HEALTH HAZARD EVALUATION REPORT 72-49-45

HAZARD EVALUATION SERVICES BRANCH

DIVISION OF TECHNICAL SERVICES

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

CINCINNATI, OHIO 45202

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EMPIRE DETROIT STEEL COMPANY
NEW BOSTON, OHIO

JUNE 1973

I. SUMMARY DETERMINATION

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 any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees to determine the potential toxicity associated with the manufacture of hot and cold rolled steel at the Empire Detroit Steel Company, New Boston, Ohio.

NIOSH industrial hygienists conducted an observational survey of this facility on January 16-18, 1973. Based on information obtained at this time, potential hazards did exist in various areas. A more complete evaluation of the working environment and a medical evaluation of selected employees was deemed necessary to complete this hazard evaluation. Bulk samples of materials used throughout the steel mill were submitted to the NIOSH laboratory for analysis.

An environmental survey was conducted on February 12-14, 1973. Environmental sample results based on an estimated 8-hour time-weighted-average exceeded the established health standards (Federal Register, Vol. 37, §1910.93, October 18, 1972) as shown below.

Substance	Standard Level Air Concentration (8-hr TWA[a])	
	p.p.m.[b]	mg/M^3 [c]
Carbon Monoxide	50	55
Cadmium	----	0.1
Nuisance Dust	----	15

[a] Time-weighted-average

[b] Parts of vapor or gas per million parts of contaminated air by volume at 25° C. and 760 mm Hg pressure

[c] Approximate milligrams of compound per cubic meter of air

Concentrations of total iron, total dust, copper, oil mist, fluoride, graphite, carbon, hydrogen chloride, cadmium, and carbon monoxide are reported. Combined concentrations had no additive effect. A total of 44 personal samples, with 78 determinations, were collected and analyzed for iron oxide, total dust, oil mist, fluoride, copper, hydrogen chloride, carbon monoxide, and cadmium. Sample results are summarized below. Only samples that exceeded the established health standards are discussed.

1. The standard for carbon monoxide was exceeded. The high carbon monoxide levels observed in the annealing furnaces reached 100 ppm (8-hour time-weighted-average). This high concentration was perhaps due to gas leakage in the chambers where the annealing furnaces are located. There are numerous gas outlets that burn continuously; but during the sampling for carbon monoxide, the industrial hygienists noted several of these outlets where gas was coming out but was not ignited.

2. Cadmium concentrations were taken on a welder in the welding shop. One sample reached over 8 mg/M^3. The welder complained of symptoms that indicated the possibility of metal fume fever.

3. Nuisance dust over the established health standards was found in the hand scarfing area, pipe shop, and open hearth area. Total iron samples were also treated in this report as nuisance dust samples. Total iron concentrations exceeded the nuisance dust established health standard in the pipe shop.

A medical evaluation was conducted on February 13, 1973, consisting of employee interviews in a number of areas in the steel mill.

1. Armature Shop - Eight workers work in this area and use trichloroethylene as a degreaser. Four workers were interviewed. There was no indication that they were experiencing symptoms of trichloroethylene overexposure.

2. Machine Shop - Fifteen welders routinely weld in the machine area or on location; in both instances poor ventilation is the rule. Five welders were questioned and four reported the classic symptoms of metal fume fever over the last year, especially when working on location in a closed, poorly ventilated area. In addition, other workers in the immediate area of the machine shop noted eye and throat irritation when heavy welding is being performed in the welding area.

3. Hand Scarfing Area - All four scarfers on the shift were interviewed. There was no indication that they were symptomatic from exposure to the irritative fumes or dusts produced during scarfing.

4. Temper Mill - Two operators who worked here were questioned. There was evidence of only an occasional dry throat with one of the workers and occasional oil mist spray settling on the worker's hand or arm. No dermatitis was noted from such oil mist exposure.

5. Open Hearth Area - Five of the twelve workers were working near the open hearth furnaces and were questioned regarding dust exposure. Most of the men were heavy smokers (1-1/2 to 2 packs per day) with chronic bronchitis, but none admitted to any shortness of breath.

