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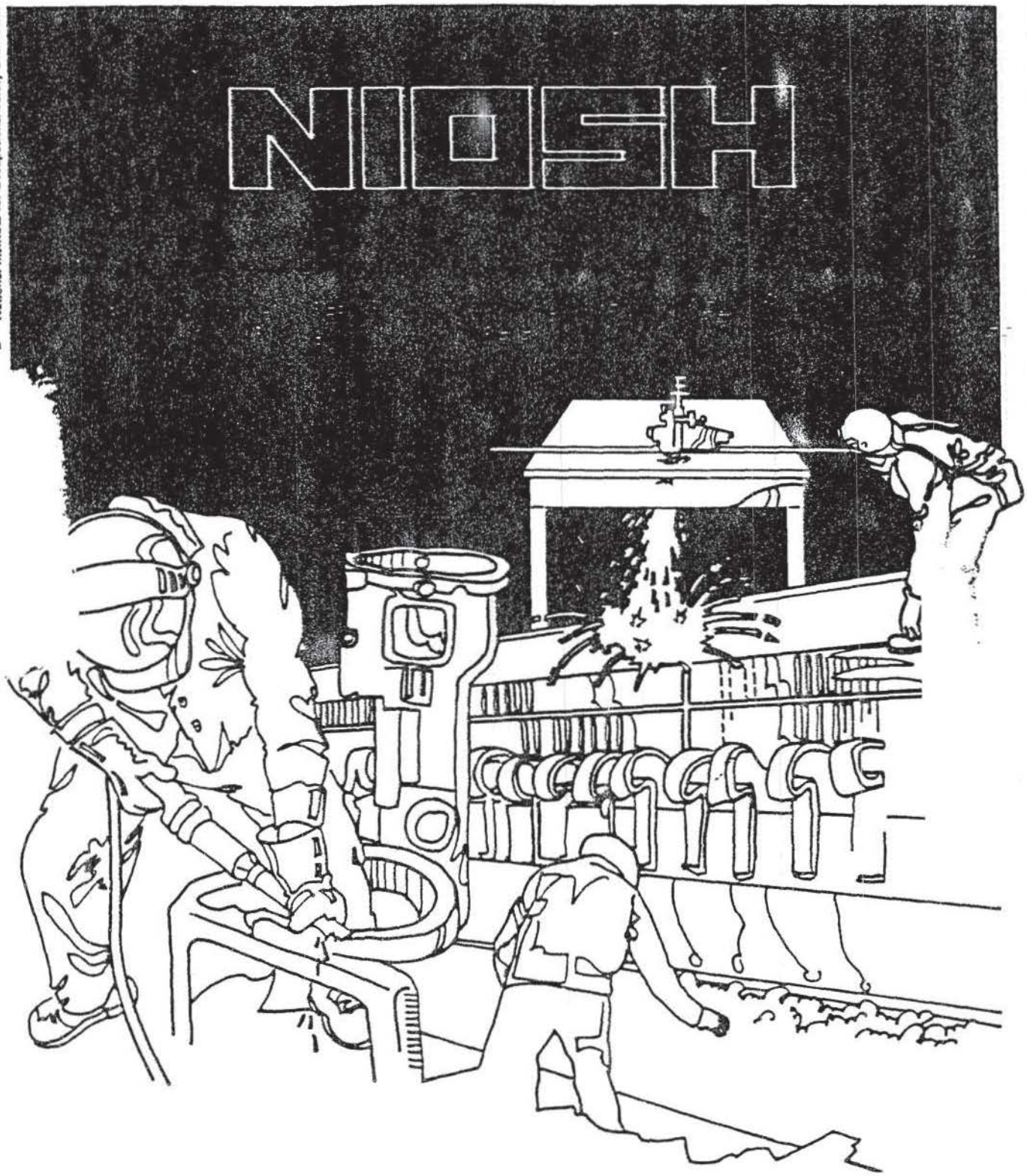

Health Hazard Evaluat[illegible] Repo[illegible]

HETA 80-112-1261
JONES AND LAUGHLIN
STEEL CORPORATION
EAST CHICAGO, INDIANA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from 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 Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 80-112-1261
FEBRUARY 1983
JONES AND LAUGHLIN STEEL CORPORATION
EAST CHICAGO, INDIANA

NIOSH INVESTIGATORS:
Peter Orris, MD, MPH
William Daniels, IH

I. SUMMARY

On April 14, 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation at the Jones and Laughlin Steel Corporation, East Chicago, Indiana, to investigate recent morbidity and mortality due to lung cancer and heart disease among workers involved in the production of seamless steel tubing.

