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Walk Through Survey Report
As Part of the Sulfuric Acid Study
at
Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

Survey Date
February 28, 1979

Report Written By
Mark Young

Survey Conducted By
Mark Young
Jay Beaumont
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Date of Report
August 6, 1979

Industrial Hygiene Section
Industry-wide Studies Branch
Division of Surveillance, Hazard Evaluations and Field Studies
National Institute for Occupational Safety and Health
Center for Disease Control
Cincinnati, Ohio

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PLACE VISITED:	Jones and Laughlin Steel Corp. Pittsburgh, Pennsylvania
DATE OF VISIT:	February 28, 1979
PERSON(S) MAKING VISIT:	Mark Young, Industrial Hygienist, NIOSH Jay Beaumont, Epidemiologist, NIOSH Jeff Leveton, Epidemiologist, Enviro Control, Inc.
PERSON(S) CONTACTED AT PLANT:	A. Mammarelli, J & L Mgr. Ind. Health Eng. J. Volkar, Gen. Supr. SSCF W. Beck, P-2-14" Bar Mill T. Harbee, Safety Inspector T. Stipanovich, Cold Strip Mill Finishing A. Frauenheim, Pers. Services W. Flaherty, Safety Co-ordinator
UNION:	M. Bagdanski, Local 1272, United Steel Workers of America, Committee Safetyman
ACKNOWLEDGEMENTS:	Dick Kupel, NIOSH, DPSE Chuck Geraci, Ph.D., NIOSH DPSE Bruce Allen, UBTL, Salt Lake City, Utah
STANDARD INDUSTRIAL CLASSIFICATION OF PLANT:	S.I.C. 3312 - Blast Furnaces, Steel Works, and Rolling and Finishing Mills

PURPOSE OF SURVEY

The purpose of this walk-through survey was to gather preliminary information to determine whether this site is suitable for in-depth industrial hygiene and/or epidemiological research involving occupational exposure to sulfuric acid mist.

ABSTRACT

NIOSH and its contractor, Enviro Control, Inc., conducted a fact-gathering industrial hygiene/epidemiological walk-through survey of Jones and Laughlin Corporation, Pittsburgh, Pennsylvania on February 28, 1979 as part of the "Mortality and Industrial Hygiene Study of Workers Exposed to Sulfuric Acid" (Contract No. 210-78-0102). Information was gathered to determine the suitability of including this site in the indepth aspects of this study. Personnel records were assessed and a general industrial hygiene evaluation which included general area sampling was accomplished. The estimated cohort for the epidemiology portion of this study is approximately 2,187. NIOSH/Enviro Control, Inc. recommends this site for inclusion in the in-depth industrial hygiene phase of this study and, possibly, the epidemiologic phase if a better cohort cannot be found in terms of record quality.

INTRODUCTION

The EPA in its Community Health and Environmental Surveillance System (CHESS) report (1970-71) studied seven U.S. cities for community exposure to air contaminants. One community had a primary exposure to sulfur oxides and particulates. The findings of the CHESS report suggest that exposures to sulfur pollutants need further study in terms of exposure levels and morbidity and mortality.

Also, the Proceedings of the Computer-based Conference on "Human Response to Sulfur Pollutants" at Brookhaven Laboratory (1974) showed that sulfates and sulfuric acid could have a possible carcinogenic and/or co-carcinogenic effect.

To further delineate health effects of sulfuric acid (H_2SO_4) mist exposure, NIOSH is conducting a retrospective cohort mortality study of a population occupationally exposed to sulfuric acid mist. In-depth industrial hygiene evaluations will also be performed in an attempt to characterize the exposures that may have occurred to the study population.

Enviro Control, Inc. has been contracted by NIOSH to perform the epidemiological aspects of this study. NIOSH has dual responsibility to monitor the contract and conduct all industrial hygiene evaluations. As part of the contract, a walk-through survey of Jones and Laughlin Steel Corporation was conducted by members of NIOSH and Enviro Control, Inc. Personnel records were assessed and a general industrial hygiene evaluation was accomplished. As part of the industrial hygiene survey, general area samples were collected for sulfuric acid mist (H_2SO_4). Observations, conclusions, and recommendations based on this data are presented in this report.

