FILE COPY

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
HE 77-34-471

MIDWEST STEEL DIVISION
NATIONAL STEEL CORPORATION
PORTAGE, INDIANA

FEBRUARY 1978

## I. TOXICITY DETERMINATION

The following determinations have been made based on environmental air samples collected June 14-16, 1977, evaluation of ventilation systems and work procedures, and available toxicity information:

A. An employee exposure to asbestos at the Deep Well (15 fibers/cubic centimeter) exceeded both the NIOSH and OSHA ceiling values of 0.5 fibers/cc and 10 fibers/cc respectively. It is recommended that the company either implement engineering controls or substitute a material at the Deep Well operation which is less hazardous from that used under the present conditions.

B. All other samples for sodium hydroxide, chromic acid, total dust, zinc oxide, hydrogen cyanide, particulate oil mist, sulfuric acid, carbon monoxide, and methyl chloroform were below the evaluation criteria.

## II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information Resources 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 the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

a) Midwest Steel Division, National Steel Corporation, Portage, Indiana
b) Midwest Steel Local Union 6103, Chesterton, Indiana
c) U.S. Department of Labor - Region V
d) NIOSH - Region V
e) Indiana Division of Labor, Indianapolis, Indiana
f) United Steelworkers of America, Pittsburgh, Pennsylvania

For the purpose of informing the 800 "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 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 received such a request from an authorized representative of the United Steel Workers of America, Local 6103 regarding exposure to workers to organic solvents, acid mists, caustics, oil mists, asbestos and welding fumes. The request stated that approximately 800 employees are being exposed to excessive toxic substances, but no specific medical problems were alleged. An interim report containing environmental data was sent to the company and Union on November 9, 1977.

## IV. HEALTH HAZARD EVALUATION

### A. Conditions of Use

The work force at the Midwest Steel Division is composed of approximately 1800 workers of which 1300 are production and 500 are supervisory. The plant is located on approximately 1000 acres of which 52 acres are under roof.

No basic steel is produced at this plant. Raw material in the form of hot rolled coils is received from plants in Detroit, Michigan, Granite City, Illinois, and Weirton, West Virginia. Virtually all of the raw product is processed through the 80 inch Continuous Pickle Line and the 52 inch or 80 inch Five Stand Cold Reduction Mills. Following cold reduction, the product is directed into one of three channels according to its intended use: 1) tin plate and tin free steel, 2) galvanized, or 3) cold rolled products.

The survey included over fifteen different areas or processes. The following is a description of each process.*

1) 80-inch Continuous Pickle Line

Continuous pickling is a process for removing the oxide from the steel surface deposited during the hot rolling operation. The oxide is removed by passing the steel through a bath of hot sulfuric acid. The steel is then given a water spray rinse and passed through a hot air dryer prior to coiling with an oil coating to protect the surface.

*Much of the information contained in this section was taken from a Midwest Steel publication.

The 80-inch Pickle Line is 991 feet long and was designed to process product widths from 24 to 72 inches.

The entry section of the line is designed with two right angle conveyors feeding the coils eye horizontal to two processors. After the processors and the oscillating upcut shears is a combination welder and flash trimmer. Next in line is the No. 1 looping pit which is 71 feet long by 13 feet wide by 16 1/2 feet deep.

Following the looping pit and tension units is a rolling mill type scale breaker. This mill is driven by two 750 horsepower, 690/875 revolutions per minute, 250 volt DC motors through 4:1 reduction gears.

Next in line is the No. 2 looping pit which is 59 feet long by 13 feet wide by 17 1/4 feet deep. Following the looping pit and master pinch rolls is the pickling tank which is sectionalized into four sections. The first and fourth sections are 90 1/2 feet long and the second and third are 89 feet long. All tanks are 7 feet 1 inch in depth. The width of all tanks is 9 feet 10 1/4 inches. The refractory lining is composed of 3 3/4 inch by 4 1/2 inch by 8 inch acid proof bricks. The steel tanks are lined with 1/4 inch of rubber. Each tank has five 16 feet covers and three 5 feet 6 1/2 inch inspection covers. There are two strip lifting mechanisms per acid tank.

The rinse tank is 42 feet long by 9 feet 10 1/4 inches wide by 5 feet deep and is followed by the hot air dryers consisting of three centrifugal blowers, each driven by a 75 horsepower, 3,600 revolutions per minute, 440 volt AC motor. The air is heated by three 400° maximum air temperature heat exchangers.

Following two free loop looping pits the delivery section of the line consists of a side trimmer with scrap chopper and conveyor, exit shear, upcoiler and tension winding reel. The maximum coil O.D. for the upcoiler and tension winding reel is 90 inches and the minimum coil I.D. for the upcoiler is 18 inches. For the tension winding reel, the coil I.D.s are 24 and 28 inches.

2) 52 inch Five Stand Cold Reduction Mill

The mill consists of five four-high stands spaced on 14 feet centers, each housing weighing approximately 110 tons.

The largest coil discharged from this mill can weigh approximately 90,000 pounds.

Coils of 90 inch maximum O.D. are moved from the chain drive entry conveyor by a mandrel in the coil transfer unit which places them on the rolls of the coil positioner. Solenoid valve controlled hydraulic power accomplishes this transfer.

Two driven saddle rolls in the coil positioner rotate the coil in order to transport the outer wrap through the coil opener into the straightener rolls. The straightener unit is removed from the pass line after straightening the head end of the strip and does not contact the strip during coil run off.

After threading the strip through the stands at speeds up to 750 feet per minute and wrapping the mandrel, the mill may be accelerated to run speed up to a maximum of 6,000 feet per minute.