In July 1980, NIOSH investigators conducted an initial survey, and in August 1980 they performed a combined environmental and medical survey during which personal breathing-zone air samples for iron oxide and total particulate were collected, and a medical questionnaire was administered to all employees in the area. In January 1981, pulmonary function testing (PFT) of employees was conducted, and in March 1981 additional environmental sampling was conducted.

Concentrations of iron oxide in 15 breathing-zone samples ranged from 0.17 to 9.2 milligrams per cubic meter of air (mg/m^3), with a mean of 2.7 mg/m^3. Four exceeded the Threshold Limit Value (TLV) recommended by American Conference of Governmental Industrial Hygienists (ACGIH) of 5 mg/m^3; however, all were below the Occupational Safety and Health Administration (OSHA) standard of 10 mg/m^3 for an 8-hour time-weighted average (TWA). Concentrations of total particulate in 15 breathing-zone samples ranged from 0.45 to 14 mg/m^3, with a mean of 4.5 mg/m^3. Three exceeded the TLV recommended by ACGIH of 10 mg/m^3 for nuisance dust; however, all were below the OSHA standard of 15 mg/m^3 for an 8-hour TWA. All employees in areas where excessive concentrations were detected were required to wear respiratory protection. No exposures to any cardiotoxic or carcinogenic agent were identified in the work environment.

Of the 80 employees in the area, 72 were interviewed by the NIOSH investigators; all were male, 60 were current cigarette smokers, 1 smoked a pipe and cigars, and 11 were nonsmokers. Thirty-six percent of the smokers and 18% of the nonsmokers (36% and 18%) complained of shortness of breath when hurrying up a slight hill; 46% and 18% indicated episodes of wheezing; 31% and 9% indicated that they coughed each morning; 43% of the smokers stated that they brought up phlegm each day, while only 1 of the nonsmokers indicated frequent sputum production.

On pulmonary function evaluation, the mean FEV_1 for the 57 smokers tested was 3.47 liters, or 93.2% of the predicted norm. For the 15 nonsmokers, the mean was 3.74 liters, or 102.9% of the predicted. The FVC results were a normal 93.7% of predicted for smokers and 100.27% for the nonsmokers. FEV_1/FVC were also normal for smokers at 0.8, and for nonsmokers at 0.83.

No morbidity or mortality above that expected for this age group in the general population due to cancer or ischemic heart disease was found.

On the basis of the data obtained in this investigation, NIOSH has determined that a potential health hazard exists at the No. 3 Seamless Tubing Mill, Jones and Laughlin Steel Company, East Chicago, Indiana, from exposures to iron oxide and airborne particulates. Recommendations related to this evaluation are contained in the body of the full report.

KEYWORDS: SIC 3317 (Steel Pipe and Tubes), iron oxide, nuisance dust, lung cancer, chronic bronchitis, wheezing, shortness of breath, steel tubing.

II. INTRODUCTION

On April 14, 1980, a representative of the United Steel Workers of America, Local 1011, requested a NIOSH health hazard evaluation of the Number 3 Seamless Mill at the Jones and Laughlin Steel Corporation, East Chicago, Indiana. The requestor was concerned with recent morbidity and mortality due to lung cancer and heart disease among workers involved in the production of seamless steel tubing. Included with the request was information on four deaths from lung cancer and five heart attacks over a period of 4 years.

On July 17, 1980, NIOSH investigators conducted an initial survey of the facility. This included an opening conference with representatives of management and the local union followed by a walk-through inspection of the area of concern. On August 19, 1980, a combined environmental and medical survey was conducted during which personal breathing zone air samples were collected for iron oxide and total particulate, and medical questionnaires were administered to the employees in the area. On January 27, 1981, a follow-up medical survey was conducted during which pulmonary function tests (PFT's) were conducted. On March 6, 1981, additional environmental samples were collected. Environmental survey results were provided by letter to the requestor and company on March 10, 1981. Individual letters containing results of the PFT's were provided to the employees on June 29, 1981.

III. BACKGROUND

A. Plant Production and Work Force

Since 1957, seamless steel tubing of varying diameters has been produced in the No. 3 Seamless Mill of the Jones and Laughlin Steel Corporation (formerly Youngstown Sheet and Tube Co.). During normal operations, approximately seven hundred, 47 foot long pipes are produced per shift. Seventy production and 7 supervisory personnel are employed in this area on the two shifts during which production occurs.

