U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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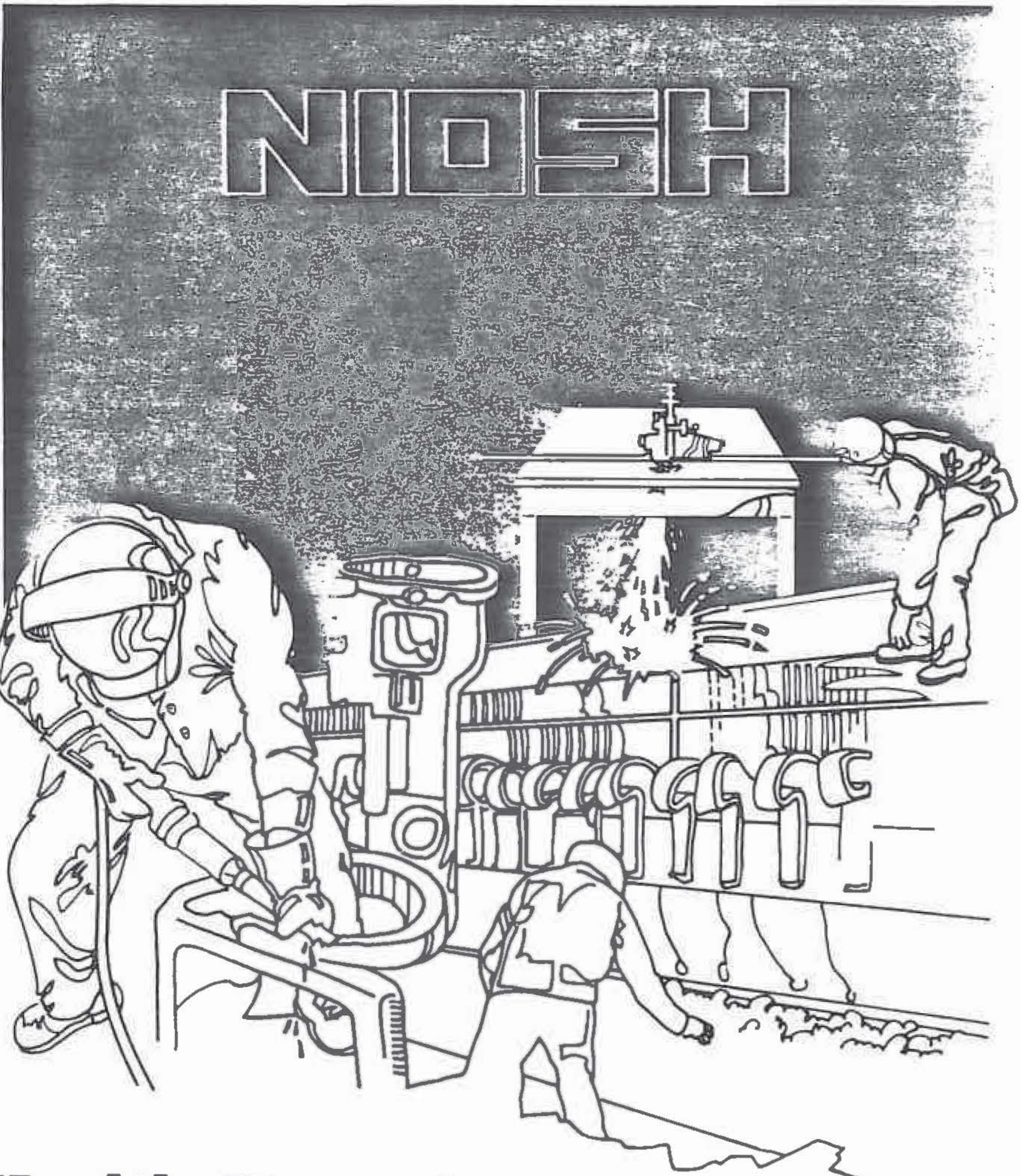

Health Hazard Evaluation Report

HHE 78-132-818
COPPER DIVISION
SOUTHWIRE COMPANY, INC.
CARROLLTON, GEORGIA

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. 699(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.

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Copper Division
Southwire Company, Inc.
Carrollton, Georgia

NIOSH INVESTIGATORS:
John R. Kominsky, I.H.
Kathleen Kreiss, M.D.

I. SUMMARY

On October 2-11, 1978, a health hazard evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) at Southwire Company in Carrollton, Georgia, a secondary copper smelter, to evaluate possible heavy metal poisoning. Personal and area air samples were obtained to measure lead, copper, nickel, cadmium, arsenic, zinc, carbon monoxide, and sulfuric acid concentrations. The medical evaluation included an interviewer-administered medical questionnaire, measurement of blood pressure, neurological examination, and blood tests for lead, copper, zinc, and biochemical and hematologic parameters.

Lead concentrations in 10 (21%) of 47 personal air samples exceeded the previous OSHA standard of 200 ug/m^3 and 37 (79%) exceeded the new OSHA standard of 50 ug/m^3. Copper fume concentrations in 13 (100%) samples exceeded the OSHA standard of 100 ug/m^3; copper dusts concentrations in 8 (24%) of 34 samples exceeded the OSHA standard of 1000 ug/m^3. Nickel concentrations in 5 (10%) of 47 samples exceeded the NIOSH recommended standard of 15 ug/m^3. Arsenic concentrations in 2 (20%) of 10 samples exceeded the NIOSH rcommended standard of 2 ug/m^3. Cadmium concentrations in 1 (2%) of 47 samples exceeded the NIOSH recommended standard of 40 ug/M^3. No excessive exposures were found for zinc, cadmium, carbon monoxide and sulfuric acid.

The medical evaluation involved 293 workers. Employees in the high lead exposure areas have a statistically significant increase of gastrointestinal symptoms, non-specific fatigue and weakness, hand tremor, joint pain, and throat irritation. In addition, employees in the dustiest work areas had an increased prevalence of respiratory symptoms such as chronic phlegm production, wheezing, and morning cough. The prevalence of hypertension (38%) among male Copper Division employees was significantly ($p = 0.01$) greater than the age, sex, and race-adjusted U.S. rates, but there was no clear association with blood lead level or with metal dust exposures. Decreased Achilles tendon reflex and impaired rapid alternating movements were significantly more prevalent (26% and 22%, respectively) in workers with lead levels over 60 ug/dl than in those with lead levels $\leq$ 60 ug/dl (9.3% and 4.2%, respectively). Both blood lead and erythrocyte protoporphyrin levels were associated ($r = 0.73$) with metal dust exposure. Seven workers had elevated serum copper levels and nine had elevated serum zinc levels, but these were not associated with either dust exposure or symptoms. The high and intermediate lead exposure groups had significantly higher mean serum creatinine (1.19 g%) than the low lead exposure group (1.14 g%), ($p < .04$).

On the basis of the environmental and medical findings, NIOSH concluded that a serious hazard of exposure to airborne dust and fume of lead, copper, arsenic and nickel existed at the Copper Division, Southwire Company, Inc., Carrollton, Georgia. Recommendations to control these hazards are made in Section VII.

KEYWORDS: SIC 3340 (Secondary Smelting and Refining of Nonferrous Metals and Alloys), lead, copper, nickel, arsenic and toxic.

II. INTRODUCTION

Under the Occupational Safety and Health Act of 1970, the National Institute for Occupational Safety and Health (NIOSH) is authorized to investigate toxic effects of substances found in the workplace. In August of 1978 the Division of Physical Health, Department of Human Resources, State of Georgia requested technical assistance from NIOSH to investigate occupational illness among workers employed at the Copper Division of Southwire, Southwire Company, Inc., Carrollton, Georgia. Preliminary inquiry by State of Georgia personnel had indicated that workers were being exposed to toxic concentrations of lead, copper, cadmium and possibly other heavy metals. Subsequently, on September 11, 1978, NIOSH received a health hazard evaluation request from an authorized representative of employees of the Copper Division of Southwire to determine if the employees were being exposed to toxic concentrations of chemicals in their workplace. The request alleged that workers were experiencing health effects including "breathing problems, heart attacks, high blood pressure, shaking hands, nausea, dizziness, headaches and high blood lead." Consequently, the investigation was conducted as a health hazard evaluation and a cooperative working relationship was maintained between NIOSH and State of Georgia investigators.

The environmental-medical investigation was conducted by NIOSH and State of Georgia investigators during October 2-11, 1978. The results of the investigation were reported to both national and regional representatives of the Occupational Safety and Health Administration resulting in a January 1979 compliance inspection of this facility by OSHA.

III. BACKGROUND

The Copper Division of Southwire is a secondary copper refinery employing approximately 300 persons. The refinery processes both low grade and high grade materials to cathode plates containing 99.99% elemental copper for internal consumption by the Southwire continuous rod system.

The recoverable scrap is treated by one of two smelting routes, depending on its grade classification. High grade scrap (such as wire, tubing, sheet, etc.) is assayed by the Sampling Department, sorted, compacted into bales, and stored for later use or taken to the anode furnace (known as the Maerz furnace) for direct re-melt and processing.

Lower grades of copper-bearing materials are processed through a standard water-jacketed secondary blast furnace for production of black copper; black copper contains 75 to 85% elemental copper. (The low-grade copper-bearing materials, including insulated wire and cable, copper fines, and baghouse dust are blended in the bedyard* for charge into the blast furnace.) The black

*Bedyard Brick Plant - Copper fines from the furnace dust collection systems are combined with a hydrated silicate bonding agent and mechanically compacted to form bricks. These metal alloy-containing bricks are either marketed or either reintroduced to the smelting process.

copper is further treated by blowing with air in a Hoboken syphon converter furnace. Air is forced through tuyeres in the sides of the converter into the molten black copper, producing blister copper containing approximately 96% elemental copper. The blister copper is then charged to the Maerz furnace. The Maerz furnace further refines the alloy by removing remaining impurities by fire-refining, followed by deoxidation and ultimate casting of the anodes for electrolytic purification.