Based on the results of the environmental and medical data presented above, it has been determined that potentially toxic conditions exist in the following areas of the Empire Detroit Steel Company:

a. Annealing furnace--on the basis of carbon monoxide levels (100 ppm TWA) in excess of the Federal standard (50 ppm).

b. Welding shop--on the basis of one cadmium sample of 8 mg/M^3, when the Federal standard is .1 mg/M^3 for an 8-hour TWA, and past history of metal fume fever from a majority of welders interviewed.

c. Hand scarfing, pipe shop, and open hearth--on the basis of nuisance dust samples which exceeded Federal standard.

Copies of this Summary Determination of the evaluation are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

a) Empire Detroit Steel Company
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region V

For purposes of informing the approximately 1000 "affected employees," the employer will promptly "post" the Summary Determination in a prominent place(s), near where affected employees work, for a period of 30 calendar days.

II. 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 any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees of the Empire Detroit Steel Company, New Boston, Ohio.

The request states that the primary hazard to be evaluated concerned the exposure of employees to numerous chemicals and compounds associated with steel manufacturing. Areas included in the hazard evaluation request are as follows:

Pickle Line, Tandem Mill, Annealing and Cold Strip, Open Hearth, Blooming Mill, Hand Scarfing, Hot Strip, Welding Shop, Temper Mill, Boilerhouse #7, Blacksmith Shop, Brickmason, Diesel Shop, Garage

This plant produces hot and cold rolled steel. It employs approximately 2500 workers. In the areas surveyed, there are approximately 1000 workers. There are three shifts operating seven days a week, twenty-four hours per day.

Many of the workers do either piece work or tonnage work. Therefore, an 8-hour exposure was difficult in some situations and impossible in others, since workers seldom work continuously for eight hours. This was especially true in the Hand Scarfing and Open Hearth Areas.

III. BACKGROUND HAZARD INFORMATION

A. Standards

The occupational health standards as promulgated by the U.S. Department of Labor (Title 29 Code of Federal Regulations, Chapter XVII, Part 1910, Subpart 1910.93, entitled "Air Contaminants") applicable to substances of this evaluation are as follows:

Substance	Eight Hour Time-Weighted Concentration	
	p.p.m.[a]	mg/M^3 [b]
Oil Mist, Mineral	---	5[c]
Iron-Fe (as Iron Oxide)	---	10
Total Dust (Inert or Nuisance Dust)	---	15
Fluoride	---	2.5
Copper	---	0.1
Hydrogen Chloride	5[d]	7[d]
Carbon Monoxide	50	55
Cadmium	---	0.1 (or 0.3[d])

[a] Parts of vapor or gas per million parts of contaminated air by volume at 25° C. and 760 mm Hg pressure.

[b] Approximate milligrams of compound per cubic meter of air.

[c] As sampled by method that does not collect vapor.

[d] Ceiling concentration and shall never be exceeded.

B. Toxic Effects

Oil Mist, Mineral - The primary effects of cutting oils and coolants are upon the skin, and dermatitis remains a common problem among workers in machining operations. Oil acne and folliculitis result basically from mechanical blockage of the follicular openings in skin contact areas. This results in comedones (blackheads) and papular lesions (pimples) associated with varying degrees of inflammation. Oil mist exposure in the steel industry results from treating hot and cold

rolled steel coils with mineral oils. Cutting oils may contain a large number of microorganisms. These organisms are almost always non-pathogenic. Oils used in the steel industry do not have the opportunity of becoming impregnated with bacteria as you find in the same oils used in coolants and cutting of metal.

The health standard for oil mist (mineral) of 5 mg/M^3 refers to airborne mist of petroleum-base cutting oils or white mineral petroleum oil. Experimental findings indicate that heat-decomposed oil fumes are irritant but apparently do not result in even relatively minor changes in the lungs at 5 mg/M^3. Theoretically, the inhalation of extremely high levels of oil mists could result in lipid pneumonitis. This has not been reported to be a problem in industry.