B. Process Description and Employee Duties

Steel stock is supplied to the mill in the form of round bars or billets. These are first heated in a rotary furnace to approximately 2200°F, then transferred on a horizontal trough to the piercing mill. As the front end of the billet enters the piercing mill, a set of rollers grip the billet moving it forward and causing it to flow over the pointed end of a mandrel. When the entire axis of the billet has traveled across the mandrel, a hollow shell is formed. An operator located in an air-conditioned booth oversees the mill, while a helper or "plugger" changes the mandrels and performs other tasks.

The hollow shell is next transported to a reheating furnace. A "heater" and a helper are positioned at the door of the furnace where they use a long metal prong to adjust the tubes for proper heating. The tube then is removed from the furnace and is conveyed to the high mill. Here the tube is automatically injected with a plug mill lubricant (composed of graphite, sodium tetraborate, and lime) and drawn by a set of rollers over an alloy steel plug. When the length of the shell has passed over

the plug, the plug is removed by the high mill plugger and the tube is ejected from the mill. A new plug is then placed on the holder and the tube is rotated 90° and enters the mill again. The action of the mill serves to reduce the wall thickness and diameter, and increase the length of the tube. An operator controls the high mill plugger from an enclosed air-conditioned booth.

After leaving the plug mill, the tube enters a reeling machine. This machine is similar to the piercer, except a cylindrical shaped mandrel is utilized. This results in a rounding out and burnishing of the inside and outside of the tube. The two reeling machines are controlled by an operator located in an enclosed air-conditioned booth.

The tube is then conveyed to the sizing mill where it is passed through various sets of rollers which further reduce the diameter and insure uniform size and roundness. The finished tube is then conveyed to another area of the mill for storage and shipping. An operator located in an enclosed air-conditioned booth controls this process. In addition, a roll assembler is stationed near the operation to repair damaged rolls and routinely replace the rollers.

C. Engineering, Personal Protection, and Administrative Controls

Ceiling fans and other air moving fans are located throughout the mill. All employees are required to wear safety glasses, safety boots with metatarsal protectors, and hard hats. Earmuffs and earplugs are utilized throughout the area. No written procedure for a respiratory program was evident, however, disposable dust, fume, and mist respirators are made available to the employees. Respirator usage is mandatory for the high mill pluggers, the roll changer, and the sizing mill operator when out of the enclosed booth. In addition, the three high mill pluggers each work for 20 minute intervals each hour to reduce exposures to heat, noise, and dust at this operation.

IV. MATERIALS AND METHODS

A. Environmental

Following the initial survey, information was obtained related to previous inspections conducted by the Occupational Safety and Health Administration (OSHA) from 1977 - 1980. A review of these data (Table 1) revealed no significant concentrations of carbon, borax, or carbon monoxide. However, high concentrations of total particulate and iron oxide were detected in personal samples collected in some work areas.

Since the OSHA sampling was conducted at a limited number of work stations, environmental surveys were conducted by NIOSH on July 17, 1980 and March 6, 1981 to further characterize employee exposures thoughout the mill. During these surveys, personal samples were collected near the breathing zone of the employees using battery-powered air sampling pumps operating at 1.5 liters per minute. These pumps were attached via tygon tubing to pre-weighed filters contained in three piece cassettes. The duration and location of sample collection are given in Table 2. The samples were analyzed for total particulate weight and iron oxide (measured as iron) by NIOSH Analytical Method P&CAM 173[1]. In

addition, in order to assess the levels of other contaminants which might be present in the environment, a bulk sample of rafter dust collected in the work area was analyzed by an Inductively Coupled Plasma - Atomic Emission Spectrometer for trace metal content.

B. Medical

On August 19, 1980, a questionnaire was confidentially administered to the employees in the No. 3 Seamless Mill. The questionnaire solicited information on the workers employment and medical histories, with specific respiratory questions modified from the British Medical Research Council's respiratory questionnaire[2]. Expected frequencies of respiratory symptoms in the study cohort were calculated based on historical data concerning community prevalence of respiratory symptoms. Chronic bronchitis was defined for the sake of comparison as cough with phlegm more than 5 days a week for more than 3 months a year for more than 2 years. These frequencies were developed with controls for the prevalence of smoking in the two populations. Further, the occurrence of cough and chronic bronchitis in this population was compared with that found by investigators in other working populations.

In addition, the employees were questioned as to the names of individuals from this work area suffering death or disability due to heart disease or cancer. Through the use of a modified SMR approach approximate expected numbers of individuals with illness or death due to lung cancer and ischemic heart disease were calculated for this group of workers. This approximation was based on information concerning morbidity and mortality rates for the United States population in 1976. These expected numbers were compared with the actual frequencies noted to be present amongst these workers based on employee questionnaires and company data.