PLANT HISTORY AND DESCRIPTION

Jones and Laughlin (J & L) Steel Corporation began producing steel in 1853. At present, J & L is a subsidiary of Ling, Tempco and Vaught Inc., Dallas, Texas. Many departments currently existing began operation in 1936. The Pittsburgh works is divided by the Monongahela River and consists of a Northside and Southside operation (Appendix 1). J & L produces non-fabricated steel.

DESCRIPTION OF WORKFORCE AND PERSONNEL RECORD KEEPING SYSTEM

Currently, there are approximately 5,000 active workers at the Jones and Laughlin Pittsburgh plant. Previously, during peak production periods, there have been up to 12,000 workers employed. Also, in the past, certain operations used workers of a particular ethnic background. The Southside "Little Mexico" operation has this name because Mexicans used to be imported for work there. Job titles that characterize workers involved in steel pickling are varied. Appendix 2 summarizes pickling operation job titles with respective numbers of workers. Approximately 80 workers are directly involved in pickling operations (two shifts only). The plant operates on three shifts per day. United Steelworkers, Local 1843 (Northside) and 1272 (Southside) represent the wage earners.

Personnel files show approximately 175,000 inactive workers. Calculations for estimating the prevalence of sulfuric acid worker exposure are based on a random sampling of records from personnel files. Out of 480 records sampled, 6 (1.25 percent) were found to meet study criteria for sulfuric acid exposure (based on job titles, when employed and length of employment). When this rate is applied to the total number of inactive workers (175,000) it can be estimated that approximately 2,187 people at this plant "ever worked" in pickling operations.

DESCRIPTION OF PROCESS AND PROCESS AREAS

Process Description

During the hot-working or rolling of steel, the steel surfaces react with oxygen to form iron oxides or mill scale. Varying quantities of ferric oxide (Fe_2O_3), ferroferric oxide (Fe_3O_4), and ferrous oxide, (FeO) form in layers, depending on the conditions of hot working, i.e., temperature, cooling rate, and access of oxygen to the steel surface. In order to further process the steel, i.e., drawing, coldworking, plating, etc., the mill scale must be removed.

Pickling is one of the most economical methods of accomplishing scale removal. Sulfuric acid has been used traditionally for pickling. However, since 1963, hydrochloric acid is being used in increasing amounts, especially on continuous pickling lines. Jones and Laughlin use H_2SO_4 in all pickling processes.

Principles of Pickling

Sulfuric acid removes mill scale by reacting with the iron oxides to form ferric and ferrous sulfate. The following reactions occur during pickling:

$$FeO + H_2SO_4 \dashrightarrow FeSO_4 + H_2O \quad (1)$$

$$Fe_2O_3 + 3H_2SO_4 \dashrightarrow Fe_2(SO_4)_3 + 3H_2O \quad (2)$$

$$Fe + H_2SO_4 \dashrightarrow FeSO_4 + H_2 \quad (3)$$

$$Fe + Fe_2(SO_4)_3 \dashrightarrow 3FeSO_4 \quad (4)$$

$$Fe(SO_4)_3 + H_2 \dashrightarrow 2FeSO_4 + H_2SO_4 \quad (5)$$

Ferrous sulfate is the predominate sulfate formed in pickling. This occurs due to the faster rate of reaction of ferrous oxide with sulfuric acid than the reactions of ferric oxide and ferroferric oxide with sulfuric acid. Also, the ferric sulfate formed in equation (2) has a tendency to go to ferrous sulfate as given in equations (4) and (5). Hydrogen gas is formed in the reaction of metallic iron and sulfuric acid, causing bubbling and sulfuric acid mist.

Heat and bath agitation are used to increase the acid activity. Temperatures range from 150° to 205°F. Heat is provided by heating coils or steam. Steam provides agitation when it is directly entered into the bath. Inhibitors are added to the bath to decrease the acid activity on the metallic iron. This reduces hydrogen gas formation, and therefore, reduces acid misting. Mechanical devices such as plastic balls and chemical inhibitors are also used to reduce misting.

Pickling at J & L is conducted by batch and continuous processes.