Strip uniformity is insured by continuous dial readings of roll pressure, strip tension and gauge. Backup roll pressure is measured by pressductor cell force gauges, which provide independent readings of force on front and back roll chocks. Tension is measured with tensiometers, the force with which the tensiometer roll is deflected is measured on load cells and metered at the operators' stations. This mill is equipped with automatic gauge control, and the finished gauge is monitored by means of an x-ray gauge.

3) 80 Inch Five Stand Cold Reduction Mill

The 80 inch Five Stand Cold Reduction mill was designed to produce cold reduced low carbon high strength steel, and consists of five four-high stands spaced on 15 foot 6 inch centers, each housing weighing approximately 144 tons. Each stand is equipped with automatic work roll changing rigs.

The 80 inch Five Stand Tandem Mill will reach a maximum speed of 5,000 FPM with 23 inch diameter work rolls. While other members of the crew are on mill floor level, the roller, or operator, is stationed in a glass enclosed, air conditioned, raised pulpit eight feet above the mill floor. The computer room is directly overhead of the operator's pulpit at a 20 foot level above the mill floor, and the electrical control room is on this same level.

Strip uniformity is insured by the automatic gauge control system which recognizes gauge deviation from a preset reference gauge and maintains the thickness of the strip delivered from the mill to within plus or minus 2 1/2 percent, or .001 inch (whichever is least) of x-ray gauge measurement. Other features incorporated in the automatic gauge control are: programmed screw movement as a function of mill speed change, programmed screw movement during strip tailout, and preset stand drive motor overspeed during strip threading.

4) Electrolytic Cleaning Line

The Electrolytic Cleaning Line is 309 feet long, operates at speeds up to 2,500 feet per minute and handles coils weighing up to 72,000 pounds coming directly from the two Five Stand Cold Reduction Mills. Both cold rolled and tin plate coils are cleaned on this line.

At the entry end of the line, the head end of the strip is fed into a lap seam welder and welded to the tail of the previous coil to provide a continuous strip. There are no looping towers on this line and the unit must stop running to charge and discharge coils.

After welding, the strip passes through an electrolytic alkali cleaner, scrubber, hot rinser, and hot air dryer to remove dirt, grease, oil, and residue from the strip to insure maximum cleanliness before entering the annealing furnace.

The cleaned coil is discharged onto a 45 foot conveyor. Discharged coils can be removed for subsequent processing in either an eye horizontal or eye vertical position. Finished coils are provided up to 72,000 pounds, 20 to 50 inches wide, and .0055 to .0780 inches gauge.

5) 48 Inch Continuous Galvanize Line

The 48 inch Continuous Galvanize Line is 914 feet long, operates at speeds up to 300 feet per minute, and handles coils weighing up to 90,000 pounds coming directly from the Cold Reduction Mills.

At the entry end of the line, the uncoiled cold reduced strip is passed through an x-ray thickness gauge as it feeds into a welder where the head end of the new coil is welded to the tail of the previous strip.

Following welding, the strip enters cleaning, scrubbing and hot rinsing tanks to insure that the strip will be perfectly clean before entering the annealing furnace. A horizontal double length loop storage system preceding the furnace area is provided whereby approximately 400 feet of cleaned strip is kept in reserve.

From the storage loop, the strip passes through the three-tier annealing furnace where it is heat treated in a controlled protective atmosphere prior to entering the galvanizing pot. The heat input is 32-million BTU per hour, generated from both radiant tube gas firing and resistance heating elements. The normal hydrogen analysis of the furnace is 25 percent with the balance of the gas being nitrogen.

The annealed strip passes through the galvanizing pot where it obtains a precise and specified coating of zinc, leaves the pot in a vertical pass to a 45 foot height and is conducted through a cooling process of air blasts, water quenching and drying in sequence. A horizontal double length loop storage system maintains approximately 415 feet of galvanized strip in reserve for mandrel change-overs or piler discharges.

6) 72 Inch Continuous Galvanize Line

The 72 Inch Continuous Galvanize Line is 1,135 feet long, operates at speeds up to 360 feet per minute, and handles coils weighing up to 90,000 pounds coming directly from the Cold Reduction Mills. It features one of

the largest and most versatile heating, holding and cooling furnaces in the industry. The continuous annealing furnace is a combination horizontal and vertical unit, 305 feet long, containing approximately 1,200 feet of strip.

At the entry end of the line, the uncoiled cold reduced strip is passed through an x-ray thickness gauge as it feeds into a welder where the head end of the new coil is welded to the tail of the previous strip.

Following welding, the strip enters cleaning, scrubbing, and hot rinsing tanks to insure that the strip will be perfectly clean before entering the annealing furnace. A horizontal double length loop storage system preceding the furnace area is provided whereby approximately 980 feet of cleaned strip is kept in reserve.

From the storage loop, the strip passes through the annealing furnace where it is heat treated in a controlled protective atmosphere prior to entering the galvanizing pot. The heat input is 109 million BTU per hour, generated from radiant tube gas firing. The normal hydrogen analysis of the furnace is 25 percent with the balance of the gas being nitrogen.

The annealed strip passes through the galvanizing pot where it obtains a precise and specified coating of zinc, leaves the pot in a vertical pass to a 90 foot height and is conducted through a cooling process of air blasts, water quenching, and drying in sequence. A horizontal double length loop storage system maintains approximately 780 feet of galvanized strip in reserve for mandrel changeovers or piler discharges.

7) Batch and Open Coil Annealing

The Batch Annealing section consists of eighteen portable box type furnaces and four single stack furnaces. There are 52 bases with four stools per base for box type furnaces and 12 bases for the single stack furnaces. Thirty five bases for box type furnaces are designed with 15 horsepower fans, and six bases with 25 horsepower fans for the circulation of the atmosphere in producing conventional batch anneal product. Three single stack bases are designed without base fans for the production of steam blue product.