As a result of the number of employees reporting respiratory symptoms on January 27, 1981, pulmonary function tests were performed on the employees who had been previously interviewed. Normal values for the United States population, corrected for age and height, were compared with those found in this population. A value of 80% or greater for the subject's Forced Vital Capacity (FVC) and One Second Forced Expiratory Volume (FEV_1), when compared with the predicted, is considered normal. A ratio of FEV_1/FVC of 75% or greater is also considered normal[10].

V. EVALUATION CRITERIA

A. Environmental

The environmental criteria described below represent airborne concentrations of substances to which workers may be exposed for eight hours a day, 40 hours per week for a working lifetime without adverse health effects. Because of wide variation in individual susceptibility, a small percentage of workers may experience discomfort from some substances at concentrations at or below the recommended criteria. A smaller percentage may be more seriously affected by aggravation of a pre-existing condition or by a hypersensitivity reaction[3]. The time-weighted average (TWA) exposure refers to the average concentration during a normal 8-hour workday.

1. Nuisance Particulates

In contrast to fibrogenic dusts which cause scar tissue to be formed in the lungs when inhaled in excessive amounts, so-called "nuisance" dusts are stated to have little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. The nuisance dusts have also been called (biologically) "inert" dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lung when inhaled in sufficient amount. However, the lung-tissue reaction caused by inhalation of nuisance dusts has the following characteristics: (1) The architecture of the air spaces remains intact; (2) Collagen (scar tissue) is not formed to a significant extent; and (3) The tissue reaction is potentially reversible.

Excessive concentrations of nuisance dusts in workroom air may seriously reduce visibility, may cause unpleasant deposits in the eyes, ears and nasal passages, or cause injury to the skin or mucous membranes by chemical or mechanical action, per se, or by the rigorous skin cleansing procedures necessary for their removal. The American Conference of Governmental Industrial Hygienists recommends a threshold limit value (TLV) of 10 milligrams per cubic meter of air (mg/M^3) for an 8-hr TWA for total dust[3]. The OSHA standard is 15 mg/M^3 for an 8-hr TWA[4].

2. Iron Oxide

Long term occupational exposure to iron oxide fume or dust may cause a condition known as siderosis, noted by the literature to be a non-progressive, non-disabling lung disease. There is no information in the literature on the combined effects of iron and other industrial dusts on the lungs. Although benign, it cannot be stated that iron dust deposits in the lungs are totally harmless. Variations in individual susceptibility and exposures may cause difficulty for some workers and not others. No information was noted in the literature regarding a relationship between iron oxide and heart attacks. ACGIH recommends a TLV of 5 mg/M^3 for an 8-hr TWA for iron oxide fume, measured as iron[3]. The OSHA standard for iron oxide is 10 mg/M^3 for an 8-hr TWA[4].

B. Medical Criteria

1. Respiratory Symptoms

The Health and Nutrition Examination Survey (HANES)[5], conducted between 1971 and 1975 by the United States Department of Health, Education and Welfare, was utilized to estimate the prevalence of respiratory symptoms in the United States population. Expected frequencies of respiratory symptoms in the study cohort were then calculated based on these data with control for prevalence of smoking.

In a study conducted by Phillips, et. al. in 1956, the prevalence of chronic cough in 1,274 male factory workers without overt evidence of pulmonary or heart disease was found to be 2.0% in nonsmokers and 51.0% in smokers[6]. In another study of 4,218 male and female postal employees by Densen, et. al., it was noted that 7.0% of nonsmokers,

12.4% of pipe or cigar smokers, and 27.0 % of cigarette smokers had a chronic cough.[7]

The prevalence of habitual cough and sputum production was found to be 11.0% for nonsmokers and 30.4% for smokers in a study of 1,451 male, light industry workers in California by Balchum, et. al.,[8]. An English study conducted by Oswald and Medvei in 1955, found the prevalence of chronic bronchitis (defined as habitual cough and sputum production during the last 5 years) to be 15.8% in 474 nonsmoking, and 18.4% in 1,940 smoking, male, civil servants.[9]

2. Ischemic heart disease and lung cancer

Community morbidity and mortality rates for lung cancer and ischemic heart disease were obtained from the Statistics of The United States 1976. Vol.2, Part A, Section 1, Table 1-8, published by The Department of Health and Human Services, U.S. Public Health Service[11].

3. Pulmonary function

Comparative normal values for pulmonary function tests utilized in this study were developed by Ronald J. Knudson, et. al. in 1976[10]. They established predictive normal pulmonary function tables for the United States population, corrected for age and height.[10].