The Maerz furnace is a 350-ton tilting reverberatory furnace which rolls to -5 degrees from horizontal for slag removal and +25 degrees during the casting cycle. The furnace is charged by two gas/oil burners. It's exit gases are treated in two waste heat boilers. The operation to produce anode copper consists of melting the charge if cold blister is the feed, or transferring the molten copper from the converter by ladle. The molten metal is oxidized by blowing air through iron pipes into the charge. The oxidation phase proceeds until the oxide content approaches 1% during which time slag may be skimmed as many as three times, depending on the impurities present. This slag is usually returned to the low grade operation. The final phase of processing is deoxidation of the molten metal. Liquid ammonia is the primary reducing agent used, though some green hardwood logs are also charged at the same time to help agitate the molten metal. Once the desired oxygen content and temperature of the molten metal is obtained, the heat is ready for casting. The casting of anodes is performed on a Mitsubishi casting wheel. Copper at about 2050 ^{o}F is tapped from the furnace into a hydraulically controlled ladle, which is the reservoir for the metal between each pour. The casting wheel holds twenty-four copper molds that have been sprayed with graphite serving as a parting agent. A block insert in each mold allows easy separation of the anode from the mold. The freshly cast anodes undergo a cooling phase via high-pressure water spray to solidify the anode, which is then transported to a yard for temporary storage. The anode ultimately undergoes electrorefining, yielding electrolytic grade copper, via standard ion exchange procedures.

The electrorefining facility consists of three main sections.

1. Tank House: The tank house consists of hundreds of cells arranged in electrical circuits and provided with a piping system to distribute the copper sulfate and sulfuric acid electrolyte. The anodes and cathodes are charged to these cells by overhead cranes. (The cathodes are thin sheets of copper, called "starting sheets", which are produced in a special stripper section of the tank house). The copper of the impure anode is dissolved electrolytically, and copper migrates to and is deposited at the cathode. Electrolysis continues until the anode is corroded to about 15% of its original weight, during which time several crops of cathodes are pulled. At the completion of the anode cycle (about twenty-eight days) the anode scrap is washed free of adhering slime, pulled by overhead crane, and transferred to the anode furnace for melting and casting into anodes. The impurities in the anode copper either dissolve in the electrolyte or fall to the bottom of the cells as slime. The impurities include lead, arsenic, gold, silver, antimony, nickel, bismuth, selenium, tellurium and other metals.

2. Electrolyte Purification: The impurity level in the electrolyte is of paramount importance in determining the impurity composition of the cathode copper. The electrolyte purification operation is performed for the purpose of controlling the concentration of copper and of soluble impurities. This is achieved by electrolysis in "liberator cells" employing insoluble lead anodes. (The crude nickel sulfate produced is washed and dewatered in a centrifuge, dried, packaged, and marketed).

3. Slime treatment: The insoluble metals and compounds that settle to the bottom of the tanks during the electrolytic cycle are screened and pumped to a slime-treatment (or "anode mud") plant. Here the slime is dewatered, dried, packaged, assayed and marketed.

IV. STUDY DESIGN AND METHODS

A walk-through survey was conducted at the Copper Division of Southwire on September 22, 1978. Background information about processes, materials, work practices, environmental controls, and employee profiles were obtained. Subsequently, the environmental evaluation was conducted on October 2-6, 1978; the medical evaluation was conducted October 4-6, 10 and 11, 1978.

A. Environmental

The environmental protocol was designed with emphasis on evaluating and characterizing exposures related to the smelting process. Secondary emphasis was directed at the electrorefining operations. The smelting process was subdivided into seven exposure areas to facilitate environmental sampling: (1) Bedyard - low grade copper bearing materials handling. (2) Bedyard - brick plant. (3) Baghouse. (4) Sampling department. (5) Blast and converter furnace. (6) Maerz furnace tear-down. (7) Cleaning of the Maerz furnace waste-heat boiler (known as the economizer). The workers involved in these areas were evaluated regarding their exposures to inorganic lead, copper, nickel, and cadmium. The workers associated with the brick plant, blast and converter furnaces, and Maerz furnace tear-down also were evaluated regarding their exposures to inorganic arsenic. Carbon monoxide exposures associated with the blast furnace charging and tending operations were evaluated. Environmental sampling in the electrorefining facility was limited to sulfuric acid and inorganic lead.

Exposures to the contaminants were evaluated using standard personal and/or work area sampling techniques. The sampling time was kept as close as possible to the entire 8- or 12-hour work shift. The airborne inorganic metals were collected on a 0.8 um pore-size polyvinylchloride copolymer membrane filter mounted in a 3-piece closed-face cassette in series with a vacuum pump operating a 1.5 lpm. The dust-laden filters were dissolved in concentrated phosphoric acid and the metal content determined using atomic absorption spectrophotometry. Arsenic could not be determined on the same filter as the other metals because of the requirements of the analytical procedure. Therefore, 10 filters were selected and analyzed for arsenic. The lower limits of analytical detection reported for lead, copper, zinc, nickel, cadmium and cadmium and arsenic were 4, 3, 4, 3, 2, and 0.3 ug per filter, respectively. Sulfuric acid was collected on a 0.8 um pore-size mixed cellulose ester membrane filter mounted in a 3-piece closed face cassette using a vacuum pump operating at 1.5 lpm. The analyte was extracted from the filter with de-ionized water and analyzed with an ion chromatograph. The lower limit of analytical detection was 10 ug per filter. Carbon monoxide was measured using direct-reading gas detector tubes (Certification No. TC-84-102).

B. Medical

The medical evaluation included an interviewer-administered medical questionnaire, measurement of blood pressure, neurological examination, and collection of blood specimens. The questionnaire sought routine demographic information, occupational history, and symptoms associated with heavy metal poisoning. Blood pressure was measured with a standard adult aneroid sphygmomanometer. Diastolic pressure was recorded as the complete cessation of Korotkoff sounds or, if there was no cessation, as the point of muffling. The neurologic examination included testing of biceps, triceps, bronchioradialis, and Achilles tendon reflexes; finger, wrist, and plantor extensor strength; hand tremor; sensory-motor coordination. Blood specimens were analyzed for creatinine, calcium, phosphorous, glucose, urea nitrogen, total bilirubin, alkaline phosphatase, lactic dehydrogenase, glutamic oxacetic transaminase, glutamic pyruvic transaminase, white blood cell count, hematocrit, copper, lead, and erythrocyte protoporphyrin (EP). Analysis for EP was performed using the micro-scale photofluorometric method.(1)

V. EVALUATION CRITERIA

A. Environmental

The environmental evaluation criteria used for this study are presented in Appendix I. Listed for each substance are the recommended environmental limit, the source of the recommended limit, and the current OSHA standard.

B. Medical

A brief review of the known toxic effects of the hazardous substances to which Southwire workers are potentially exposed follows.

1. Inorganic Lead: Inhalation of lead dust and fumes is the major route of lead exposure in industry. A secondary source of exposure may be from ingestion of lead dust contamination on food, cigarettes, or other objects. Once absorbed lead is excreted from the body very slowly. The absorbed lead can damage the kidneys, peripheral and central nervous systems, and the blood forming organs (bone marrow). These effects may be felt as weakness, tiredness, irritability, digestive disturbances, high blood pressure, kidney damage, mental deficiency, or slowed reactrion times. Chronic lead exposure is associated with infertility and with fetal damage in pregnant women.

Blood lead levels below 40 ug/100ml whole blood are considered to be normal levels which may result from daily environmental exposure. However, fetal damage in pregnant women may occur at blood lead levels as low as 30 ug/100ml. Lead levels between 40-60ug/100ml in lead exposed workers indicate excessive absorption of lead and may result in some adverse health effects. Levels of 60 to 100ug/10ml represent unacceptable elevations which may cause serious adverse health effects. Levels over 100 ug/100ml are considered dangerous and often require hospitalization and medical treatment.

The new OSHA standard for lead in air is 50ug/M^3 on an eight hour time-weighted average for daily exposure. For this particular industry the current standard is 50 ug/M^3. Pending current litigation of the 50 ug/M^3 lead standard, employers must achieve the 200 ug/M^3 level (old OSHA standard) through engineering and administrative controls, and must protect workers at the 50 ug/M^3 permissible exposure level through any combination of controls, including the use of proper respiratory protection. The standard also dictates that in four years workers with blood lead levels greater than 50ug/100ml must be immediately removed from further lead exposure and in some circumstances workers with lead levels less than 50 ug/100ml must also be removed. At present medical removal of workers is necessary at blood lead levels of 60 ug/100ml or greater. Removed workers have protection for wage, benefits, and seniority for up to eighteen months until their blood levels adequately decline and they can return to lead exposure areas.

2. Copper Fume and Dusts(2): Inhalation of copper fumes produces metal fume fever, which is characterized by chills, transient fever, nausea, thirst and exhaustion. Inhalation of dusts and mists of copper salts can result in congestion of the nose and throat, and on occasion, ulceration with perforation of the nasal septum.

3. Arsenic (3,4): Cancer is the most serious hazard of long-term exposure to arsenic. Arsenic can cause cancer of the skin, lungs, and liver. Spots (like warts) may appear on the skin of workers exposed to arsenic long before cancer develops (arsenical kerotosis). Arsenic can also cause irritation of the membranes of the eyes, nose, and throat, perforation of the nasal septum, nerve damage, and liver damage.

4. Inorganic Nickel(5): Metallic nickel can cause sensitization (allergic) dermatitis known as "nickel itch". Nickel dust may cause nasal or lung cancer in humans; and nickel fume in high concentrations is a respiratory irritant.