Batch Pickling

Batch pickling of hot-worked blooms, billets, bars, and coiled rounds is accomplished with sulfuric acid.

There is generally at least a series of three tanks: acid tank, water tank, and coating tank. The steel is attached to racks or hooks so that all surfaces are exposed to the acid. Different types of steel pickle at different rates which require different conditions. The temperature of the acid bath varies from 150° to 205°F; the acid baths may be agitated; pickling time may vary from a few minutes to as long as an hour.

After passing out of the acid tank, the steel is washed in a water tank and dipped into a coating tank. Coating the steel neutralizes any excess acid, provides protection from oxidation, and acts as a lubricant in further processing. Some common coatings are lime, borax, and inorganic phosphate compounds. The steel is then air dried.

The acid tank can be made of steel, wood, brick, or concrete. The tank is generally lined with neoprene or rubber. Acid-resistant brick or terra cotta tile is used as lining in place of the rubber, or as a lining between the rubber and acid. Lead has been used as a lining, but has been discontinued due to its susceptibility to cracking.

Continuous Pickling

Scale from hot-rolled steel coils is removed in continuous pickling lines using sulfuric acid. (Hydrochloric acid has been replacing sulfuric acid since 1963 as it is becoming more economical). A continuous pickling line consists of equipment to uncoil the hot-rolled steel, flex or roll the steel to crack the scale before pickling, 3 to 5 30-foot-long acid tanks, water rinsing tanks, coating tanks, and drying and recoiling equipment.

A typical continuous pickling line operates at 300 to 400 feet per minute and can reach speeds as high as 800 feet per minute. The acid is heated to between 175°F to 220°F, and ranges in concentration from 7% to 20%. The acid concentration increased in each tank from the beginning to the end of the line. Inhibitors are used to prevent excessive pickling in instances of line delays or stoppages.

The acid tanks are made of steel lined with rubber. The rubber is protected by a lining of acid-proof silica-base brick.

Process (Pickling Operation) Areas

A total of five pickling areas currently exist at this plant. All have separate operations (one is not presently operating). Of those operations, all are batch operations except one continuous.

- "Southside" Cold Finish Department - includes two batch pickling operations; "Little Mexico" and Pickling Rounds.
- "Hazelwood" Cold Finishing Department - includes bar and coil batch pickling operations.
- "Rolling Mills" Steel Surface Conditioning Department - batch operation. P 2-14" bar pickling (batch) is done outdoors.
- "Strip Mill" Department - currently have only one pickle line ("B" line) operating (two lines prior to 1974). Pickling operation is continuous and consists of four 60 foot long acid tanks and one 60 foot long split tank with hot and cold water rinse.

The physical plant layout showing the location of these departments is shown in Appendix 1.

DESCRIPTION OF PAST EXPOSURES

Worker exposure measurements for H_2SO_4 mist have been taken by J & L and OSHA. Copies of these reports were not available, but can be obtained.

Present controls for each pickling department are listed in Appendix 3. Basically, the processes and exposures should be comparable for batch operations since 1914 and since 1938 for the continuous process.

Acid workers in the strip mill have complained of seemingly high acid mist concentrations during periods of peak production.

DESCRIPTION OF MEDICAL, INDUSTRIAL HYGIENE AND SAFETY PROGRAMS

The Pittsburgh works have a full time occupational health physician (as well as a corporate Medical Director). The plant physician has responsibility over 11 full time R.N.s, 3 part-time R.N.s and 1 physician's assistant. The staff is divided into a main-health center on the Southside and two dispensaries on the Northside. The plant also employs two medical specialists part-time. Complete pre-employment physicals are required of all employees. Periodic physicals are required for employees of certain job areas and those returning from lay-offs.

The industrial hygiene program is headed by a certified industrial hygienist. A certified industrial hygiene technician provides the assistance for the C.I.H.

The safety department consists of a plant safety administrator that oversees a staff of 4 safetymen. J & L also has a corporate safety professional.

All three departments have a close cooperative work relationship. Each department reports to the plant personnel director, and to the corporate level. The programs combine to provide health-care, compliance requirements, employee personal-protective equipment and job safety and first aid training. Protective equipment supplied by J & L includes hard-hat, clothing, glasses, and respirators. There are separate facilities for eating and showering.