VI. RESULTS

A. Environmental

Concentrations of iron oxide in 15 breathing zone samples ranged from 0.17 to 9.2 mg/M^3, with a mean of 2.7 mg/M^3. Four exceeded the TLV recommended by ACGIH of 5 mg/M^3 for iron oxide; however, all samples were below the OSHA standard of 10 mg/M^3 for an 8-hour TWA. Concentrations of total particulate in 15 breathing zone samples ranged from 0.45 to 14 mg/M^3, with a mean of 4.5 mg/M^3. Three exceeded the TLV recommended by ACGIH of 10 mg/M^3 for nuisance dust; however, all were below the OSHA standard of 15 mg/M^3 for an 8-hour TWA. All employees in areas where concentrations in excess of the recommended evaluation criteria were detected were required to wear respiratory protection. Therefore, the above concentrations reflect potential rather than actual exposures. A complete listing of these results is given in Table 2.

Laboratory analysis revealed that the major component of the dust in the personal samples was iron oxide, with an average composition of 62%. Analysis of the bulk "rafter sample" of dust collected in the work area revealed the metal content of the dust to be primarily iron, with lesser amounts of calcium, sodium, and magnesium, along with trace amounts of several other metals. No significant quantities of any known carcinogenic agent were identified during the survey.

B. Medical

Of the 80 employees in the area 72 were interviewed by the NIOSH investigators, all were male, 60 were current cigarette smokers, one individual smoked a pipe and cigars, and 11 were nonsmokers. Of these employees, 44% of the smokers and 55% of the nonsmokers were forty years of age or less and 14.8% of the smokers and 45% of the nonsmokers were Black. Approximately half of the subjects had been employed by the company for more than 10 years. (Table 3)

Thirty-six percent of the smokers and 18% of the nonsmokers complained of shortness of breath when hurrying up a slight hill. Three percent of the smokers complained of shortness of breath when walking on level ground with men their own age. Two percent of the smokers said that they were short of breath when walking on level ground at their own speed. No nonsmokers reported shortness of breath on level ground. No increased shortness of breath was noted by either group on the first day back at work.

Forty-six percent of the smokers and 18% of the nonsmokers indicated episodes of wheezing. One of the nonsmokers had been diagnosed as asthmatic and 12 of the smokers reported previous asthmatic attacks. Eighteen percent of the smokers reported frequent wheezing while none of the nonsmokers reported this problem.

Thirty-one percent of the smokers and 9% of the nonsmokers indicated that they coughed each morning for a period of at least three months this year. Twelve percent of the smokers and 9% of the nonsmokers indicated they coughed throughout the day. Thirty-four percent of the smokers and 9% of the nonsmokers stated that their cough was present for longer than the last two years.

Forty-three percent of the smokers stated that they brought up phlegm each day, five or more days a week, for a period of at least three months this year. Thirty-six percent indicated they had chronic bronchitis by indicating that they had this phlegm production for longer than the last two years. Only one of the nonsmokers indicated frequent sputum production, and this for less than two years. (Table 4)

There was no increased prevalence of chronic bronchitis in those smoking workers employed by the company for more than 10 years, when compared to those employed less than 10 years. However, the more senior employees did experience more shortness of breath than did their co-workers with a shorter length of employment. No variation with length of employment was noted in the group of nonsmokers. (Table 7)

At the time of administration of the pulmonary function tests, four workers that reported cigarette use on the questionnaire had stopped smoking. The mean FEV_1 for the 57 smokers was 3.47 liters or 93.2% of the predicted norm. There were six smokers with FEV_1 values below 80% of predicted. For the 15 nonsmokers, the mean was 3.74 liters or 102.9% of the predicted, with no workers registering less than 80% of the predicted norm. The mean FVC results were a normal 93.7% of predicted for smokers and 100.27% for the nonsmokers. Three smokers

and no nonsmokers registered FVC values below 80%. Mean FEV_1/FVC values were also normal for smokers at 0.8 and for nonsmokers at 0.83. Five smokers, 2 exsmokers, and 4 nonsmokers had values below 0.80. (Table 8)

Seven deaths due to lung cancer and five heart attacks were reported during the confidential employee interviews.

VII. DISCUSSION

The results of the environmental survey indicate that concentrations of iron oxide and total particulate in some personal samples were in excess of the recommended evaluation criteria. Those job categories which demonstrated these excessive concentrations were the sizing mill operator, roll assembler, and high mill plugger. It should be noted that the company has identified the potential for high exposures in these areas and requires the use of respiratory protection for all of these employees, provides for air-conditioned work booth for the sizing mill operator, and utilizes the administrative control of employee rotation among the high mill pluggers. These controls, when properly utilized, should reduce exposures within acceptable levels.