VI. RESULTS AND DISCUSSION

A. Environmental

1. Lead, Copper, Nickel, Cadmium and Zinc

A total of 47 personal samples were collected for airborne inorganic lead. The analyses show that 10 values (21.3%) exceed 200 ug/m^3;

18 values (38.3%) were between 100 and 199 ug/m^3; 10 values (21.3%) were between 50 and 99 ug/m^3; and 9 values (19.1%) were less than 50 ug/m^3 (Table 1). By comparison, the OSHA standard is 50 ug/m^3. The average airborne lead concentrations by the seven job categories evaluated (Table 2 and Figure 1) are: cleaning of waste heat boilers - laborers (2259 ug/m^3), baghouse attendant (440 ug/m^3), press brick operators (161 ug/m^3), metals assistants and charges (135 ug/m^3), Mearz tear down - laborers (117 ug/m^3), bedyard - auxiliary operators (109 ug/m^3), and Sampling Dept. - furnace personnel (42 ug/m^3).

A tank house filtration operator was exposed to 813 ug/m^3 of inorganic lead over a 40 minute period while shovelling slime from drying pans into barrels.

A total of 47 personal samples were collected for airborne copper (Tables 2 and 3). Figure 2 presents the average exposure concentrations by work areas. Thirteen were collected on personnel directly associated with the blast and converter furnaces or the Sampling Department furnace. Thus, these exposures were assumed to be copper fume. All of these 13 samples showed concentrations of copper fume (mean 390 ug/m^3, range 120-988 ug/m^3) greater than the 100 ug/m^3 OSHA standard. Eight (24%) of the 34 samples exceeded the 1000 ug/m^3 OSHA standard for copper dusts. Highest average copper dust concentrations were found in laborers cleaning the waste heat boilers (17564 ug/m^3), followed by mearz furnace tear-down personnel (1243 ug/m^3) and bedyard auxiliary operators (4158 ug/m^3).

Forty-seven personal samples were collected for airborne inorganic nickel (Table 4). Figure 3 presents the average exposure concentrations by work areas. Five (11%) showed concentrations of nickel (mean 26 ug/m^3, range 16-40 ug/m^3) greater than the 15 ug/m^3 NIOSH recommended standard. These five samples included three of four collected from laborers cleaning the waste heat boiler, one of nine on bedyard auxiliary operators, and one of seven from press brick operators (Table 2).

Forty-seven personal samples were collected for airborne cadmium (Table 2). Figure 3 presents the average exposure levels by work areas. One (2.1%) showed a concentration of cadmium (45 ug/m^3) greater than the 40 ug/m^3 NIOSH recommended standard (Table 5).

Forty-seven personal samples were collected for airborne zinc (Table 2). Figure 2 presents the average exposure levels by work areas. Thirteen of the 47 samples were collected on workers directly associated with furnace operations and are considered to be zinc oxide fume. None of the 13 samples showed a zinc oxide fume concentration (average 490 ug/m^3, range 260-1688 ug/m^3) greater than the 5000 ug/m^3 NIOSH recommended standard. Thirty-four of the 47 samples were considered to be zinc dusts. The average zinc dust concentration was 1189 ug/m^3 (range 125 - 36209 ug/m^3).

Work area concentrations of airborne lead, copper, nickel, and cadmium were measured in the blast furnace control room on two consecutive days (Table 6). The sampler was positioned about 6 feet above the control room floor to approximate the breathing zone of the workers. On both days, the 8-hour time-weighted average lead concentration exceeded the 50 ug/m^3 standard (mean 59 ug/m^3, range 57 - 62 ug/m^3). The airborne concentrations of copper, zinc, nickel and cadmium were less than 29% of their respective criteria.

2. Inorganic Arsenic

A total of 10 personal samples were collected for airborne arsenic analysis (Table 7). The samples were collected on laborers involved in Maerz furnace tear-down, hot metals assistants, and press brick plant operators. Arsenic concentrations ranged from 0.72 to 3.2 ug/m^3. Two (20%) exceeded the 2 ug/m^3 NIOSH recommended standard.

3. Carbon Monoxide

Carbon monoxide concentrations were measured using direct reading colorimetric detector tubes in general work areas associated with the blast furnace (Table 8). The levels were all less than 29% of the 35 ppm NIOSH recommended standard, except for two samples obtained 1-2 feet from the face of the blast furnace charging door during charging. These samples showed a carbon monoxide concentration of at least 700 ppm. By comparison, NIOSH recommends a ceiling value of 200 ppm. Although a worker could conceivably be in this high-exposure area, there was no indication that this occurs.

Considerable concern about carbon monoxide exposure existed among maintenance workers responsible for repairing the electronically controlled crane which operated about 40 feet above the blast and converter furnaces. Carbon monoxide concentrations measured on the crane, while positioned over the blast furnace, were less than 20 ppm (Table 8).

Carbon monoxide levels measured in the Sampling Department around the quality control furnaces were less than 5 ppm.

4. Sulfuric Acid

Five samples were collected to evaluate tank house personnel exposures to airborne sulfuric acid (Table 9). The airborne sulfuric acid concentrations were less than 27% (mean 112 ug/m^3, range 42-265 ug/m^3) of the 1000 ug/m^3 OSHA or NIOSH recommended standard.

B. Medical

1. Study Population

Two hundred ninety-three employees were evaluated. This number included 20 of approximately 100 contract maintenance workers on the Copper Division's list of 297 production employees. In addition, the employee sample included several auxilliary personnel also not listed. Hence we saw roughly 90% of production employees and roughly 73% of all persons who regularly work at the Copper Division of Southwire.

The study population consisted of 282 men and 11 women: 75% were white, the remainder black. The mean age of the white workers was 30.2 years, and that of the black workers 31.5, with ages ranging from 18 to 64. Eighty-two percent of the population were aged 40 or less. For the purposes of epidemiologic analysis, employees were categorized as office workers, industrial supervisory personnel, or industrial workers. All employees were also divided into three groups on the basis of anticipated exposure to metallic dust and fume. The grouping of work areas is shown in Table 10.

2. Symptoms

Table 11a shows the percent of employees in high, intermediate, and low exposure categories reporting a work-associated increase in symptoms in the year preceding the study. Employees in the high exposure group have a statistically significant increase of gastrointestinal symptoms, nonspecific fatigue and weakness, hand tremor, joint pain, and throat irritation. Since many of these symptoms could be associated with lead poisoning, we analyzed the prevalence of symptoms by erythrocyte protoporphyrin level (Table 11b). Nausea, vomiting, and prevalence of hand tremor did not appear to be as closely associated with erythrocyte protoporphyrin level as they were with place of work within the Copper Division. Nor were they significantly associated with lead level. However, there was a striking increase in abdominal pain: 44% of the workers with blood lead levels higher than 60 ug/dl had experienced abdominal discomfort within the preceding year as compared to 11% of those with lead levels of 60 or less (Table 11c). In addition, the prevalence of nocturia increases with increasing lead. Comparing workers with lead greater than or equal to 60 <u>and</u> erythrocyte protoporphyrin of 2000 or higher with those employees whose blood lead was 20 or less <u>and</u> erythrocyte protoporphyrin was 800 or less, led to no different associations of symptoms than had erythrocyte protoporphyrin groupings alone.

There was no significant relation of muscular cramps or nocturia to area of work, or to lead or erythrocyte protoporphyrin group. Nor were previous diagnoses of anemia, hypertension, gastritis, kidney or prostate disease associated with work area.

Table 12 shows respiratory symptoms among smokers and nonsmoking employees according to place of work, grouped according to anticipated metal and dust exposure. Fifty-four percent of workers in dusty areas were smokers compared to 60% in intermediate areas and 48% in low dust exposure areas. There were higher prevalences of respiratory symptoms among smokers, and chronic bronchitis, chronic phlegm production, and wheezing accompanied by shortness of breath were significantly increased in the dustiest work areas for smokers. In contrast, non-smokers who worked in dusty areas were more likely to experience morning cough in addition to chronic bronchitis and shortness of breath with wheezing. The prevalence of chest pain was similar in smokers and non-smokers in each work area, and when both smokers and non-smokers together were grouped according to exposure area, there was a significant increase in chest discomfort in dusty areas ($p = .0035$, not shown in Table 12).

3. Physical Examination

a. Blood Pressure

The prevalence of hypertension (defined as systolic blood pressure 140mm Hg or greater or diastolic 90mm Hg or greater) was 38.7% among the male Copper Division employees. When compared to age, sex, and race--adjusted rates for the U.S. population[16], this is a 30% increase, significant at the p=.01 level (Table 13). The rate of hypertension among black male employees was 51.4%, a 50% increase over the expected age-adjusted rate. The most striking increase in hypertension prevalence was seen in the group of black employees ages 18-34; when black males in the age groups 18-24 and 25-34 are grouped together, the increase in prevalence of hypertension over national race and sex-specific figures is 78% $p < .01$, ($X^2 = 6.67$).

The definition of hypertension used above is a liberal one, and includes persons with borderline, definite, and severe hypertension. As shown in Table 13a, the prevalence of borderline hypertension, defined as hypertension with a systolic less than 160 and a diastolic less than 95, was not significantly increased over the rates for the U.S. black and white age-adjusted male populations. In contrast, definite hypertension, defined as systolic blood pressure of 160 or greater OR diastolic of 95 or greater, was statistically increased ($p < .05$) by 40% over U.S. rates (Table 13b). This increase is seen in both black (50%) and white (30%) workers. Again among black workers ages 18-34 the rate of definite hypertension is 2.6 times that of the comparable U.S. population of black males ($X^2=9.87$, $p < .01$). Table 13c shows the rates of severe hypertension, defined as a diastolic blood pressure of at least 105 mm Hg. Although the number of such workers is too small to achieve statistical significance when compared to the national rates, the increased rate of white and black employees is similar to the increases seen for borderline and definite hypertension.