INSPECTION OF THE PLANT

There is potential H_2SO_4 mist exposure in all 5 pickling areas. As mentioned employees in the strip mill (continuous operation) complained of high H_2SO_4 mist exposures. There are respirators available but are not required to be worn in any of the areas. Work practices seemed adequate although a report of accidents/illnesses was not obtained. General housekeeping was in order.

DESCRIPTION OF SURVEY METHODS

General area samples were taken for the 2 batch pickling and 1 continuous pickling operations. Specific areas, sample numbers and pump location are

given in Appendices 3 and 4. Barometric pressure, relative humidity and atmospheric temperatures were recorded. All sampling pumps were checked and monitored during sampling period.

SAMPLING AND ANALYTICAL METHODS

Sulfuric Acid

Sulfuric acid mist samples were collected at a calibrated flow rate of 1.5 lpm using MSA Model G sampling pumps, in conjunction with 37 mm, 0.8 micron pore size, AA Millipore filters as a collection medium. Sampling time for all acid samples was approximately three hours (Appendix 4). Refer to Sampling Data Sheet #S174 "NIOSH Manual of Sampling Sheets" (1972 Edition).

The samples were analyzed for sulfuric acid via ion chromatography with a Dionex Model 10 ion chromatograph. The limit of detection is 4 ug/filter.

RESULTS

General area measurements are shown on Sampling Summary Sheet (Appendix 4). The samples were analyzed by Utah Biomedical Test Laboratory, Salt Lake City, Utah. Analytical results indicate presence of H_2SO_4 in respective areas. Measurements of H_2SO_4 range from .039 to 1.2 mg/m^3. Airborne concentrations of 1.2 mg/m^3 in the strip mill (continuous operation) indicate a potential problem area (Federal Standard is 1.0 mg/m^3 TWA).

The general area measurements represent an approximate three hour sampling time and should not be confused with time weighted averages. The air samples indicate the exposures that might be expected as an aide for planning in-depth sampling strategy.

CONCLUSION

Previous process and control changes have not significantly altered the typical steel pickling processes at J & L. For these reasons, reconstructing approximate worker exposures to H_2SO_4 mist prior to 1960 is feasible.

General area samples of H_2SO_4 mist taken in the strip mill indicate a potential problem area.

Some of the potential problems of using employment records to identify a cohort of individuals occupationally exposed to sulfuric acid at this plant are:

- Crane operators for steel pickling operations are difficult to deal with due to the fact that this specific job has a large amount of "within plant mobility". It would be hard to figure how long such individuals worked in specific pickling operations. However, <u>most</u> crane operators probably have worked in pickling at some time.

- The ability to partition continuous versus batch pickling workers and to determine the length of time a worker was on a respective job is at best difficult.

- Exposure of operation foremen is difficult to ascertain.

- Multiple titles for the same job compounds the problem of determining sulfuric acid exposure by job title. Much time would be needed to become familiar with the nomenclature.

In summary, employee records at this plant are not of the highest quality, but if a better cohort cannot be located, J & L records would be sufficient for an epidemiologic study.

RECOMMENDATIONS

NIOSH recommends this site for inclusion in the in-depth industrial hygiene phase of this study. It is also recommended that J & L evaluate TWA exposures of H_2SO_4 mist in the strip mill area. NIOSH would recommend this site for study only if better records cannot be found elsewhere.

