F |
| | greater than | 15.0 | D |

* A - Reusable or replaceable filter-type air-purifying dust respirator

B - Single-use dust respirator

C - Powered air-purifying positive-pressure dust respirator

D - Type C positive-pressure supplied air respirator

E - Replaceable filter-type air-purifying fume respirator

F - Powered air-purifying positive-pressure fume respirator