Another way of looking at blood pressure in this population is to examine mean systolic and diastolic pressures for the different age groupings, as shown in Table 13d. Overall, the mean diastolic blood pressure among Southwire male employees was increased ($p < .001$) over the age and race-adjusted rate for Southern males, as were mean diastolics for both white and black populations. The increase in diastolic pressure was again most striking among the younger age groups of white and black employees. The mean systolic blood pressure in blacks was also significantly increased ($p < .01$) in the 25-34 age group.

There was no significant association between hypertension and lead level, either by regression or in grouped data. Nor were hypertensives distributed differently by erythrocyte protoporphyrin group. As would be predicted from these negative findings, dust and metal fume exposure groups also did not differ in mean systolic or diastolic blood pressure, nor in prevalence of hypertension. However, specific work areas varied considerably in the prevalence of hypertension. Definite hypertension rates between 30 and 40% occurred among maintenance workers distributed all over the plant, lift shop workers, and anode storage workers, as compared to 18% in the general population. The prevalence of borderline hypertension was over 50% in the small number of baghouse and laboratory workers. Although the differences among hypertension prevalences were not of statistical significance, supervisors had a higher rate (49%) of diastolic hypertension than did office workers (38%) or industrial workers (31%). As is usual in hypertension screening data, end-digit preference was not uniformly distributed: 44.5% of systolic blood pressures ended in zero, and 33.2% of diastolic. This compares to 46.9% and 43.9% for systolic and diastolic zero digit preference in the national Health and Nutrition Examination Survey [13].

b. Neurologic Examination

Only two findings on neurologic examination were associated with elevated blood lead level: Achilles tendon (ankle) hyporeflexia and difficulty with rapid alternating movements (adiadochokinesia). The population with blood lead levels of 60 ug% or less had a 9.3% prevalence of decreased ankle reflexes as compared to a 25.9% of those with lead levels over 60 (p=.0201). The prevalence of adiadochokinesia also increased as lead level increased, with 22.2% of the employees with lead levels over 60 showing such difficulty, as compared to 4.2% of the remaining workers (p=.0009). This association was substantiated by an increased prevalence in the elevated erythrocyte protoporphyrin group. Although finger extensor weakness was seen primarily in the group with lead levels over 40 ug% (5-fold increased rate), the number of employees having this finding are too small to achieve statistical significance. As shown in Table 14, there was no association between elevated blood lead level and abnormal finger to nose test, presence of hand tremor, other reflex abnormalities or muscle weakness. Only one patient had a positive Romberg sign or nystagmus, and only 3 were considered to have gait abnormalities.

There was no association between neurologic abnormalities and quantity of alcohol habitually consumed. Among the patients with abnormal rapid alternating movements, and excluding the three who averaged 3 or more drinks per day, only two persons had blood lead levels less than 40 ug%, and one of these two had an elevated erythrocyte protoporphyrin. Their mean blood lead was 51 ug% and mean EP 2267 ug/l erythrocytes. Only two of the 17 patients with adiadochokinesia had finger extensor weakness, and two others had decreased Achilles tendon reflexes.

3. Laboratory Findings

Table 10 shows the mean lead levels of workers in various areas of the plant grouped into high, intermediate, and low exposure groups. As would be predicted from the means of these categories of exposure to dust and fumes, the ranges varied markedly: six percent of the workers in the high exposure group had blood lead levels of 40 ug% or less, whereas only 5% of the low exposure population had lead levels above 40 ug%, these being in laboratory workers. Two percent of intermediate exposure workers had lead levels over 60 ug%, as compared to a majority in the high exposure group. The mean blood lead for the study population as a whole was 37.2 (standard deviation 16.5) with the highest being 83 ug%. Only 17.6% were 20 ug% or lower, and 38.7% were over 40 ug%. Twenty-eight of 290 samples (9.7%) were over 60 ug%.

The mean erythrocyte protoporphyrin levels increased dramatically with increasing exposure category. The overall mean for the population was 1308 ug/l erythrocytes, and ranged as high as 10,548. The mean for a normal adult population is 518 with a standard deviation of 144 (17), comparable to the mean of the low exposure group. Table 15a shows the mean erythrocyte protoporphyrin for the various lead groupings. A linear regression analysis of log (erythrocyte protoporphyrin) versus blood lead yields a correlation coefficient of $r = 0.731$.

Table 15b corroborates anecdotal accounts of dustier work conditions for evening and night shifts. Third shift workers had significantly elevated blood lead levels in all exposure groups, although the evening shift in the high exposure group had higher mean erythrocyte protoporphyrin levels than did the night shift. The 12-hour day workers in high and intermediate exposure groups had slightly higher mean blood lead levels than 8-hour day workers. For mean lead levels, shift and exposure group functioned independently; for erythrocyte protoporphyrin they were not independent although both were significantly associated with statistically significant differences in mean EP level.

Supervisory personnel were not significantly protected from lead exposure as compared to industrial workers as a whole and in each exposure category (Table 15c). Office workers in the intermediate exposure group, which included the Maerz office and receiving area, had higher lead and erythrocyte protoporphyrin levels than other office workers.

Nonwhite workers had a mean lead value of 42.7 ug% (S.D. = 17.2) and white workers a mean of 35.3 ug% (S.D. = 15.8). The erythrocyte protoporphyrin mean was also elevated among the black workers. Whereas 7.3% of whites had lead values over 60 ug%, the corresponding percentage in blacks was 16.0%. These racial differences in lead levels are best explained by lack underrepresentation among office workers and overrepresentation in high exposure industrial jobs.

Employees who had worked over one year had higher lead and erythrocyte protoporphyrin levels than those with lesser tenure, in both high and intermediate exposure categories. The number of employees hired within the preceding year was too small to estimate the number of months before steady-state blood lead or erythrocyte protoporphyrin levels were reached. There were four employees with lead levels over 60 ug% who had worked four months or less at the Copper Division; one of these, a blast furnace worker, had a lead level of 74 ug% after 2 months employment.

Smokers had higher blood leads ($p=.045$) and higher erythrocyte protoporphyrins ($p=.059$) than non-smokers (Table 15d). However, in comparison with area of work, smoking accounted for a relatively small portion of the variance in blood levels.

There were only five employees who may have had lead exposure apart from their occupation. Only two of these had lead levels greater than 40 ug% (each had part-time automobile repair work as the non-occupational exposure).

Seven employees had elevated serum copper levels (normal range 80 - 160 ug%), with the highest value being 239 ug% in an office worker with a blood lead of 11 ug%. Only one of these seven had other abnormal metal values: a blast furnace worker with a serum zinc of 130 ug%, lead of 59 ug% and erythrocyte protoporphyrin of 6359 ug/l erythrocytes. The remaining six had lead levels less than 40 ug, and half were lower than 15 ug%. All seven worked the day shift, and three were office workers.

Nine employees had serum zinc values above the normal range of 60 - 125 ug%, the highest being 339 ug% in an office worker. Only three had blood lead levels above 40 ug%, and only one of these had a very high lead (76; with an erythrocyte protoporphyrin of 6055). Two of those with elevated zinc were office workers.

Anemia, defined as a hematocrit less than 40%, was present in 12 employees, 3 of whom were women. The lowest hematocrit was 35, and this person had a blood lead of 26 and an erythrocyte protoporphyrin of 1862. Of the 12, only three persons had a lead level of greater than 40 ug%, but all these levels were below 60 ug%. Polycythemia, defined as a hematocrit greater than 50%, was present in 12 employees, and 6 of them had leads of greater than 40 ug%. There was no association of anemia or polycythemia with work area. Of interest, the highest lead found in the study, 83 ug%, occurred in a bag house worker with a hematocrit of 50%.

There were no persons with both abnormal creatinine (normal range to 1.5 ug%) and BUN (range to 25), nor did mean creatinine increase significantly with increasing lead level (Table 15a). The high and intermediate exposure group together had a mean creatinine of 1.19 g% as compared to a mean of 1.14 g% for the low exposure group, a difference which is statistically significant at p=.04.

There were no significant differences among the 3 exposure groups for the remaining blood tests. These included calcium, glucose, BUN, total bilirubin, alkaline phosphatase, lactic dehydrogenase, SGOT, SGPT, WBC, hematocrit, copper and zinc. The serum phosphorus was significantly higher in the high exposure group (3.62 vs 3.32 intermediate and 3.26 in low exposure groups); p=.001).

VII. RECOMMENDATIONS

A. Exposure Control

1. Engineering

a. The NIOSH investigation has determined that certain work activities involve excessive exposure to lead, copper, nickel and arsenic. Since the most significant and widespread overexposure is to lead, control priorities should be directed towards this substance with a target control value of less than 50 ug/m^3.

b. While air lead control priorities should be directed primarily at those areas of highest exposure, consideration should be given to control of concentrations in work stations adjacent to these areas. For example, work area sampling conducted in the blast furnace control room showed that the average background levels (59 ug/m^3) of lead exceeded the 50 ug/m^3 OSHA standard. Since certain furnace affiliated personnel (such as foremen) spend a significant amount of time in the control room, effort should be directed towards controlling the airborne lead level. This may require changes in both the control room's ventilation system and housekeeping procedures.

c. Engineering should be the principal means of controlling exposure to lead. A number of approaches may be used in combination, including isolation, enclosure, local exhaust ventilation, good plant design for ease and effectiveness of housekeeping, and procedures for materials handling that avoid contamination of the workplace. Reference 14 identifies, evaluates, and characterizes the best available exposure controls presently being used in the secondary nonferrous smelting industry. The information offered in this publication may provide Southwire Company engineers with ideas for the successful control of employee exposure.