The results of the medical survey indicated that the difference between the prevalence of shortness of breath among the workers in this study when compared with the prevalence of this symptom as reported by the HANES data, was not statistically significant (Table 5). In addition, no increased prevalence of shortness of breath was evident among those nonsmokers employed by the company for over 10 years when compared to those employed for less time. However, those smokers employed more than ten years by the company were more likely to have symptoms of shortness of breath than those smoking employees with shorter employment. The correlation coefficient between length of employment and years of cigarette smoking was 0.413 indicating that approximately 16% of the observed variation could be related to duration of cigarette consumption. When the prevalence of shortness of breath is reduced by 16%, a differential relating to length of employment is still present but no longer statistically significant. Therefore, it is not clear whether the increased prevalence of shortness of breath in longer term employees is due to increased duration of cigarette smoking, employment, increasing age or a combination of factors. (Table 7)

Wheezing was reported significantly more frequently than would be expected to report this symptom on the basis of the HANES data (Table 5).

The prevalence of chronic cough in this cohort was compared with both Phillips' and Densen's studies. Nonsmokers in this group exhibited no more chronic cough than nonsmokers in these studies. On the other hand, smokers manifested significantly more cough when compared with Densen's study (Table 6). The prevalence of chronic morning cough in this group was also compared with the HANES data and showed significantly more complaints than the control (Table 5). This also held true for the prevalence of morning phlegm (Table 5). It should be noted that both of these findings may have been caused exclusively by the smoking members of this study group.

Chronic bronchitis was significantly more frequent in the group of smoking workers than in either the Belchum or Oswald study. This finding was not replicated in the nonsmoking group (Table 6).

The PFT's performed on these workers were all within the normal limits established by Knudson (Table 8). Further, the pulmonary functions did not decrease with increasing years of employment. However, it is possible that the healthy worker effect could be present in this group of employees. Specifically, any employees who developed severe respiratory problems, may have stopped work or transferred to other areas of the plant prior to this survey.

In order to assess the accuracy of the symptomatologic history given by the employees, chronic bronchitis and grade of shortness of breath was correlated with the PFT results. Those employees reporting chronic bronchitis had significantly decreased FEV_1 and FEV_1/FVC values when compared to the other employees. Further, the grade of shortness of breath varied directly with PFT results (Table 9). These findings tend to confirm the validity of the subjective reports of pulmonary symptomatology.

When the age of the population and prevalence of cigarette smoking is considered, the numbers of lung cancer deaths and heart attacks are not unusual compared with the frequency of lung cancer deaths among males of these ages in the United States.

In conclusion, it would appear that among the employees in this study, those who smoked cigarettes experienced more respiratory symptoms than fellow smokers not working in this environment. Nonsmokers appeared to experience no increased prevalence of pulmonary problems. However, the limitations of this study do not allow an accurate assessment of possible pulmonary function abnormalities due to exposure to these industrial dusts and cigarette smoke. Further no increased incidence of lung cancer or ischemic heart disease is evident from the information collected during this study.

VIII. RECOMMENDATIONS

The company should continue their efforts to reduce dust exposures within the No. 3 Seamless Mill. Enclosures should be fully utilized to limit employee exposures in the work areas. Any additional engineering controls, including the utilization of local exhaust ventilation where possible, would be the preferable means of controlling exposures. In the interim, employees at those jobs with potentially high exposures should continue to be required to wear NIOSH/MSHA approved respirators and adhere to a proper respiratory protection program. These employees should be made aware of the proper use and limitations of the respirators. Workers should not be assigned to tasks requiring the use of respirators unless it has been demonstrated that they are physically able to perform the work and use the equipment. Respirators should be properly fitted and the adequacy of the face-piece-to-face seal should be tested for each employee.

IX. REFERENCES

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared By:

Peter Orris, M.D., M.P.H.
Medical Officer
NIOSH - Region V
Chicago, Illinois

William J. Daniels
Industrial Hygienist
NIOSH - Region V
Chicago, Illinois

Environmental Evaluation:

Richard S. Kramkowski
Regional Consultant
NIOSH - Region V
Chicago, Illinois

Daniel Almaguer
Industrial Hygienist
NIOSH - Region V
Chicago, Illinois

Originating Office:

Division of Surveillance, Hazard Evaluations, & Field Studies,
Hazard Evaluation and Techinical Assistance Branch
Cincinnati, Ohio

XI. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Services (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH publications office at the Cincinnati address. Copies of this report have been sent to the following:

1. United Steel Workers Union, Local No. 1011
2. Jones and Laughlin Steel Company
3. U.S. Department of Labor, OSHA - Region V
4. NIOSH Regional Offices/Divisions

For the purposes of informing the affected employees, copies of the report should be posted in a prominent place accessible to the employees, for a period of 30 calendar days.