The Open Coil Annealing section consists of eight portable cylinder type furnaces and 16 single stool bases. Before and after to Open Coil Annealing, the coil product must be loose wound and tight wound respectively. The winding of the coils is performed on a vertical coiling line equipped to accommodate a 74,000 pound coil and produce a loose wound coil O.D. of 114 inches and a tight wound coil O.D. of 77 inches.

Both types of annealing facilities include cylindrical inner covers and are fired by natural gas through radiant tubes inside the furnace. The four single stack furnaces, as well as six of the 18 multiple stack furnaces, are of the direct fired type.

Multiple stack batch furnaces are equipped to accommodate three to four coils high on each stool with a four stool base load of approximately 220 tons. Single stack batch furnaces are equipped to accommodate four to five coils high on the single stool bases with a base load of approximately 60 tons. Single stack open coil furnaces are equipped to accommodate two or three coils high, with a single stool base load of approximately 28 tons.

The annealing atmosphere presently used in the heating, soaking, and cooling sequence by both facilities is HNX gas which is blended on the plant site. A typical Batch Anneal fire and soak cycle is approximately 30 hours as compared to approximately nine hours for Open Coil Anneal. The cooling cycle on Batch Anneal is decreased by the introduction of air from the basement flowing on the inner covers. This air is provided by six wall type ventilating fans. The cooling cycle on Open Coil Anneal is speeded up by the positioning of a cooling cover which forces air over the inner cover and cools the charge.

8) Sheet Temper Mill

The 80 Inch Sheet Temper Mill is a single stand four-high mill designed to operate at speeds up to 3,500 feet per minute in order to impart flatness, surface properties and temper to cold reduced, annealed steel to meet customers' requirements.

The mill housing with its overall length of 10 1/2 feet and width of 13 1/2 feet houses two 56 inch by 80 inch back up rolls and two 21 inch by 80 inch work rolls.

The entry end of the mill is designed to accept coils with 16 1/2-20, and 24 inch I.D.s; maximum 72 inch O.D.; 22 to 74 inches wide; .0149 to .0930 inches gauge; and 74,000 pounds maximum weight. The delivery end is designed to discharge coils with 20 and 24 inch I.D., maximum 72 inches O.D., and 74,000 pounds maximum weight.

Coils to be processed are moved along an entry conveyor in an eye vertical position, down ended to an eye horizontal position, transferred, turned around and hoisted to the double mandrel drag reel in preparation for processing. The head end of the strip is then threaded through the mill at speeds of 120 to 700 feet per minute. At the delivery end of the mill, the strip passes through an automatic x-ray thickness gauge, spray type automatic oiler, air cylinder operated printer, and finally fed onto the exit mandrel with the guidance of a hydraulically operated belt wrapper. Following the charging and threading operation, the mill is accelerated to the proper speed for processing.

After processing, the finished coil is stripped from the exit mandrel, moved along the exit conveyor, weighed, banded, and ticketed for shipment or further processing.

9) Number Two Tin Recoil Line

The number two Tin Recoil Line is a preparation unit designed to operate at speeds of 4,500 feet per minute to recoil, side trim, split or combine coils prior to tinning or weirchrome processes, or prior to shipment of tin, weirchrome, galvanize or black plate coils. The unit is capable of handling coils with 16 1/4 and 20 inch I.D. and 90 inch maximum O.D., weighing up to 60,000 pounds, 18 to 50 inches wide and .0044 to .0359 inches gauge.

The unit is equipped with entry coil hoist, pay-off reel, entry pinch roll unit, x-ray thickness gauge, edge control system, welder, side trimmer, burr removal unit, exit pinch roll unit, up-cut shear, delivery conveyor and scale.

The strip, all ranges of product, is threaded through the line at speeds up to 1,500 feet per minute prior to acceleration to top processing speed which is 4,500 feet per minute.

10) Electrolytic Tinning Line

The Electrolytic Tinning Line is more than 600 feet long, operates at speeds up to 2,000 feet per minute, and has been designed to handle a wide variety of widths, basis weights and coating specifications.

At the entry end of the line, the uncoiled, annealed, double-reduced and/or temper rolled steel strip is fed into a welder where the head end of the new coil is welded to the tail of the previous strip.

After welding, the strip passes through an x-ray thickness gauge and subsequently enters the entry looping tower which provides approximately 1,200 feet of reserve strip for a stop-start time during welding.

Following the looping tower and tension units is an electrolytic cleaning tank 55 feet long and six feet wide to remove dirt, grease and oil from the strip. In line with the cleaning tank, a scrubber tank 17 1/2 feet long and 5 2/3 feet high is employed to remove residue on the strip from the cleaning operation. Following the scrubber tank is a pickling tank 103 feet long and six feet wide to clean oxides from the strip. In line with the pickling tank, a second scrubber tank is employed to remove residue from the strip.

After the cleaning and pickling operations, the strip passes through the horizontal plater unit which includes pretreating and electroplating bottom of strip in 18 horizontal cells on first tier; electroplating top of strip in 14 horizontal cells on second tier; reclaiming, anodic marking, washing, rinsing and drying on the third tier. The solution temperature

is maintained between 135°F and 155°F. Plating current is supplied by 32 silicon-diode rectifiers--one rectifier (9,000 amps at 20 volts) per cell.

Following the plater section is the reflow tower which gives the coated strip the melted finish that many customers prefer. Next, the molten tin on the strip is solidified in water in the quench tank directly under the tower. The strip then passes through one of two independent tank sections. The first tank has two full-size grids for cathodic treatment of the plate in a sodium carbonate solution. The second tank has two full-size grids for cathodic treatment in a sodium bi-chromate solution. A third tank has been provided for future use.