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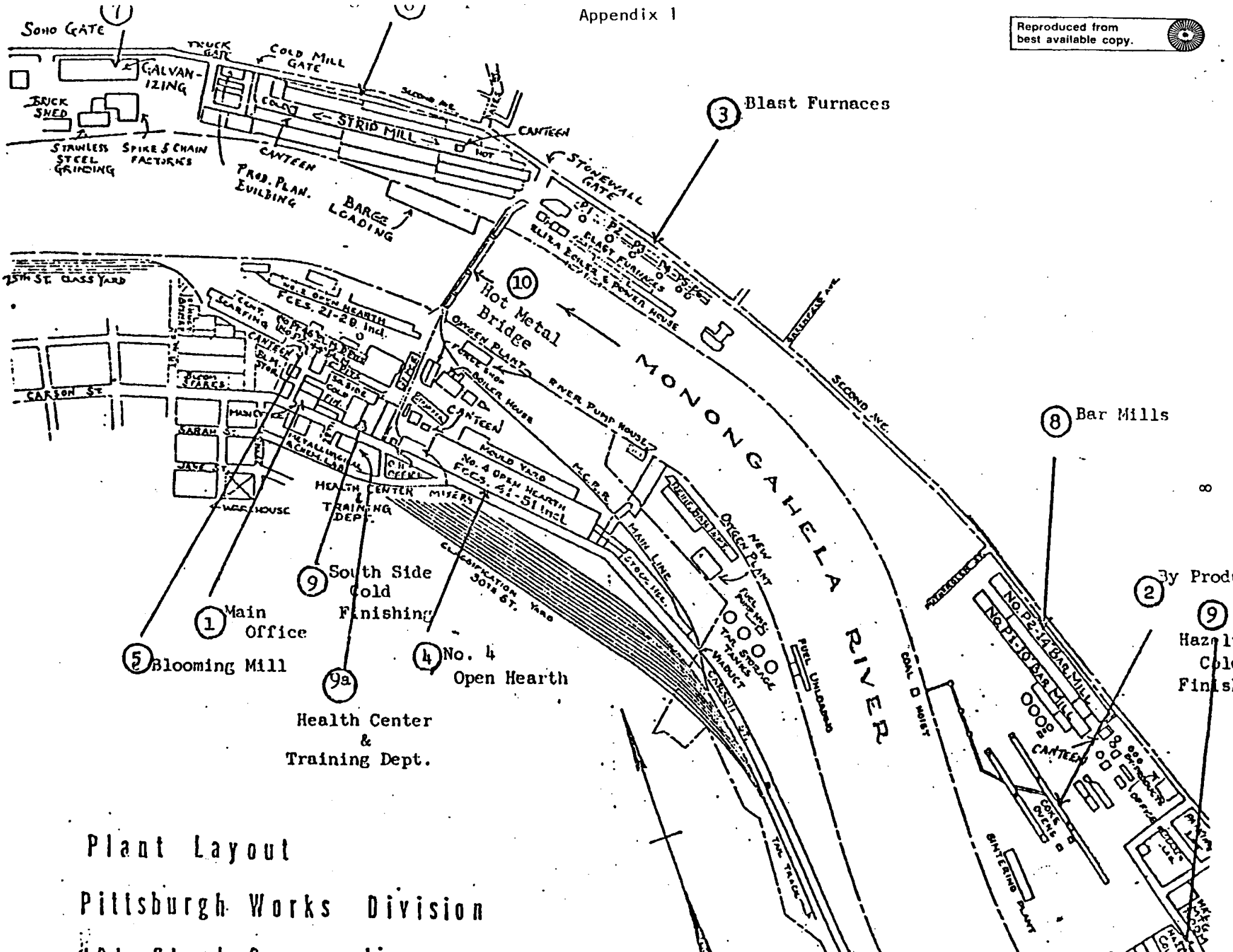

Plant Layout

Pittsburgh Works Division

Appendix 2

SUMMARY OF WORKERS INVOLVED IN PICKLING OPERATIONS - JONES AND LAUGHLIN STEEL COMPANY

PICKLING OPERATION AREA	JOB TITLE	NUMBER OF WORKERS/SHIFT
Southside		
(1) Pickling Rounds	• Pickler	1
	• Pickler Helper	2
	• Crane Follower	1
	• Crane Operator	2
	Subtotal	6
(2) "Little Mexico"	• Pickler	1
	• Pickler Helper	1
	• Crane Operator	1
	Subtotal	3
	Total	8
Hazelwood		
(1) Bar	• Pickler	1
	• Pickler Helper	1
	• Crane Operator	1
	Subtotal	3
(2) Coil	• Pickler	1
	• Pickler Helper	2
	• Crane Operator	1
	Subtotal	4
	Total	7
Bar Mills	• Pickler	1
	• Crane Follower/Helper	1
	• Crane Operator	1
	• Clerk	1
	• Foreman	1
	Total	5