Iron-Fe (as Iron Oxide) - Iron and iron salts are generally considered to be of low orders of toxicity and are essential constituents of the human body. These needs are met by dietary intake. Excessive ingestion seldom results in toxicity, since absorption from the gastrointestinal tract is limited to body needs. However, the inhalation of Fe_2O_3 particulates eventually results in a benign pneumoconiosis (siderosis) manifested solely by radiographic stippling of the lungs. This occurs most commonly in electric-arc welders, silver polishers, and other rouge users. This condition results in few, if any, symptoms and causes no disability.

A standard of 10 mg/M^3 for iron oxide fume should prevent the development of X-ray changes in the lungs on long-term exposure. Although these changes are not considered to be associated with any physical disability, they sometimes present problems in differential diagnosis. More information is needed on the relationship of iron deposits in the lungs to exposure to other industrial dust.

Total Dust (Inert or Nuisance Dust) - Nuisance dusts have little adverse effects on the lungs and do not produce significant disease or toxicity when exposures are kept under reasonable control. These dusts are biologically inert in that when inhaled, the architecture of the alveoli remains intact; little or no scar tissue is formed; and any reaction provoked is potentially reversible. Excessive concentrations in workroom air may reduce visibility, cause unpleasant accumulations in the eyes, ears, or nose, and secondarily cause injury to the skin due to the vigorous cleansing procedures necessary for their removal.

Fluoride - Toxic effects of fluoride may be categorized into three groups: (a) Acute systemic intoxication; (b) local corrosion of mucous membranes and skin; and (c) chronic bone damage. Fluoride fumes are found in various foundries. Concentrations above 10 mg/M^3 have been shown to cause nosebleeds. At levels above 5 mg/M^3 eye and respiratory irritation have been observed. These symptoms are often found in welders using fluoride-coated welding electrodes. The standard of 2.5 mg F/M^3 is sufficiently low to prevent irritative effects and protect the worker against bone changes.

Copper - One of the chief industrial exposures to copper from which there are potential health effects is the fume. Fume exposures occur in copper and brass plants and in welding copper-containing metals. Health effects consist of irritation of the upper respiratory tract, metallic or sweet taste, nausea, metal fume fever, and in some instances discoloration of the skin and hair. Concentrations of copper fume from welding operations of 1 to 3 mg/M^3 of air for short periods resulted in altered taste response but no nausea; levels of from 0.02 to 0.4 mg/M^3 did not cause complaints.

Inhalation of dusts and mists of copper salts in considerably higher, but generally unmeasured, concentrations can result in congestion of nasal mucous membranes, sometimes of the pharynx and, on occasion, ulceration with perforation of the nasal septum. If copper salts in sufficient concentration reach the gastrointestinal tract, they act as irritants, producing salivation, nausea, vomiting, gastric pain, hemorrhagic gastritis, and diarrhea. Chronic exposures may result in an anemia, but chronic poisoning as from lead does not occur. On the skin, copper salts also act as irritants, producing itching eczema; and on the eye, conjunctivitis or even ulceration and turbility of the cornea.[1]

On the basis of current information, the standard of 0.1 mg/M^3 should protect the worker from any of the adverse effects of copper exposure.

Hydrogen Chloride - The harmful effects of hydrogen chloride are primarily on the eyes, skin, and mucous membranes. Discoloration of teeth and tooth decay have been noted from low exposures to hydrogen chloride. The most frequent route of entry is by inhalation. Pulmonary edema is possible, but usually the cough and choking sensation from intense irritation of upper respiratory tract compel the worker to leave the area before pulmonary edema occurs. The standard of 5 ppm or 7 mg/M^3 should protect a worker from any adverse effects caused by this chemical.