A final washing and drying operation completes the cleaning process. The coated strip next enters the exit looping tower which provides approximately 800 feet of reserve strip for a start-stop time for making a cut from one delivery reel to another.

In the final process, the coated strip passes through an electrostatic oiler before being coiled on one of two delivery tension reels which can handle finished coils up to 90,000 pounds, 18 to 45 inches wide and .0043 to .036 inches in thickness.

11) Weir Chrome Line

The chrome line is more than 400 feet long, operates at speeds up to 1,550 feet per minute, and has been designed to handle widths of 18 to 48 inches. At the entry end of the line, the uncoiled, annealed and double reduced steel strip is fed into a welder where the head end of the new coil is welded to the tail of the previous strip. Before welding, the strip passes through an x-ray thickness gauge for cropping and subsequently enters the entry looping tower which provides approximately 975 feet of reserve strip for stop-start weld cycle.

Following the looping tower are two electrolytic cleaning tanks, each approximately 40 feet long, to remove dirt, grease and oil from the strip. In line, and after each cleaning tank, is a 12 foot scrubber tank which is used to remove residue on the strip after the cleaning operation. Following the second scrubber is a pickling tank about 50 feet long which cleans oxides from the strip. In line with the pickling tank, a third scrubber tank is employed to remove residue from the strip. After the cleaning and pickling operation, the strip passes through five vertical electroplating tanks where the strip is chrome coated on both sides, then through two vertical rinse tanks and two vertical electrolytic chemical treatment tanks, a chem-treat washer and strip dryer. Plating current is supplied by seven silicon diode rectifiers capable of delivering a total of 56,000 amps at 36 volts. The chemical treatment rectifier will deliver 8,000 amps at 24 volts.

Following the chem-treat dryer, the strip enters the exit looping tower which provides approximately 975 feet of strip storage for start-stop delivery end operation to transfer strip from one to the other of the delivery reels.

In the final process, the coated strip passes through an electrostatic oiler, is inspected, and gauged before being coiled on one of the two delivery tension reels. The delivery reels can handle finished coils up to 60,000 pounds, 90 inches O.D., 18 to 48 inches wide and .0045 to .023 inches in thickness.

12) Pre-Treatment Plant

The pre-treatment area is located just east of the continuous annealing building. After proper pre-treatment, the flows are discharged to the industrial wastes sewer or to sludge disposal pipelines. The oily wastes sewer terminates at the mixing tank of the chemical treatment plant and its flow is given final treatment here. Sludges are disposed of in holding lagoons. Sanitary sewage is pumped over to the west side of Burns Ditch to the sewage treatment plant.

13) Deep Well

Waste sulfuric acid from the continuous pickler is disposed of down a 4,300 feet deep well. A product containing asbestos is used in the treatment process. An operation adds approximately two to four 50-pound bags of the product into the deep well. This process takes about 10-15 minutes and occurs once every five days or so.

14) Central Maintenance

This department is responsible for the supervision and operation of the central shops including machine, structural, pipe, carpenter, paint, scale, refrigeration, crane repair, electric and electronic facilities. In addition, the department is responsible for all outside and inside contract shop work in conjunction with the plant maintenance and repair program.

15) Boiler House

All heating and processing steam is generated by four dual fuel (natural gas and oil) boilers at a pressure of 225 PSIG and a temperature of 550°F. All boilers are equipped with automatic combustion and safety control equipment.

All industrial water is pumped from Lake Michigan through an 84 inch concrete intake pipe extending 2,800 feet into the lake. The intake structure is 30 feet below the surface of the lake.

16) Chemical Treatment Plant

Waste water from mill operations convey additive materials including pH depressants, suspended solids, floating and soluble oils, color inducing substances, iron, tin, zinc, chromium and fluoride. The concentrations of all of these have to be controlled to within acceptable limits before releasing any water to Burns Ditch.

B. Environmental Evaluation Methods

Results of the personal and area samples were used to evaluate employee exposures. The personal samples were attached near the breathing zone of the employees to collect a representative sample of air. Each of the sampling data tables (Tables I-VI) includes information denoting the types of samples collected and their location. The analytical methods used for the respective contaminants are also provided in each table.

Atmospheric samples for particulate oil mist and for sulfuric acid were collected on 0.8 micron (u) mixed cellulose ester filters mounted in three-piece closed face cassettes; air was drawn through the samplers at a flow rate of 1.5 liters per minute (lpm) for four hours using a vacuum pump. Filters used for the collection of sulfuric acid were removed from the cassettes and placed in scintillation vials within one hour of completing the sampling period.

Atmospheric samples for total dust, chromic acid, and zinc oxide were collected on 5u polyvinyl chloride (PVC) filters in the manner mentioned above.

Atmospheric samples for methyl chloroform were collected on activated charcoal tubes. Air was drawn through the tube by a vacuum pump at a flow rate of approximately 50 milliliters per minute.

Atmospheric samples for carbon monoxide were taken using Drager* colorimetric gas detector tube units. These 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.

Atmospheric samples for hydrogen cyanide were collected with a midget impinger containing 10 milliliters (ml) of 0.1 N sodium hydroxide. Air was drawn through the impinger using a vacuum pump operating at a flow rate of 1.0 lpm.

An atmospheric sample for asbestos was collected on an 0.8u mixed cellulose ester filter at a flow rate of 2.0 lpm. The filter was encased in a three-piece plastic cassette with the face cap removed and the filter completely exposed.

---

*Mention of commercial product does not constitute endorsement by NIOSH

Atmospheric samples for sodium hydroxide were collected with a fritted glass bubbler containing 15 ml of 0.0075 N hydrochloric acid; air was drawn through the bubbler at a flow rate of 1.0 lpm.