TABLE 1

RESULT OF OSHA SURVEYS CONDUCTED AT THE NUMBER 3 SEAMLESS MILL
JONES AND LAUGHLIN STEEL COMPANY

Survey Date	Job Title	Substance/ Concentration	Substance/ Concentration	Substance/ Concentration
8/17/77	Sizing Mill Operator	Borax/ 0.032 mg/M^3	Iron oxide/ 0.30 mg/M^3	Carbon/ 0.036 mg/M^3
8/17/77	Plug Mill Plugger	Borax/ 0.032 mg/M^3	Iron oxide/ 0.32 mg/M_3	Carbon/ 0.024 mg/M^3
4/11/78	Sizing Mill Operator	Borax/ 0.07 mg/M^3	Iron oxide/ 4.28 mg/M_3	Carbon/ 0.04 mg/M^3
4/11/78	Sizing Mill Operator	Borax/ 0.08 mg/M^3	Iron oxide/ 4.70 mg/M_3	Carbon/ 0.34 mg/M^3
3/6/80	Plug Mill Plugger	Total Dust/ 10.7 mg/M^3	Iron Oxide/ 5.46 mg/M_3	Lead/ None Detected
3/6/80	Plug Mill Plugger	Total Dust/ 10.4 mg/M^3		
3/6/80	Reheat Furnace Heater	Total Dust/ 11.4 mg/M^3	Iron Oxide/ 5.59 mg/M_3	Carbon Monoxide/ Trace(< 25 ppm)
3/6/80	Mill Crane Operator	Total Dust/ 3.9 mg/M^3		
3/6/80	Sizing Mill Operator	Total Dust/ 46.2 mg/M^3	Iron Oxide/ 38.4 mg/M_3	Lead/ None Detected
3/6/80	Roll Assembler	Total Dust/ 12.8 mg/M^3	Iron Oxide/ 5.38 mg/M_3	Lead/ None Detected

TABLE 2

RESULTS OF ENVIRONMENTAL SAMPLES COLLECTED AT THE
JONES AND LAUGHLIN STEEL CORPORATION
(August 19, 1980 and March 6, 1981)

Job Title	Sample Date	Sample Time (min.)	Sample Volume (liters)	TWA* Iron Oxide† (mg/M3)	TWA - Total Particulate (mg/M3)
High Mill Plugger	8/19	188	282	0.85	1.2
#2 Reeler Operator	8/19	394	591	0.32	0.47
Sizing Mill Operator	8/19	406	609	9.2	14
Reheat Furnace Operator	8/19	392	588	0.68	1.2
Reheat Furnace Helper	8/19	429	644	0.26	0.45
Roll Assembler	8/19	426	639	4.7	10
High Mill Plugger	8/19	414	621	2.7	7.0
#1 Piercer Plugger	8/19	371	556	0.17	0.52
#1 Reeler Operator	8/19	418	627	0.54	1.1
High Mill Plugger	3/06	440	660	5.0	6.6
High Mill Plugger	3/06	416	624	5.1	8.6
High Mill Plugger	3/06	411	616	6.6	10
Sizing Mill Operator	3/06	341	512	2.2	4.1
Roll Assembler	3/06	392	588	0.58	0.82
Reheat Furnace Operator	3/06	235	352	1.9	1.7

* All values reflect time weighted averages (TWA) for the duration of sampling. These values would be expected to representative of the TWA for an operation proceeding similarly for the full 8-hour shift.

† These values reflect the concentration of iron, per the ACGIH criteria.

TABLE 3

DEMOGRAPHIC AND SMOKING INFORMATION FOR JONES AND LAUGHLIN WORKERS SURVEYED BY NIOSH INVESTIGATORS AUGUST 19, 1980

		SMOKERS		NONSMOKERS	
		#	%	#	%
Population:		61		11	
Age:	<31	18	29.5	5	45.5
	31-40	9	44.3	1	54.5
	41-50	11	78.7	2	72.7
	51-60	22	98.4	3	100
	>60	1	1.6		
Sex:	Male	61	100	11	100
Race:	Black	9	14.8	5	45
	White	52	85.2	6	55
Time at J & L:	<10yrs	30	49.2	5	45.5
Type of Smoking:	Cigarettes	60	98.4		
	Pipe/Cigar	1	1.6		