Carbon Monoxide - Carbon monoxide is an odorless, colorless, tasteless gas which is an active reducing agent for chemicals at elevated temperatures, but is principally encountered as a waste product of incomplete combustion of carbonaceous material. The best understood biologic effect of carbon monoxide (CO) is its combination with hemoglobin (Hb) to form carboxyhemoglobin (COHb), thereby

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[1] American Conference of Governmental Industrial Hygienists, Documentation of the Threshold Limit Values for Substances in Workroom Air, 1971, page 59.

rendering the hemoglobin molecule less able to bind with oxygen. This action of CO results in more persons succumbing each year to acute CO poisoning than to any other single toxic agent, except alcohol.[2]

Numerous publications and investigations have pointed out that CO exposures exist in almost every industrial setting. A standard of 35 ppm determined as a time-weighted average (TWA) exposure for an 8-hour workday (40 hour week), has been proposed by the National Institute for Occupational Safety and Health (NIOSH) to the U.S. Department of Labor. However, at present a standard of 50 ppm for an 8-hour exposure is in effect. At this level, a person will reach a COHb level of 5%, which is the amount of COHb that an employee engaged in sedentary activity would be expected to approach in eight hours continuous exposure. This proposed standard does not take into consideration the smoking habits of the worker, since the level of COHb in chronic cigarette smokers has generally been found to be in the 4-5% range prior to CO exposure.

Cadmium - Cadmium fumes may cause acute poisoning, with lung edema the outstanding symptom. Fatal cases of cadmium poisoning have been estimated to occur at concentrations of 50 mg/M^3. Workers exposed to concentrations of cadmium fumes ranging from 1 to 6.6 mg/M^3 and cadmium oxide dust at 17 mg/M^3 showed no evidence of chronic injury. There have been reports concerning workers with 20-year exposure to concentrations between 3 and 15 mg/M^3 showing proteinuria and emphysema. The present evidence indicates that serious chronic effects following exposures to cadmium can occur even after a latent interval. Once established, this disease is progressive. The standard of 0.1 mg/M^3 is recommended to protect the worker from the hazards associated with cadmium fumes.

Trichloroethylene - Trichloroethylene has been classified as an acute narcotic that may cause death from respiratory failure if exposure is severe and prolonged. There appears to be little evidence of a chronic or cumulative effect. Typical effects of acute exposure to elevated levels are headache, dizziness, and sleepiness. The Federal standard of 100 ppm appears to be low enough to protect workers from liver damage or serious central nervous system effects and probably most effects from trichloroethylene exposure.

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[2] Criteria Document Publication: HSM 73-11000, DHEW, National Institute for Occupational Safety and Health, Criteria for a Recommended Standard...Occupational Exposure to Carbon Monoxide, 1972, page III-1.

IV. HEALTH HAZARD EVALUATION

A. Initial Visit - Observational Survey

An initial hazard evaluation survey of the Empire Detroit Steel Company, New Boston, Ohio, was made on January 16-18, 1973, by Bobby J. Gunter, Ph.D., and Raymond L. Ruhe. The function of the National Institute for Occupational Safety and Health and its responsibilities, according to Section 20(a)(6) of the Occupational Safety and Health Act of 1970, and the purpose of the visit were explained to Messrs. C. R. Schmitt, Plant Manager; Tom Hall, Director of Safety; and John Phillips, Compliance Committee, United Steelworkers of America, Local 2116.

The following is a summary of the walk-through survey of the plant. Empire Detroit Steel Company is located in New Boston, Ohio, and has been in operation for over fifty years. The main production of this plant is hot and cold rolled steel. They also have a coke-producing plant which has been reported in hazard evaluation #72-37. The production of hot and cold rolled steel involves many operations. Areas surveyed during this investigation consist of the following:

Pickle Line, Tandem Mill, Annealing and Cold Strip,
Open Hearth, Blooming Mill, Hand Scarfing, Hot Strip,
Welding Shop, Temper Mill, Boilerhouse #7,
Blacksmith Shop, Brickmason, Diesel Shop, Garage

A brief description of each area, and the potential occupational exposures, are given in the following section.

Pickle Line - The pickle line consists of four, 60 ft. long closed containers with a hydrogen chloride mixture through which hot rolled steel is passed. The only contaminant to which a worker may be potentially exposed in this area is hydrogen chloride vapors.

Tandem Mill - In this area, coils of rolled steel are treated with a mineral oil. There is some production of iron oxide; thus, the only two contaminants of significance were oil mist and iron oxide.

Annealing and Cold Strip - The annealing area is where coils of steel are heated in gas furnaces. In this area the major health hazard was a potential carbon monoxide exposure.