C. Evaluation Criteria

1. Toxic Effects

Only those substances in which the airborne concentrations approached or exceeded 20 percent of the applied exposure limits will be discussed in this section.

a. Sulfuric Acid: Sulfuric acid is classified as a primary irritant[1]. 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[2]. Splash injuries to the eyes are in practice the most serious adverse effect of sulfuric acid in industry. Contact with concentrated acid of any magnitude is capable of producing irreparable corneal damage resulting in blindness[3]. Dental lesions are also common; they affect mainly the incisors[2] through the softening of the dentine[1].

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[2].

b. Asbestos: Asbestos is a generic term which applies to a number of naturally occurring silicates of variable composition, but basically is of a form of hydrous magnesium silicate. Their chief characteristic is a structure composed of long, parallel, flexible fibers, capable of repeated longitudinal subdivision. The most widely used form in the United States is chrysotile, a fibrous form of serpentine. Other types include amosite, crocidolite, tremolite, anthophyllite and actinolite[4].

One of the potential health hazards associated with exposure to asbestos is that of inhalation of airborne fibers, resulting in a type of pneumoconiosis referred to as asbestosis[4]. Asbestos fibers are capable of passing through the upper respiratory tract and depositing in the terminal bronchioles of the lungs. The fibers, upon deposition in the terminal bronchioles, initiate a tissue response which results in the coating of the fiber with the ultimate production of what is known as the asbestos "body". If large quantities of the fibers are inhaled over a prolonged period, the tissue reaction progresses until a generalized, diffuse fibrosis becomes evident. This fibrosis is first seen in the lower lobes of the lungs, but eventually if exposure continues, appears in the other lobes as well. The fibrosis can impair the transfer of oxygen across the alveolar membrane and result in respiratory insufficiency, or cardiac failure.

Along with asbestosis, studies have provided conclusive evidence that exposure to asbestos fibers causes cancer in man. The frequency of bronchiogenic cancer is greater in occupationally exposed persons, as well as an increased occurrence in development of mesotheliomas of the pleura and peritoneum. These asbestos associated neoplasms may occur without radiological evidence of asbestosis. The effects of inhaled asbestos fibers are potentiated by smoking and possibly other environmental agents.

c. Oil Mist: Exposure to oil mist will cause mucous membrane irritation from direct contact of the liquid or aerosol with pulmonary tissue. Frequent and prolonged contact with the skin will lead to skin irritation and dermatitis. The Threshold Limit Value (TLV) is recommended as an index of good industrial practice as well as to prevent the minor changes in the lungs that may occur from inhalation exposure[5].

2. Environmental Criteria

Airborne exposure limits for the protection of 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:

1. NIOSH: Criteria for a Recommended Standard....Occupational Exposure to various substances.

2. Threshold Limit Values (TLV): Guidelines for Airborne Exposures Recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) for 1977.

3. OSHA Standard: The air contaminant standards enforced by the U.S. Department of Labor - Occupational Safety and Health Administration - as found in the Federal Register - 29 CFR 1910.1000 (Tables Z-1, Z-2).

| | SOURCE* | | |
|---|---|---|---|
| | NIOSH | TLV | OSHA |
| Chromic Acid | 0.025 mg/$M^3$ | 0.05 mg/$M^3$ | (0.1 mg/$M^3$) |
| Total Dust | - | 10 mg/$M^3$ | 15 mg/$M^3$ |
| Zinc Oxide | 5 mg/$M^3$ | 5 mg/$M^3$ | -5 mg/$M^3$ |
| Hydrogen Cyanide | (5 mg/$M^3$) | 11 mg/$M^3$ | 11 mg/$M^3$ |
| Asbestos | 0.1 fibers/cc & (0.5 fibers/cc) | 5 fibers/cc | 2 fibers/cc** & (10 fibers/cc) |
| Sodium Hydroxide | (2 mg/$M^3$) | (2 mg/$M^3$) | 2 mg/$M^3$ |
| Particulate Oil Mist | - | 5 mg/$M^3$ | 5 mg/$M^3$ |
| Sulfuric Acid | 1 mg/$M^3$ | 1 mg/$M^3$ | 1 mg/$M^3$ |
| Carbon Monoxide | 35 ppm | 50 ppm | 50 ppm |
| Methyl Chloroform (1,1,1-trichloroethane) | 350 ppm | 350 ppm | 350 ppm |

*Concentrations, in parts of substance per million parts of air (ppm), fibers per cubic centimeter (cc), or milligrams of substance per cubic meter of air (mg/$M^3$), are based often on an 8-hour time-weighted average exposure (TWA). Values in parentheses represent concentrations which should not be exceeded even instantaneously as commonly measured in a 15-minute period.

**OSHA has proposed a 0.5 fibers/cc TWA standard.

D. Evaluation Results and Discussion

Tables I through VI illustrate the results of environmental sampling for the various substances mentioned. A personal sample collected for asbestos (15 fibers/cc) during the addition of "Fibra-Flo" at the Deep Well Area exceeded both the NIOSH and OSHA ceiling values of 0.5 fibers/cc and 10 fibers/cc, respectively (Table VI).

All other sampling results for the various contaminants presented in Tables I through VI were within acceptable health limits. These included total dust, zinc oxide, hydrogen cyanide, particulate oil mist, sulfuric acid, carbon monoxide, sodium hydroxide, and methyl chloroform. Samples collected at the "Weir Chrome Line" were being analyzed when the interim report of November 9, 1977, was issued. These samples for chromic acid dust/mist are now presented in Table VI and indicate all concentrations were below the evaluation criteria. In the interim report of November 9, 1977, it was stated that two area samples for sodium hydroxide collected in the Electrolytic Tin Line (first basement and second floor tank) exceeded the evaluation criteria. It is now known that sodium hydroxide is not used in this area, but that three salts (sodium chloride, sodium bifluoride, and sodium ferrocyanide) are contained in the Plating solution. The analytical method used was unable to differentiate between the different sodium compounds, therefore, the total sodium content was erroneously calculated as sodium hydroxide.