TABLE 4

RESPIRATORY SYMPTOMS REPORTED BY JONES AND LAUGHLIN

WORKERS TO NIOSH INVESTIGATORS

AUGUST 19, 1980

		SMOKERS		NONSMOKERS	
		#	%	#	%
SOB† Grade	1	22	36.1	2	18.2
	2	2	3.3	0	0.0
	3	1	1.6	0	0.0
	4	0	0.0	0	0.0
Cough In AM:		26	42.6	2	18.2
Cough >3mos/yr:		19	31.1	0	0.0
Yrs of Cough:	<2	5	8.2	1	9.1
	>2	21	34.4	1	9.1
Phlegm Production In AM >3 mos/yr:		26	42.6	1	9.1
Yrs of Phlegm:	<2	4	6.6	1	9.1
	>2	22	36.0	0	0.0
Episodes Of Wheezing:		28	45.9	2	18.2
Episodes Of Wheezing On Most Days:		11	18.0	0	0.0

† - Shortness of Breath

TABLE 5

COMPARISON OF THE ACTUAL WITH THE PREDICTED NUMBER OF JONES AND LAUGHLIN WORKERS WITH RESPIRATORY SYMPTOMS

	Shortness of Breath		Wheezing		Morning Cough		Morning Phlegm	
	(+)*	(-)**	(+)	(-)	(+)	(-)	(+)	(-)
J. & L.	24	48	30	42	20	32	27	45
HANES[5]	15.3	56.7	9.4	62.6	12.4	59.6	14.2	57.8
	$X^2=2.63$† P=0.10††		$X^2=14.7$ P=0.00012		$X^2=6.99$ P=0.008		$X^2=5.53$ P=0.0187	

* (+) - Positive response
** (-) - Negative response
† X^2 - Chi Squared
†† P - Probability Value

TABLE 6

COMPARATIVE PREVALENCE OF RESPIRATORY SYMPTOMS AMONGST JONES AND LAUGHLIN WORKERS AND IN CONTROL POPULATIONS STRATIFIED FOR SMOKING

	SMOKERS			NON SMOKERS		
	(+)*	(-)**		(+)	(-)	
COUGH:						
J. & L.	26	35		2	9	
Densen[7]	1586	4846	P=0.0012†	112	1803	P=0.97
Phillips[6]	420	403	P=0.2	9	451	P=0.99
CHRONIC COUGH WITH SPUTUM:						
J. & L.	26	34		1	10	
Belchum[8]	365	833	P=0.036	28	225	P=0.655
CHRONIC BRONCHITIS:						
J. & L.	20	40		0	11	
Oswald[9]	421	2196	P=0.00037	96	889	P=0.326

* (+) - Positive response
** (-) - Negative response
† P - Probability Value

TABLE 7

COMPARATIVE PREVALENCE OF SHORTNESS OF BREATH
BETWEEN RECENT AND VETERAN JONES AND LAUGHLIN WORKERS

SMOKERS:

	Present	Absent
<10 yrs. J&L	7	23
>10 yrs. J&L	15	16
X^2=4.08	P=0.043	OR=.32

TABLE 8

PULMONARY FUNCTION TEST CUMULATIVE DATA
JONES AND LAUGHLIN WORKERS
January 27, 1981

	Mean (St.D.)	% of Expected (St.D.)
FEV1:		
Smokers(n=57):	3.5L (0.7)	93.2% (12.8)
Nonsmokers(n=5):	3.7L (0.6)	102.9% (11.0)
FVC:		
Smokers(n=57):	4.3L (0.7)	93.7 (9.5)
Nonsmokers(n=5):	4.6L (0.9)	100.3 (8.3)
FEV1/FVC:		
Smokers(n=57):	0.80 (0.08)	
Nonsmokers(n=5):	0.83 (0.07)	

TABLE 9

COMPARISON OF SHORTNESS OF BREATH AND PULMONARY FUNCTION TESTS
OF JONES AND LAUGHLIN WORKERS

SOB GRADE	N	FEV_1: Mean (SD)	% of Exp.(SD)	FVC: Mean (SD)	% of Exp.(SD)	FEV_1/FVC: Mean(SD)
1	47	3.6(0.6)	97.4(12.9)	4.4(0.7)	95.4(9.9)	0.82 (0.06)
2	24	3.4(0.8)	93.3(12.8)	4.3(0.8)	94.8(8.9)	0.79 (0.09)
3	1	2.7	80.0	3.56	85.0	0.74
4	1	2.8	74.0	4.6	98.0	0.61
5	0					