Open Hearth Area - The open hearth area is very dusty. The dust created in this area is graphite and other dust, which in most cases was nuisance.

Blooming Mill - The blooming mill area is where red hot steel ingots are rolled and made into longer strips of steel. The major health hazard in this area was iron oxide. This operation is mechanized and is performed almost completely with the workers not in direct contact with the operation.

Hand Scarfing Area - Hand scarfing of large slabs of steel coming from the blooming mill is done by an oxygen acetylene torch which is used to burn the slag from the steel. Various metal samples were taken in this area to determine what exposures were present.

Hot Strip Area - The hot strip area is adjacent to the blooming mill. In this area slabs of steel are flattened and rolled into much thinner coils of steel. The major health concern in this area is to iron oxides.

Welding Shop - The many different fluxes and electrode coatings used in the welding shop made it necessary for samples to be analyzed for copper, fluoride, cadmium, and iron oxide.

Temper Mill - The temper mill is another area where cold rolled steel is treated with mineral oil. Samples taken in this area consisted of mineral oil mist.

During the observational survey, Boilerhouse #7 was checked for noise, the only obvious health hazard. This area has a continuous noise level of 112 dBA near the two large engines located in the east end of the building. No obvious health hazards were observed in the Blacksmith Shop, Electrical Shop, Brickmason Area, Diesel Shop, or Garage. Therefore, these areas were not included in the environmental survey. Samples were collected for CO, SO_2, and NO_2.

In many of these areas, the worker is not directly exposed to health hazards. Instead, he is operating machines by computers and is isolated from the process. The brochure in the Appendix defines the various operations of Empire Detroit's steel manufacturing.

On the initial walk-through survey, production in most of these departments appeared less than normal. Numerous machine breakdowns were noted. Ventilation throughout the plant was non-existent. The walkways and floors were very slippery from oil mist. The aisles were cluttered with pieces of scrap metal. In general, the housekeeping throughout the plant was virtually non-existent. There appeared to be plenty of employees to take care of the housekeeping. However, this was not part of their job description; and none seemed to be concerned. There should be a management-union-effort to encourage employees to clean up all areas.

After the initial visit was made, it was determined that a physician should conduct a medical evaluation of several areas in order to ascertain whether any symptoms were due to occupational exposures.

B. Environmental Evaluation

Bulk samples of solutions mentioned in Initial Visit - Observational Survey were analyzed for major ingredients. Appropriate environmental sampling procedures were obtained to measure airborne concentrations.

On February 12-14, 1973, an environmental sampling survey was conducted by Bobby J. Gunter, Ph.D., and Raymond L. Ruhe to determine environmental exposure of employees. Samples for oil mist and copper were collected on pre-weighted glass fiber filters. Samples for total dusts, iron oxide, copper, and fluoride were collected on pre-weighted cellulose membrane filters. Carbon and graphite samples were collected on silver membrane filters. Hydrogen chloride samples were taken by using two impingers in series and using sodium acetate as a collection medium. The air was drawn through the collection mediums by an MSA Model G battery-powered vacuum pump operating at a rate of 1.7 liters per minute for four to seven hours to simulate an 8-hour time-weighted-average exposure.

All air samples were analyzed by the Division of Laboratories and Criteria Development, National Institute for Occupational Safety and Health, Cincinnati, Ohio. Results of these determinations may be found in Exhibits A through F located in the Appendix.

In the hand scarfing, pipe shop, and open hearth areas, nuisance dust levels were very high. Cadmium levels were above recommended levels when the welder was using a solder high in cadmium content. Carbon monoxide levels were very high in the annealing furnace. This was due to gas leaking from pipes located throughout this area.

C. Medical Evaluation

A medical evaluation was conducted on February 13, 1973, consisting of employee interviews in a number of areas in the steel mill.

Results and Discussion

1. Armature Shop - Eight workers work in this area and use trichloroethylene as a degreaser. Four workers were interviewed. There was no indication that they were experiencing symptoms of trichloroethylene overexposure.