On the morning of June 14, 1977, two NIOSH investigators experienced mucous membrane irritation while in the Pickle Line. Temple steel (grade G773) was pickled that morning. It was alleged that this type steel produces the worst fuming problem.

The following list indicates the tank conditions at that time:

| Tank | (acid strength cascade) % Sulfuric Acid | % Iron |
|---|---|---|
| 1 | 13 | 26 |
| 2 | 15 | 24 |
| 3 | 17 | 21 |
| 4 | 20 | 19 |

Temperature of all acid tanks: 206°F.
Temperature of rinse tank: 185°F.

The three basic areas where sulfuric acid and water vapor escape include:

1. Portals - used to check acid
2. Cracks - between adjoining hood covers
3. Cover Lifters

The Pickle Line has eight exhaust hoods distributed along the pickling tanks. While the exhaust system is designed with two fans, only one was operating during the survey. Thus while no overexposures to surfuric acid were noted there is a need for improvements in the system. In some areas, local exhaust slots were clogged by metal scale and thus cutting off the air flow.

## V. RECOMMENDATIONS

Deep Well - It is recommended that Midwest Steel either implement engineering controls in the Deep Well Area or substitute a material which is less hazardous than that used under the present conditions. For example, a bulk sample of the "Fibra-Flo" contained asbestos, whereas the "Fibra-Cell" did not. The respirator used during this operation is NIOSH approved for asbestos-containing dusts. Respirator protection should be continued until exposures to asbestos can be lowered to acceptable levels.

A formal respirator program should be maintained in the event that respiratory protection is used. Minimum procedures such as those outlined in the Occupational Safety and Health Standards, 29 CFR 1910.134(b)(1)-(11), should be followed. This program should be used whenever respiratory protection is needed in the plant.

Pickle Line - The release of sulfuric acid can be diminished through improved maintenance of the existing ventilation system. The covers for the acid tanks should be adjusted so they do not block local exhaust slots. All slots should be checked to see that they operate efficiently. The Pickle Tanks should also be maintanied under a slight negative pressure.

Batch Annealing Area and 48, 72 Inch Galvanizing Lines - It has been alleged that maintenance personnel have experienced heat related problems when servicing overhead cranes. It is recommended that Midwest Steel conduct a heat stress study in the Girder area housing the transistor banks. A similar study might be considered for the various levels of the 48 and 72 inch Galvanizing Lines.

## VI. AUTHORSHIP AND ACKNOWLEDGEMENTS

Project Officer: Thomas L. Anania

Report Prepared By:
Thomas L. Anania
James H. Price
William A. Evans
Industrial Hygienists
Industrial Hygiene Section
Hazard Evaluations and Technical Assistance Branch
Cincinnati, Ohio

Originating Office:
Jerome P. Flesch
Acting Chief
Hazard Evaluations and Technical Assistance Branch
Cincinnati, Ohio

### Acknowledgements

Environmental Evaluation:
James H. Price
Thomas L. Anania
William A. Evans
Industrial Hygienists
Cincinnati, Ohio

Analytical Laboratory Services:
Robert Kurimo
Donald Dollberg, PhD.
Michele Bolyard
Walter Kim
DPSE, MSB, MSS

Report Typed By:
Marie Holthaus
Clerk-Typist
Industrial Hygiene Section
Hazard Evaluations and Technical Assistance Branch
Cincinnati, Ohio

## VII. REFERENCES

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

2. International Labour Office, Encyclopedia of Occupational Health and Safety, McGraw-Hill, N.Y. 1972, p. 1372.

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

4. Criteria for a Recommended Standard...Occupational Exposure to Asbestos, 1972. HEW Publication (NIOSH) HSM 72-10267.

5. Documentation of The Threshold Limit Values for Substances in Workroom Air, American Conference of Governmental Industrial Hygienists, 3rd Edition, 1971.

Table I

SUMMARY OF AIR SAMPLING FOR SULFURIC ACID[1]

MIDWEST STEEL CORPORATION
PORTAGE, INDIANA

June 14-15, 1977

| Date | Location | Job Classification | Sample Type | Sampling Period | Sampling Volume ($M^3$)[2] | Concentration ($mg/M^3$)[3] |
|---|---|---|---|---|---|---|
| 6-14-77 | Pickle Line | Coiler | P[4] | 0755-1055 | 0.27 | 0.14 |
| | | | | 1220-1520 | 0.27 | 0.15 |
| | Pickle Line | Inspector | P | 0800-1055 | 0.26 | 0.16 |
| | | | | 1220-1520 | 0.27 | 0.12 |
| | Crane 18 | Craneman | P | 0805-1055 | 0.26 | 0.16 |
| | | | | 1235-1535 | 0.27 | 0.16 |
| | Pickle Line | Acid Tester | P | 0815-1058 | 0.24 | N.D.[5] |
| | | | | 1235-1525 | 0.26 | 0.12 |
| | Temper Mill Control Panel | Column M101 | A[6] | 0820-1120 | 0.27 | N.D. |
| | | | | 1225-1525 | 0.27 | N.D. |
| | Tractor Shop | Mobile Equipment Repairman | P | 0837-1137 | 0.27 | N.D. |
| | Tractor Shop | Column H89 | A | 0840-1140 | 0.27 | N.D. |
| | Tractor Shop | Column H91 | A | 0835-1135 | 0.27 | N.D. |
| 6-15-77 | Pickle Line | Acid Tester | P | 0810-1110 | 0.27 | 0.09 |
| | | | | 1225-1527 | 0.27 | N.D. |
| | Crane 18 | | A | 0830-1125 | 0.26 | 0.09 |
| | | | | 1230-1530 | 0.27 | 0.14 |
| | Pickle Line | Coiler's Desk | A | 0802-1102 | 0.27 | N.D. |
| | | | | 1225-1525 | 0.27 | 0.09 |