2. Personal Protective Equipment

a. Respiratory Protection

The use of respirators is not recommended as a primary means of exposure control. It should be employed in the following circumstances only

- during the time necessary to install engineering controls and institute work practices required to reduce excessive exposures;

- in work situations where engineering control methods and work practices are either technically not feasible or only feasible to an extent which is still insufficient to reduce the exposure to acceptable limits; or

- in emergencies or occasional brief non-routine exposures.

Respirators should be selected from those approved by NIOSH, and a respiratory program consistent with the requirements of the Occupational Safety and Health Act (29 CFR 1910.134 and 30 CFR 11) should be instituted. Close monitoring is required to maintain effectiveness of the program.

The specificity of respirators with respect to application and use should be thoroughly understood by the first-line supervisors and workers. Respirators designed for dusts will not prevent absorption of fumes. Where exposure is to lead fume, a fume respirator must be used. (NIOSH investigators observed workers exposed to lead fume wearing respirators designed for acid mists.)

b. Clothing

Street clothes should not be used in lead-contaminated areas. Special work clothing should be worn. Street clothes and soiled work clothes must not be stored in the same locker. Separate lockers should be provided.

3. Work Practices and Procedures

Adequate washing facilities should be provided and used by all workers. It is particularly important that workers wash carefully before eating and leaving for home.

Lunchroom facilities must be separate from the lead processing areas. Care should be taken that air and surfaces in the lunchroom are not contaminated with lead. Workers should wash before eating.

Dust suppression compounds or water should be used in dusty areas to minimize airborne metal-bearing dusts.

Dry sweeping should be avoided. The use of vacuum sweeping and water washing, where feasible, is preferred.

Smoking, eating, and drinking in lead-processing areas should be prohibited. Smoking materials and foodstuffs should not be brought into the lead-processing areas. Smoking is particularly hazardous. It affords an opportunity for direct ingestion of lead from the hands or the cigarette. Furthermore, particles of lead on cigarettes may be pyrolized and inhaled as a fume.

VIII. REFERENCES

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2. American Conference of Governmental Industrial Hygienists: Documentation of the Threshold Limit Values, Third Edition 1971, Third Printing 1976, Cincinnati, Ohio.

3. Occupational Safety and Health Standard, Subpart Z - Toxic and Hazardous Substances: Arsenic ... 29 CFR 1910.1018.

4. NIOSH Criteria for a Recommended Standard ... Occupational Exposure to Inorganic Arsenic, Revised 1975.

5. NIOSH Criteria for a Recommended Standard ... Occupational Exposure to Inorganic Nickel, 1977.

6. NIOSH Criteria for a Recommended Standard ... Occupational Exposure to Inorganic Lead, Revised 1978.

7. Occupational Safety and Health Standards, Subpart Z - Toxic and Hazardous Substances: Lead ... 29 CFR 1910.1025.

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11. NIOSH Criteria for a Recommended Standard ... Occupational Exposure to Sulfuric Acid, 1975.

12. NIOSH Criteria for a Recommended Standard ... Occupational Exposure to Carbon Monoxide, 1972.

13. National Center for Health Statistics: Blood pressure levels of persons 6-74 years, United States, 1971-1974 Hyattsville, Md: National Center for Health Statistics, 1977 (Vital and Health Statistics, Series 11: Data from the National Health Survey, No. 203) (DHEW publication no. (HRA) 78-1648 - Series 11, No. 203).

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IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared By:	John R. Kominsky Project Officer Industrial Hygiene Section
	Kathleen Kreiss, M.D. Medical Officer Center for Disease Control
Environmental Survey:	John R. Kominsky Bruce A. Hollett William A. Evans Industrial Hygienists Industrial Hygiene Section
Medical Survey:	Kathleen Kreiss, M.D. Mark Nelson, M.D. Dorine Kramer, M.D. Richard Wilson, M.D. Stephen Crowley Center for Disease Control Atlanta, Georgia
	Thomas W. McKinley Pat Malone Ralph C. Davis Naresh K. Chawla State of Georgia Atlanta, Georgia
Originating Office:	Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations and Field Studies Cincinnati, Ohio
Report Typed By:	Odessa Brown Clerk-Typist

X. 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 NIOSH, Publications Office at the Cincinnati address.

Copies of this report have been sent to:

a. Copper Division of Southwire, Southwire Company, Inc., Carrollton, Georgia 30117

b. Authorized representative of the employees at the Copper Division of Southwire, Southwire Company, Inc., Carrollton, Georgia

c. Regional Program Consultant, Region IV, NIOSH, Atlanta, Georgia 30323

d. Regional Administrator, Region IV, OSHA, U.S. Department of Labor, Atlanta, Georgia 30309

e. Director, Division of Physical Health, Georgia Department of Human Resources, State of Georgia, Atlanta, Georgia 30334.

For the purpose of informing the approximately 292 "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.

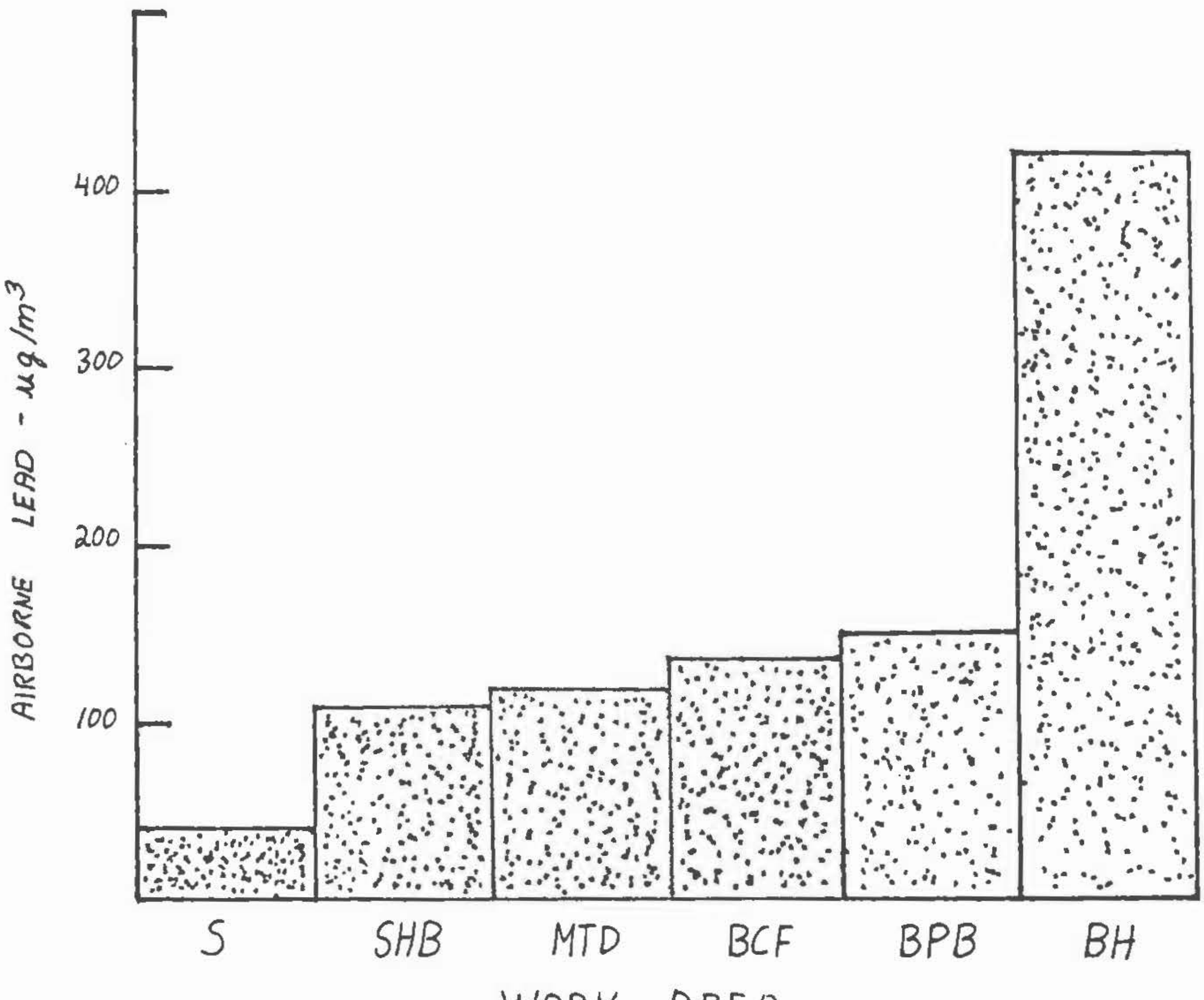
FIGURE 1

AVERAGE AIRBORNE LEAD EXPOSURES VS WORK AREA

SOUTHWIRE COMPANY, INC.