2. Machine Shop - Fifteen welders routinely weld in the machine area or on location; in both instances poor ventilation is the rule. Five welders were questioned, and four reported the classic symptoms of metal fume fever over the last year, especially

when working on location in a closed, poorly ventilated area. In addition, other workers in the immediate area of the machine shop noted eye and throat irritation when heavy welding is being performed in the welding area.

3. Hand Scarfing Area - All four scarfers on the shift were interviewed. There was no indication that they were symptomatic from exposure to the irritative fumes or dusts produced during scarfing.

4. Temper Mill - Two operators who worked here were questioned. There was evidence of only an occasional dry throat with one of the workers and occasional oil mist spray settling on the worker's hand or arm. No dermatitis was noted from such oil mist exposure.

5. Open Hearth Area - Five of the twelve workers were working near the open hearth furnaces and were questioned regarding dust exposure. Most of the men were heavy smokers (1-1/2 to 2 packs per day) with chronic bronchitis, but none admitted to any shortness of breath.

Summary

No hazard exists as a result of worker exposure to trichloroethylene in the armature area. A definite hazard is believed to exist at times with welders as evidenced by cases of metal fume fever.

D. Conclusions

Based on the results of the environmental and medical data presented above, it has been determined that potentially toxic conditions exist in the following areas of the Empire Detroit Steel Company:

a. Annealing furnace--on the basis of carbon monoxide levels (100 ppm TWA) in excess of the Federal standard (50 ppm).

b. Welding shop--on the basis of one cadmium sample of 8 mg/M^3, when the Federal standard is .1 mg/M^3 for an 8-hour TWA, and past history of metal fume fever from a majority of welders interviewed.

c. Hand scarfing, pipe shop, and open hearth--on the basis of nuisance dust samples which exceeded Federal standard.

V. RECOMMENDATIONS

The following recommendations are offered in assistance so that the observed health hazards may be eliminated or controlled.

1. Welding operations should be upgraded to comply with regulations set forth by the U.S. Department of Labor (Federal Register, October 18, 1972, Title 29, Chapter XVII, Subpart Q - Welding, Cutting, and Brazing). This will require installation of local exhaust ventilation for all portable welding operations and either local or booth type ventilation for stationary welding operations. Much improved and more extensive shielding will also be necessary.

2. Respirators approved by the U.S. Bureau of Mines for protection against cadmium fumes should be worn by affected employees until appropriate engineering control is installed.

3. As good occupational medical practice, all men exposed to dusty environments containing dusts of the so-called nuisance nature should be given yearly chest X-rays.

4. Personal protective equipment should be provided for employees exposed to hazards which cannot be adequately abated by engineering controls. At no time should personal protective equipment be substituted for engineering controls when engineering controls are feasible and in accordance with required practice.

5. Better housekeeping throughout the plant, including vacuuming of dust and removal of scrap metal. Education of employees on better work habits would eliminate many obvious hazards.

6. Prominent warning signs, specifying the associated hazards, should be provided wherever hazardous materials are used.

7. Shielding be provided for all welding operations so that workers in adjacent work areas are protected.

8. The general sanitation, i.e., washrooms, lunchrooms, etc., of the facility be upgraded to conform with U.S. Department of Labor Regulations (Federal Register, October 18, 1972, Title 29, Chapter XVII, Subpart J).

9. Carbon monoxide levels could be brought to an acceptable level in the annealing furnace by making sure that all of the gas leaks are eliminated. If new leaks occur, they should be ignited to prevent a buildup of gas until the leak can be eliminated.

EXHIBIT A - TOTAL DUST AND IRON

Personal Air Sample Results

mg/M^3 - milligrams of compound per cubic meter of air

Location	Sample No.	mg/M^3 Total Dust	mg/M^3 Total Iron
Hand Scarfing Area	1 HA	5.83	5.47
Hand Scarfing Area	2 HA	66.34	5.21
Iron Work Area	7 HA	2.29	0.72
Sheet Metal Shop	6 HA	4.07	1.03
Pipe Shop	38 HA	16.17	21.50
Hot Strip	14 HA	3.02	0.21
Hot Strip	10 HA	0.60	0.13
Hot Strip	23 HA	2.83	0.65
Hand Scarfing Area	8 HA	9.90	1.0
Hand Scarfing Area	21 HA	9.00	2.3
Hand Scarfing Area	5 HA	7.03	1.98
Hand Scarfing Area	24 HA	5.07	0.36
Blooming Mill Area	13 HA	1.63	0.74
Hot Strip	9 HA	1.45	0.496
Hot Strip	3 HA	2.35	0.713
Hot Strip	18 HA	3.57	0.655
Open Hearth	50 HA	1.86	0.049
Open Hearth	44 HA	7.39	0.312