1 - Samples analyzed using Barium-Thorin Titration. Lower limit of detection was 16 ug per sample

2 - $M^3$ = cubic meter

3 - The OSHA Standard, TLV, and NIOSH Recommended standard for sulfuric acid are 1 milligram of sulfuric acid per cubic meter of air (1 $mg/M^3$)

4 - P = Personal sample collected in breathing zone of employee

5 - N.D. = None detected

6 - A = Area sample

Table II

SUMMARY OF AIR SAMPLING FOR OIL MIST PARTICULATES[1]

MIDWEST STEEL CORPORATION
PORTAGE, INDIANA

June 14-16, 1977

| Date | Location | Job Classification | Sample Type | Sampling Period | Sampling Volume ($M^3$)[2] | Concentration ($mg/M^3$)[3] |
|---|---|---|---|---|---|---|
| 6-14 | #1 Tin Temper Mill | Roller | P[4] | 0940-1207 | 0.22 | 0.6 |
| | | Roller | P | 1207-1542 | 0.43 | 0.4 |
| | | Feeder | P | 0938-1207 | 0.22 | 0.6 |
| | | Feeder | P | 1207-1540 | 0.43 | 0.3 |
| | | Craneman | P | 940-1230 | 0.26 | 0.8 |
| | | Craneman | P | 1230-1535 | 0.37 | 0.7 |
| 6-15-77 | 80-inch Tandem Reduction Mill | Feeder | P | 1300-1550 | 0.34 | 0.5 |
| | | Coiler | P | 1300-1550 | 0.34 | 0.5 |
| | | Strip Finisher | P | 1300-1550 | 0.21 | 0.7 |
| | | Inspector | P | 1300-1545 | 0.32 | 0.5 |
| 6-15-77 | 52-inch Fine Stand Mill | Catcher | P | 0807-1015 | 0.22 | 0.5 |
| | | Catcher | P | 1015-1200 | 0.21 | 0.6 |
| | | Roller | P | 0804-1016 | 0.23 | 0.7 |
| | | Roller | P | 1017-1200 | 0.21 | 1.5 |
| | | Asst. Roller | P | 0810-1015 | 0.25 | 0.7 |
| | | Asst. Roller | P | 1015-12:00 | 0.21 | 0.8 |
| | | Inspector | P | 0814-1017 | 0.25 | 0.5 |
| 6-15-77 | Continuous Annealling Mill | Feeder | P | 1334-1441 | 0.13 | 1.3 |
| | | Feeder | P | 1441-1540 | 0.13 | 1.2 |
| | | Feeder Helper | P | 1335-1441 | 0.13 | 1.4 |
| | | Feeder Helper | P | 1441-1540 | 0.13 | 1.4 |
| 6-15-77 | Central Maintenance | Near 40-inch Lathe | A | 0835-1055 | 0.28 | 0.9 |
| | | Near Column H-112 | A | 0844-1544 | 0.84 | 0.1 |
| 6-14-77 | Chemical Treatment | Operator | P | 0840-1200 | 0.40 | 0.4 |
| | | Operator | P | 1200-1530 | 0.42 | 0.5 |

1 - Samples analyzed using non-dispersive infrared spectrophotometry.

2 - $M^3$ = Cubic meter.

3 - The OSHA standard and TLV for oil mist particulates are 5 milligram of oil mist per cubic meter of air ($mg/M^3$).

4 - P = Personal; A = Area.

Table III

SUMMARY OF CARBON MONOXIDE SAMPLING USING
DRAGER INDICATOR TUBES

BATCH ANNEALING AREA AND 48, 72 INCH GALVANIZING LINES

MIDWEST STEEL CORPORATION
PORTAGE, INDIANA

June 15-16, 1977

| Date | Time | Location | Concentration (ppm)[1] |
|---|---|---|---|
| June 15 | 0930 | Crane Cab 32 - south end of Batch Anneal | ND[2] |
| June 15 | 0940 | Crane Cab 32 - center of Batch Anneal | 5 |
| June 15 | 0950 | Crane Cab 32 - north end of Batch Anneal | 5 |
| June 15 | 0955 | Crane Cab 32 - girder enclosure inside crane assembly | 5 |
| June 15 | 1015 | Column G61 | ND |
| June 15 | 1340 | Crane Cab 32 - south end of Batch Anneal | ND |
| June 15 | 1350 | Crane Cab 32 - center of Batch Anneal | ND |
| June 15 | 1355 | Crane Cab 32 - north end of Batch Anneal | 5 |
| June 15 | 1410 | Column G61 | ND |
| June 16 | 1000 | 48 inch Galvanizing Line - furnace/2nd level | <5 |
| June 16 | 1000 | 48 inch Galvanizing Line - furnace/3rd level | <5 |
| June 16 | 1000 | 72 inch Galvanizing Line - furnace/2nd level | <5 |
| June 16 | 1000 | 72 inch Galvanizing Line - furnace/3rd level | <5 |
| June 16 | 1000 | 72 inch Galvanizing Line - furnace/4th level | ND |

1 - ppm - parts of contaminant per million parts of air by volume.

2 - N.D. - Non-Detectable.