PICKLING OPERATION AREA	JOB TITLE	NUMBER OF WORKERS/SHIFT
Blooming Mill (Outdoors and presently not in operation)		
	• Craneman	1
	• Crane follower	2
	• Pickler	1
	Total	4
Strip Mill	• Feeder	2
	• Stitcher Operator	1
	• Burner	1
	• Shearman	1
	• Shearman Helper	1
	• Craneman	1
	• Recorder	1
	• Stocker	1
	• Roller Operator	1
	• Oiler	1
	• Millwright	1
	• Millwright Helper	1
	• Pipefitter	1
	• Pipefitter Helper	1
	• Turn Foreman	1
	• Electrician	1
	• Craneman	3
	• Tractor Driver	1
	Total	21
Mesta Pickler (went out of service in 1971)	• Pickler	1
	• Pickler Helper	2
	• Tractor Operator	1
	Total	4

Grand Total (pickling workers (shift): 50

Appendix 3

J & L Steel Corporation

Pittsburgh Works

Sulfuric Acid Pickling Operations

Dept. Area	Location	Began Operation	Physical Description	Purpose	Type	No. of H_2SO_4 General Area Samples	Controls				Remarks
							Temp.	Vent.	Inhibitor Used	Respirator Worn	
Blooming Mill	no longer used	1951-74	no longer used	---	Batch	---	--	--	--	--	
Cold Finishing Southside I	Rounds Dept. (Lower end)	1914	Batch Tanks (2) Lime Tank (1)	Descaling Rounds	Batch	1	None	Roof Louvers	Rodene 87 Inhibitor Supp.	None	Sampling pump placed on top center ledge of the control ventilation system.
Cold Finishing Southside II	Little Mexico (upper end)	1914	Batch Tank Lime Tank	Descaling flats squares	Batch	1	None	Roof Louvers	Rodene 87 Inhibitor Supp.	None	Pump placed on acid worker desk.
Cold Finishing Hazelwood	Bar Side	1914	Batch Tanks (2) coil (2) bars Lime Tank (1)	Descaling bars Neutralize acid	Batch	---	None	Roof Louvers Powered (2)	Rodene 87 Inhibitor Supp.	None	---
Rolling Mills P 2-14"	Conditioning bed	1914	Batch tank	Descaling blooms & billette	Batch	---	None	None	Parkin GSX #5 Inhibitor Supp.	None	Steam turned off at end of each pickling cycle
Strip Mill	Cold Strip Mill	1938	4 Pickling tanks; 1 hot rinse tank; "B" line only	Descale & Surface cleansing	Continuous	3	Recorded	Forced Fume Exhaust thru Scrubbers	Parkin Inhibitor Nelco Fume Supp. Nelco Soap in Looping Pit	None	Fume exhaust recently rehabilitated. 1 pump placed on top of icebox from splitter & adjacent to break area. 1 pump placed across from #4 grid tank by walk-over. 1 pump placed near trimmer by operator stand.

Appendix 4

Sampling Summary Sheet

Date June 15, 1979

Plant: Jones & Laughlin Steel Corp.
Pittsburgh Works
Pittsburgh, Pennsylvania

Temperature Range: 49° - 65°F
Atmospheric Pressure: 30.10"
Relative Humidity: 57%

Date 1979	Sample No.	Area Sampled	Time Start	Time Stop	Sample Volume (liters)	Total Weight (ug)	Concentration H_2SO_4 mg/m3	
2/28	AH2	Cold Finishing - Southside Rounds Dept. (Lower end)	11:45	15:51	370	51	0.14	
2/28	BH2	Cold Finishing - Southside Little Mexico (Upper end)	11:55	15:56	360	14	0.039	
2/28	CH2	Cold Strip Mill - Northside (continuous pickling)	14:03	17:32	310	110	0.35	
2/28	DH2	Cold Strip Mill - Northside	14:08	17:38	320	370	1.2	
2/28	EH2	Cold Strip Mill - Northside	14:15	17:42	310	380	1.2	
2/28	Blank Filter					<4		