CARROLLTON, GEORGIA

OCTOBER 2-6, 1978



LEGEND:

S	SAMPLING	BCF	BLAST-CONVERTER FURNACE
SHB	SCRAP HANDLING BEDYARD	BPB	BRICK PLANT BEDYARD
MTD	MEARZ TEAR DOWN	BH	BAGHOUSE

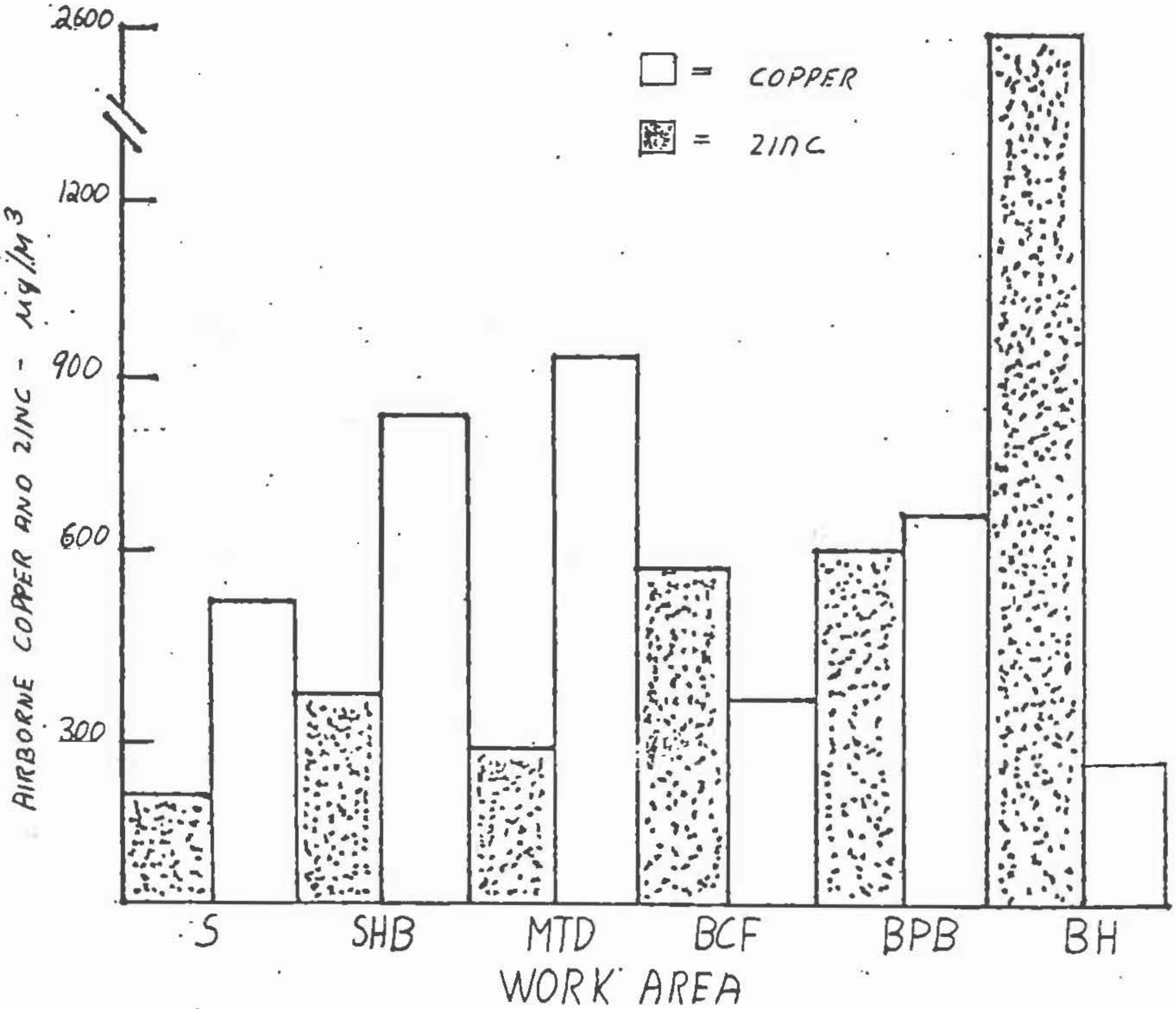
FIGURE 2

AVERAGE AIRBORNE COPPER AND ZINC EXPOSURES VS WORK AREA

SOUTHWIRE COMPANY, INC

CARROLLTON, GEORGIA

OCTOBER 2-6, 1978



LEGEND:

S	SAMPLING	BCF	BLAST-CONVERTER FURNACE
SHB	SCRAP HANDLING BEDYARD	BPB	BRICK PLANT BEDYARD
MTD	MEARZ TEAR DOWN	BH	BAGHOUSE

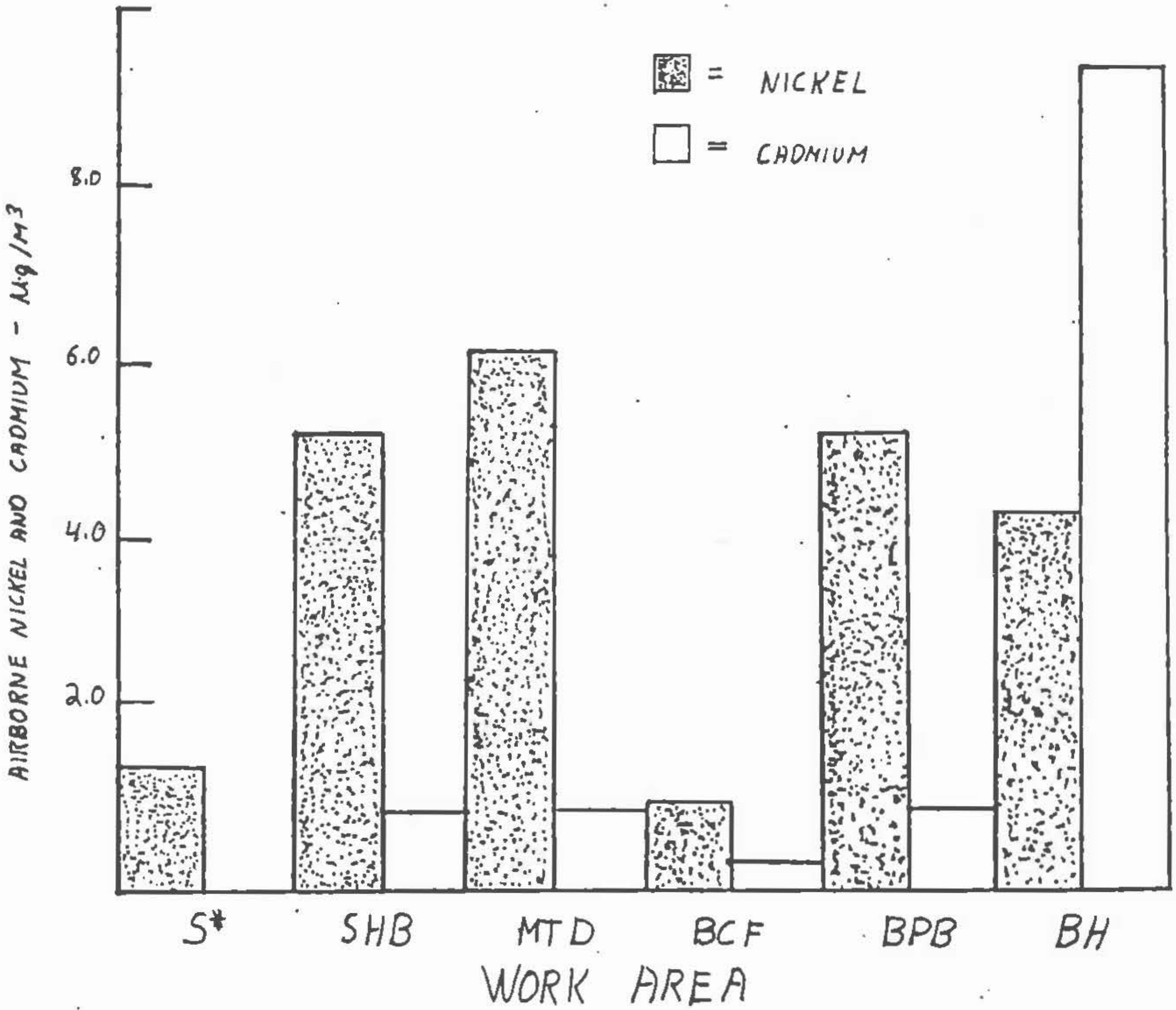
FIGURE 3

AVERAGE AIRBORNE NICKEL AND CADMIUM EXPOSURES VS WORK AREA

SOUTHWIRE COMPANY, INC

CARROLLTON, GEORGIA

OCTOBER 2-6, 1978



LEGEND:

S	SAMPLING	BCF	BLAST-CONVERTER FURNACE
SHB	SCRAP HANDLING BEDYARD	BPB	BRICK PLANT BEDYARD
MTD	MEARZ TEAR DOWN	BH	BAGHOUSE

*ALL CADMIUM SAMPLES WERE < 2 µg.

Table 1

Personal Exposures to Airborne Inorganic Lead

Southwire Company, Inc.
Carrollton, Georgia

October 2-6, 1978

Sample Description	No. of Samples	Distribution of Concentrations - µg/m³ 0 - 49 n	(%)	50 - 99 n	(%)	100 - 199 n	(%)	200+ n	(%)
Baghouse: attendant	10			1	(10)	6	(60)	3	(30)
Blast/Converter Furnaces: Hot Metals Assistants and Chargers	10			2	(20)	7	(70)	1	(10)
Maerz Furnace Tear Down: Laborers	4			3	(75)			1	(25)
Maerz Furnace - Cleaning of Waste Heat Boiler: Laborers	4							4	(100)
Sampling Dept: Furnace Operator, Tender and Weigher	3	3	(100)						
Bedyard (Scrap Handling) Auxiliary Operators	9	4	(44)	2	(22)	3	(33)		
Bedyard (Brick Plant): Press Brick Operators	7	2	(29)	2	(29)	2	(29)	1	(14)
Total	47	9	(19.1)	10	(21.3)	18	(38.3)	10	(21.3)

Table 2

Summary of Lead, Copper, Nickel, Cadmium and Zinc Personal Sampling Results
(Personal Exposures - ug/m^3)