3 - Health Criteria:

| NIOSH | TLV | OSHA |
|---|---|---|
| 35 ppm | 50 ppm | 50 ppm |

Table IV

SUMMARY OF AIR SAMPLING CONDUCTED FOR METHYL CHLOROFORM

MIDWEST STEEL CORPORATION
PORTAGE, INDIANA

June 15, 1977

| Location | Sample Type | Concentration (ppm)[1] |
|---|---|---|
| Tractor Shop - Column H-89 | A[2] | 5 |
| Tractor Shop - Column H-89 | A | 2 |
| Central Maintenance - Column H-113 | A | 5 |
| Central Maintenance - Column H-113 | A | 6 |

1 - ppm - parts of contaminant per million parts of air by volume.

2 - A - Area sample

3 - Health Criteria:

| NIOSH | TLV | OSHA |
|---|---|---|
| 350 ppm | 350 ppm | 350 ppm |

Table V

RESULTS OF SAMPLING FOR SODIUM HYDROXIDE (NaOH)[1]

MIDWEST STEEL CORPORATION
FORTAGE, INDIANA
June 14-16, 1977

| Date | Location | Job Classification | Sample Type | Sampling Period | Sampling Volume ($M^3$)[2] | Concentration ($mg/M^3$)[4] |
|---|---|---|---|---|---|---|
| 6-15-77 | Continuous Annealling | Asst. Operator | P[3] | 1343-1542 | 0.12 | 0.14 |
| | | Near Cleaning Tank (East Side) | A | 1347-1542 | 0.12 | 0.10 |
| 6-16-77 | 48-inch Galvanizing Line | Caustic Loading Area | A | 0815-1150 | 0.22 | 0.06 |
| | Weir Chrome Line | Top of Tank | A | 0825-1145 | 0.20 | 0.06 |
| | Electrolytic Tin Line | Solution Tender | P | 0836-1142 | 0.19 | 0.10 |
| | Continuous Annealling Line | Asst. Operator | P | 0845-1137 | 0.17 | 0.08 |
| | Cleaning Line | Near Tank | A | 0857-1130 | 0.15 | 0.2 |

1 - Samples analyzed using atomic emission. Analytical limit of detection was 0.2 microgram/ml of NaOH.

2 - $M^3$ = Cubic meter

3 - P = Personal; A = Area

4 - $mg/M^3$ = milligrams per cubic meter of air.

HEALTH CRITERIA:

| NIOSH | TLV | OSHA |
|---|---|---|
| (C)[5] 2 $mg/M^3$ | (C) 2 $mg/M^3$ | 2 $mg/M^3$ |

5 - C = Ceiling value not to be exceeded at any time.

Table VI

RESULTS OF SAMPLING FOR MISCELLANEOUS AIR CONTAMINANTS[1]

MIDWEST STEEL CORPORATION
PORTAGE, INDIANA
June 14-16, 1977

| Date | Location | Job Classification | Sample Type | Sampling Period | Sampling Volume ($M^3$)[2] | Concentration of Contaminants ($mg/M^3$)[3] |
|---|---|---|---|---|---|---|
| 6-15-77 | Weir Chrome Line | Operator | P | | | 0.01 $mg/M^3$ (Chromic acid - $CrO_3$) |
| | | Operator | P | | | N.D.[5] |
| | | Asst. Operator | P | | | 0.01 $mg/M^3$ |
| | | Asst. Operator | P | | | N.D. |
| 6-14-77 | Chemical Treatment Plant | Operator | P[4] | 0825-0855 | 0.05 | N.D.[5] (Total Dust) |
| 6-14-77 | Pretreatment Building | Helper | P | 1030-1100 | 0.05 | N.D. (Total Dust) |
| 6-15-77 | 72-inch Galvanizing Line | Near Line | A | 0800-1500 | 0.84 | -[6] |
| | 48-inch Galvanizing Line | Booth | A | 0800-1500 | 0.32 | N.D. (Zinc Oxide) |
| | 48-inch Galvanizing Line | Pot Area | A | 0800-1500 | 0.32 | 0.03 $mg/M^3$ (Zinc Oxide) |
| 6-15-77 | Electrolytic Tin Line | Welder | P | 1405-1422 | 0.02 | 0.3 $mg/M^3$ (Hydrogen Cyanide) (HCN) |
| | | Solution Tender | P | 1417-1545 | 0.09 | 0.06 $mg/M^3$ (HCN) |
| 6-16-77 | Deep Well | Pre-Treat Operator | P | 0935-0950 | 0.03 | 15 fibers of asbestos per cubic centimeter (15 fibers/cc) |

1 - ANALYTICAL METHODS:
Zinc oxide - X-ray powder diffraction (Limit of detection: 5 micrograms (ug) )
Hydrogen cyanide - Cyanide specific electrode;(Limit of detection: 0.1 ug per ml)
Asbestos - Phase contrast microscopy; (Limit of detection: 0.05 fibers/cc)
Chromic acid - Colorimetry with diphenylcarbazide (Limit of detection: 0.4 ug)

2 - $M^3$ = Cubic meter

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

4 - P = Personal; A = Area

5 - N.D. = Non-detectable

6 - This sample was lost during shipment to laboratory.

HEALTH CRITERIA

| | NIOSH | TLV | OSHA |
|---|---|---|---|
| Total Dust | - | 10 $mg/M^3$ | 15 $mg/M^3$ |
| Zinc Oxide | 5 $mg/M^3$ | 5 $mg/M^3$ | 5 $mg/M^3$ |
| Hydrogen Cyanide | (C)* 5 $mg/M^3$ | 11 $mg/M^3$ | 11 $mg/M^3$ |
| Asbestos | 0.1 fibers/cc | 5 fibers/cc | 2 fibers/cc |
| Chromic Acid | 0.025 $mg/M^3$ | 0.05 $mg/M^3$ | (C)* 0.1 $mg/M^3$ |

C = Ceiling value which should not be exceeded.