EXHIBIT B - TOTAL DUST AND COPPER

Personal Air Sample Results

mg/M^3 - milligrams of compound per cubic meter of air

N/D - Non-Detected

Location	Sample No.	mg/M^3 Total Dust	mg/M^3 Total Copper
Open Hearth	32 AA	1.176	N/D
Open Hearth	40 AA	0.628	N/D
Open Hearth	30 AA	61.320	N/D
Open Hearth	38 AA	4.730	N/D
Open Hearth	29 AA	1.128	N/D
Maintenance Shop	41 AA	2.13	N/D
Carpenter Shop	35 AA	1.68	N/D
Electric Shop	16 HA	5.00	N/D
Electric Shop	50 AA	3.02	N/D
Electric Shop	37 AA	3.36	0.036
Blooming Mill Area	31 AA	8.54	N/D
Blooming Mill Area	18 AA	1.34	N/D
Welding Shop	12 HA	3.10	N/D
Welding Shop	19 HA	12.50	N/D
Iron Work Area	15 HA	2.36	N/D
Iron Work Area	4 HA	1.68	N/D
Welding Shop	20 HA	2.56	N/D
Electric Shop	11 HA	2.35	0.035
Forge Shop	16 HA	0.83	0.0046

EXHIBIT C - TOTAL DUST AND OIL MIST

Personal Air Sample Results

mg/M^3 - milligrams of compound per cubic meter of air

Location	Sample No.	mg/M^3 Total Dust	mg/M^3 Total Oil Mist
Tandem Mill	42 AA	---	0.109
Tandem Mill	43 AA	0.545	0.213
Temper Mill	33 AA	1.71	0.097
Temper Mill	17 AA	0.614	0.054
Open Hearth	40 AA	1.45	0.069
Tandem Mill	34 AA	1.46	0.098
Tandem Mill	39 AA	1.40	0.201
Tandem Mill	46 AA	0.891	0.050

EXHIBIT D - TOTAL DUST AND FLUORIDE

Personal Air Sample Results

mg/M^3 - milligrams of compound per cubic meter of air

N/D - Non-Detected

< - Less Than

Location	Sample No.	mg/M^3 Total Dust	mg/M^3 Total Fluoride
Welding Shop	12 HA	3.10	< 0.022
Welding Shop	19 HA	12.50	0.022
Iron Work Area	15 HA	2.36	0.020
Iron Work Area	4 HA	1.68	0.027
Welding Shop	20 HA	2.56	0.020
Electric Shop	11 HA	2.35	N/D
Forge Shop	16 HA	0.83	N/D

EXHIBIT E - TOTAL GRAPHITE AND CARBON

Personal Air Sample Results

mg/M^3 - milligrams of compound per cubic meter of air

Location	Sample No.	mg/M^3 Total Graphite	mg/M^3 Total Carbon
Open Hearth	15 SM	0.483	0.096
Open Hearth	45 SM	113.37	5.66
Open Hearth	65 SM	0.665	0.179
Open Hearth	55 SM	2.10	0.21
Open Hearth	10 SM	1.14	0.29

EXHIBIT F - TOTAL HYDROGEN CHLORIDE

Personal Air Sample Results

mg/M^3 - milligrams of compound per cubic meter of air

Location	Sample No.	mg/M^3 Total Hydrogen Chloride
Pickle Line	1 A	0.104
Pickle Line	1 B	0.03
Pickle Line	2 A	0.28
Pickle Line	2 B	0.019
Pickle Line	3 A	0.313
Pickle Line	3 B	0.015
Pickle Line	4 A	0.78
Pickle Line	4 B	0.017