Southwire Company, Incorporated
Carrollton, Georgia

October 2-6, 1978

Sample Description	No. of Samples	Lead		Copper		Nickel		Cadmium		Zinc	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Baghouse Attendant	10	440	82-2012	256	80-790	2.3	LLD*-9.0	9.5	LLD-45	2584	298-8446
Blast/Converter Furnaces: Metals Assts. & Charger	10	135	70-212	348	120-988	0.98	LLD-5.5	0.28	LLD-2.8	574	153-1688
Mearz Tear Down: Laborers	4	117	77-221	1243	438-2702	6.3	4.1-8.7	0.83	LLD-3.3	250	192-435
Cleaning of Waste Heat Boiler: Laborers	4	2259	536-4812	17584	5358-36209	26	9.7-40	23	6.4-37	3768	781-6702
Sampling Dept.: Furnace Opr., Tender and Weigher	3	42	34-47	532	260-846	1.4	LLD-4.3	-	-	210	190-224
Bedyard (Scrap Handling): Auxiliary Operators	9	109	33-360	848	191-4158	5.2	LLD-16	0.83	LLD-6.5	351	117-1190
Bedyard (Brick Plant): Press Brick Operator	7	151	35-612	654	155-2330	4.8	LLD-17	2.5	LLD-12	601	128-2427

Table 3

Personal Exposures to Airborne Copper

Southwire Company, Incorporated
Carrollton, Georgia

October 2-6, 1978

Sample Description	No. of Samples	Distribution of Concentrations - ug/m^3							
		0 - 499		500 - 999		1000 - 1499		2000+	
		n	(%)	n	(%)	n	(%)	n	(%)
Baghouse: Attendant	10	9	(90)	1	(10)				
Blast/Converter Furnaces: Hot Metals Assistants and Charges	10	8	(80)	2	(20)				
Maerz Furnace Tear Down: Laborers	4	1	(25)	2	(50)			1	(10)
Maerz Furnace - Cleaning of Waste Heat Boiler: Laborers	4							4	(10)
Sampling Dept.: Furnace Operator, Tender and Weigher	3	2	(67)	1	(33)				
Bedyard (Scrap Handling): Auxiliary Operators	9	7	(78)					2	(22)
Bedyard (Brick Plant): Press Brick Operators	7	4	(57)	2	(29)			1	(14)
Total	47	31	(65.9)	8	(17.0)			8	(17.0)

Table 4

Personal Exposures to Airborne Inorganic Nickel

Southwire Company, Incorporated
Carrollton, Georgia

October 2-6, 1978

Sample Description	No. of Samples	Distribution of Concentrations - $\mu g/m^3$ 0 - 4.9 n	(%)	5.0 - 9.9 n	(%)	10.0 - 14.9 n	(%)	15.0 - 49:9 n	(%)
Baghouse: Attendant	10	8	(80)	2	(20)				
Blast/Converter Furnaces: Hot Metals Assistants and Charges	10	9	(90)	1	(10)				
Maerz Furnace Tear Down: Laborers	4	1	(25)	3	(75)				
Maerz Furnace - Cleaning of Waste Heat Boiler: Laborers	4			1	(25)			3	(75)
Sampling Dept.: Furnace Operator, Tender and Weigher	3	3	(100)						
Bedyard (Scrap Handling): Auxiliary Operators	9	6	(67)		(22)			1	(11)
Bedyard (Brick Plant): Press Brick Operators	7	4	(57)	2	(29)			1	(14)
Total	47	31	(65.9)	11	(23.4)			5	(10.6)

Table 5

Personal Exposures to Airborne Cadmium

Southwire Company, Incorporated
Carrollton, Georgia

October 2-6, 1978

Sample Description	No. of Samples	Distribution of Concentrations - ug/m³ 0 - 19 n	(%)	20 - 29 n	(%)	30 - 39 n	(%)	40 - 49 n	(%)
Baghouse: Attendant	10	8	(80)	1	(10)			1	(10)
Blast/Converter Furnaces: Hot Metals Assistants and Charges	10	10	(100)						
Maerz Furnace Tear Down: Laborers	4	4	(100)						
Maerz Furnace - Cleaning of Waste Heat Boiler: Laborers	4	2	(50)			2	(50)		
Sampling Dept.: Furnace Operator, Tender and Weigher	3	3	(100)						
Bedyard (Scrap Handling): Auxiliary Operators	9	9	(100)						
Bedyard (Brick Plant): Press Brick Operators	7	7	(100)						
Total	47	43	(91.5)	1	(2.1)	2	(4.3)	1	(2.1)

Table 6

Blast Furnace Control Room -
Work Area Levels of Metallic Aerosols

Southwire Company, Incorporated
Carrollton, Georgia

October 4-5, 1978

Date	Sample Location	Sample Time-Hrs	Airborne Concentration - ug/M³ Lead	Copper	Zinc	Nickel	Cadmium
10-4	6 ft above floor	7.55	57	44	221	4.4	LLD
10-5	6 ft above floor	7.67	62	60	185	LLD[A]	LLD

[A]Lower Limit of Detection. The LLD's for nickel and cadmium are 3 and 2 ug per sample, respectively.

Table 7

Personal Exposures to Arsenic

Southwire Company, Incorporated
Carrollton, Georgia

October 3-5, 1978

Date	Worker	Sample Time hours	Air Level - ug/m^3
10-3	Laborer No. 1: Tear Down of Maerz Furnace	4.43	1.8
10-3	Laborer No. 1: Tear Down of Maerz Furnace	5.98	0.93
10-4	Laborer No. 5: Tear Down of Maerz Furnace	4.43	1.3
10-4	Laborer No. 5: Tear Down of Maerz Furnace	6.00	3.2
10-3	Hot Metals Asst. No. 1	7.68	1.6
10-4	Hot Metals Asst. No. 2	7.83	0.72
10-5	Hot Metals Asst. No. 2	7.92	0.94
10-4	Hot Metals Asst. No. 4	8.00	2.1
10-3	Brick Press Operator No. 3	11.52	1.6
10-4	Brick Press Operator No. 5	11.80	1.3

Table 8

Exposures to Carbon Monoxide

Southwire Company, Incorporated
Carrollton, Georgia

October 4, 1978

Sample Description	Time of Sample	Air Level-ppm
Blast Furnace: Pouring Floor	1450	< 5
Blast Furnace: Working Platform - Area between Blast and Holding Furnace	1500	<10
Blast Furnace: Working Platform - Copper Hold Area	1506	<10
Blast Furnace: 1-2' from Face of Door During Charging	1520	≥700
Blast Furnace: 1-2' from Face of Door During Charging	1530	≥700
Blast Furnace: Charging Level - Door Closed	1535	<10
Blast Furnace: Pouring Floor During Pouring	1615	< 5
Blast Furnace: " " " "	1620	< 5
Blast Furnace: Working Platform - Copper Hold Area	1625	<10
Blast Furnace: Working Platform - During Pouring	1627	<10
Crane Positioned Over the Blast Furnace	1403	<20
" " " " " "	1406	<10
" " " " " "	1413	<15
" " " " " "	1419	<15
" " " " " "	1422	<15
Sampling Department: During Pouring	1130	< 5
" " " "	1155	< 5

Table 9

Tank House - Sulfuric Acid Exposures

Southwire Company, Incorporated
Carrollton, Georgia

October 5, 1978

Type of Sample	Sample Description	Sample Time Hours	Air Level $\mu g/M^3$
Personal Breathing Zone	Filtration Operator	5.83	125
Personal Breathing Zone	Tank Inspector	7.20	46
Personal Breathing Zone	Tank Loader No. 1	7.20	265
Personal Breathing Zone	Tank Loader No. 2	7.00	83
Work Area	Center Aisle - Commercial Tank Area	6.89	42

Table 10

Mean Blood Lead and Erythrocyte Protoporphyrin in Workers by Work Area

Southwire Company, Incorporated
Carrollton, Georgia

October 4-11, 1978

	No. of Employees	Mean Lead ug%	Mean erythrocyte protoporphyrin ug/l of erythrocytes
High Exposure	48	61.8 ± 12.1	3736 ± 2330
Baghouse	7	58.1 ± 16.8	2664 ± 1825
Boiler	3	54.7 ± 15.0	1450 ± 1290
Blast Furnace	38	63.0 ± 11.0	4114 ± 2354
Intermediate Exposure	141	38.4 ± 11.0	1024 ± 683
Entire plant	37	35.5 ± 10.1	843 ± 380
Bed Yard	19	43.8 ± 8.2	941 ± 665
Brick House	3	44.7 ± 4.0	984 ± 697
Maerz Furnace	35	37.9 ± 12.4	1181 ± 865
Casting Operation	5	33.4 ± 3.4	1531 ± 1187
Sampling Furnace	12	40.2 ± 9.4	824 ± 344
Receiving Area	20	41.7 ± 11.9	1173 ± 754
Anode Storage Area	10	33.1 ± 12.5	1008 ± 633
Low Exposure	100	23.7 ± 8.1	547 ± 208
Tank House	55	26.1 ± 7.8	541 ± 202
Nickel Sulfate Plant	3	16.0 ± 4.0	517 ± 184
Lift Shop	8	24.4 ± 7.7	682 ± 358
Laboratories	3	22.7 ± 9.6	588 ± 211
Offices	31	20.0 ± 7.6	521 ± 169
Total Population	289	37.2 ± 16.4	1308 ± 1531

Table 11a

Work Associated Symptoms in the Preceding Year
Among Southwire Employees by Place, 1978

Southwire Company, Incorporated
Carrollton, Georgia

October 4-11, 1978

Symptom	Percent Prevalence in 3 Exposure Groups High (N = 51)	Intermediate (N = 142)	Low (N = 99)	P Value
Unusual fatigue	60	37	31	.0249
Muscular weakness	32	13	7	.0062
Metal fume fever	28	5	5	.0000
Anorexia	36	23	16	.1181*
Nausea	36	19	8	.0042**
Vomiting	19	11	2	.0338*
Constipation	23	9	6	.0261
Abdominal pain	32	11	10	.0083
Hand tremor	28	16	8	.0273**
Irritability	40	26	17	.1180*
Joint pains	34	16	14	.0483
Headache	38	30	19	.0659
Diarrhea	23	8	9	.0760
Nose or sinus complaints	62	60	42	.1062
Throat irritation	36	22	15	.0364
Dermatitis	36	18	15	.0623
Sweet taste of cigarettes	68	61	38	.0007
Nocturia	21	19	13	.5801

* Significant at $p < .01$ when analyzed by employees grouped by erythrocyte protoporphyrin into those EP $\leq$800, 801-2000, 2000 ug/l

** Not significant by employees grouped by erythrocyte protoporphyrin levels

Table 11b

Work-Associated Symptoms in the Preceding Year Among Southwire Employees Grouped by Erythrocyte Protoporphyrin Level

Southwire Company, Incorporated
Carrollton, Georgia

October 4-19, 1978

Symptom	Percent Prevalence in 3 EP groups (ug/l of erythrocytes) > 2000 N = 42	801-2000 N = 83	< 800 N = 161	P Value
Unusual fatigue	60	41	31	.0032
Muscular weakness	31	15	9	.0085
Metal fume fever	29	7	4	.0001
Anorexia	45	18	19	.0021
Nausea	29	19	15	.3684
Vomiting	17	12	6	.1192
Constipation	26	11	6	.0017
Abdominal pain	31	15	9	.0101
Hand tremor	21	21	10	.1498
Irritability	42	28	19	.0044
Joint pains	38	16	14	.0096
Headache	33	31	24	.1163
Diarrhea	14	11	10	.4930
Nose or sinus complaints	58	60	50	.5885
Throat irritation	31	31	15	.0061
Dermatitis	33	23	15	.0809
Sweet taste of cigarettes	74	60	46	.0032
Nocturia	21	16	16	.4171

Table 11c

Work Associated Symptoms in the Preceding Year
Among Southwire Employees Grouped by Lead Level

Southwire Company, Incorporated
Carrollton, Georgia

October 4-11, 1978

	Percent Prevalence according to lead: (ug·%)				
	< 20	21-40	41-60	≥60	
Symptoms	N=49	N=126	N=84	N=27	P Value
Unusual fatigue	18	38	41	67	.0008
Muscular weakness	4	11	18	33	.0165
Metal fume fever	6	4	12	26	.0074
Anorexia	10	21	26	37	.0728
Nausea	10	16	20	37	.0884
Vomiting	2	9	14	11	.2844
Constipation	4	8	11	30	.0054
Abdominal pain	8	10	14	44	.0001
Hand tremor	10	10	19	33	.0307
Irritability	6	28	25	48	.0069
Joint pains	6	15	23	41	.0103
Headache	14	27	32	33	.0728
Diarrhea	10	9	11	22	.3449
Nose or sinus complaints	12	42	36	11	.0590
Throat irritation	14	20	32	16	.1192
Dermatitis	12	19	23	30	.5770
Sweet taste of cigarettes	31	55	60	78	.0004
Nocturia	6	77	19	30	.0779

Table 12

Respiratory Symptoms Among Southwire Employees by Place and Smoking Habit, 1978

Southwire Company, Incorporated
Carrollton, Georgia

October 4-11, 1978

Symptom	Percent Prevalence in 3 exposure groups			
	High	Intermediate	Low	
Smokers (N=160)	N=26	N=86	N=48	P Value
Morning cough	54	38	33	.4198
Chronic bronchitis	54	28	31	.0515
Morning phlegm	58	30	42	.1169
Chronic phlegm	54	23	23	.0111
Wheezing	58	30	38	.0642
Chronic wheezing	19	13	21	.1415
Shortness of breath				.0233
with wheezing	39	13	13	.0233
Chest pain	58	29	23	.0345
Non Smokers* (N=128)	N=21	N=57	N=49	
Morning cough	28	14	4	.0305
Chronic bronchitis	33	25	10	.0537
Morning phlegm	38	26	16	.3217
Chronic phlegm	29	25	4	.1539
Wheezing	33	18	16	.6139
Chronic wheezing	19	/	6	.0673
Shortness of breath				
with wheezing	19	9	12	.0102
Chest pain	52	25	25	.2976

* Includes 41 ex-cigarette smokers

Table 13
Prevalence of Hypertension in Male Southwire Employees by Race and Age, 1978, as Compared to Rates for the U.S. Population, 1971-1974 (16)

Southwire Company, Incorporated
Carrollton, Georgia

October 4-11, 1978

Age	Observed	Observed Rate Per 100 Persons	Expected Rate Per 100 Persons	Observed/Expected
White				
18-24	11/68	16.2	19.6	0.8
25-34	31/83	37.3	27.6	1.4
35-44	18/37	48.6	35.9	1.4
45-54	10/16	62.5	53.3	1.2
55-64	1/3	33.3	58.0	0.6
Total 18-64	71/207	34.3	28.7	1.2
Black				
18-24	6/19	31.6	15.2	2.1
25-34	17/30	56.7	35.4	1.6
35-44	5/12	41.7	60.6	0.7
45-54	6/7	85.7	53.8	1.6
55-64	3/4	75.0	68.0	1.1
Total 18-64	37/72	51.4	33.8	1.5*
Both Races				
18-64	108/279	38.7	30.0	1.3**

* $p < .05$, $X^2 = 6.59$
** $p < .01$, $X^2 = 7.05$

Table 13a

Prevalence of Borderline Hypertension in Male Southwire Employees
by Age and Race, 1978, Compared to Rates for U.S. Population,
1971 - 1974 (16)

Southwire Company, Incorporated
Carrollton, Georgia

October 4-11, 1978

Age	Observed	Observed Rate Per 100 Persons	Expected Rate Per 100 Persons	Observed / Expected
White				
18-24	6/68	8.8	14.7	0.6
25-34	23/83	27.8	19.4	1.4
35-44	8/37	21.6	18.6	1.2
45-54	6/16	37.5	27.5	1.4
55-64	0/3	0.0	26.9	0
Total 18-64	43/207	20.8	18.4	1.1
Black				
18-24	3/19	15.8	10.6	1.5
25-34	6/30	20.0	17.7	1.1
35-44	1/12	8.3	22.4	0.4
45-54	3/7	42.9	17.0	2.5
55-64	1/4	25.0	18.1	1.4
Total 18-64	14/72	19.4	16.6	1.2
Both Races				
18-64	57/279	20.4	17.9	1.1

Table 13b

Prevalence of Definite Hypertension in Male Southwire Employees by Race and Age, 1978, Compared to Rates for The U.S. Population, 1971 - 1974 (16)

Southwire Company, Incorporated
Carrollton, Georgia

October 4-11, 1978

Age	Observed	Observed Rate Per 100 Persons	Expected Rate Per 100 Persons	Observed / Expected
White				
18-24	5/68	7.4	4.9	1.5
25-34	8/83	9.6	8.2	1.2
35-44	10/37	27.0	17.3	1.6
45-54	4/16	25.0	25.8	1.0
55-64	1/3	33.3	31.1	1.1
Total 18-64	28/207	13.5	10.3	1.3
Black				
18-24	3/19	15.8	4.6	3.4
25-34	11/30	36.7	17.7	2.1
35-44	4/12	33.3	38.2	0.9
45-54	3/7	42.8	36.8	1.2
55-64	2/4	50.0	49.9	1.0
Total 18-64	23/72	31.9	21.9	1.5
Both Races				
Total 18-64	51/279	18.3	13.3	1.4*

* $p < .05$

Table 13c

Prevalence of Blood Pressure of at least 105 mm Hg Diastolic Among Male Southwire Employees by Race and Age, 1978, Compared to Rates for U.S. Population 1971-1974 (16)

Southwire Company
Carrollton, Georgia

October 4-11, 1978

Age	Observed	Observed Rate Per 100 Persons	Expected Rate Per 100 Persons	Observed / Expected
White				
18-24	1/68	1.5	0.8	1.9
25-34	1/83	1.2	1.7	0.7
35-44	3/37	8.1	5.3	1.5
45-54	2/16	12.5	8.9	1.4
55-64	0/3	0	7.4	0.0
Total 18-64	7/207	3.4	2.7	1.3
Black				
18-24	0/19	0	0.5	0.0
25-34	4/30	13.3	8.9	1.5
35-44	4/12	33.3	12.7	2.6
45-54	1/7	14.3	18.8	0.8
55-64	1/4	25.0	20.7	1.2
Total 18-64	10/72	13.9	8.9	1.6
Both Races				
Total 18-64	17/279	6.1	4.3	1.4

Table 13d

Systolic and Diastolic Blood Pressure of Male Southwire Employees by Age and Race, 1978, Compared to Means in Southern Male U.S. Population, 1971 - 1974 (16)

Southwire Company, Incorporated
Carrollton, Georgia

October 4-11, 1978

Age	No. of Employees	Mean Stystolic and S.D.	Expected Mean	Mean Diastolic and S.D.	Expected Mean
White					
18-24	68	124.8±10.7	125.0	78.6±10.7*	75.7
25-34	83	128.5±13.2	128.7	83.1± 9.6	81.7
35-44	37	131.4±14.0	128.0	86.0±13.7	83.8
45-54	16	134.3±15.2	135.7	90.5±12.0	88.5
55-64	3	134.3±18.3	139.8	86.0±12.0	87.1
Total 18-64	207	128.2±13.0	128.0	82.8±11.4**	80.7
Black					
18-24	19	127.9± 9.6	124.2	83.3± 9.6*	77.3
25-34	30	137.4±16.4**	129.1	89.6±13.0*	84.0
35-44	12	134.0±20.6	137.6	90.1±16.2	90.6
45-54	7	137.4±15.9	141.3	93.1±10.3	93.1
55-64	4	137.5±17.5	143.7	91.8±14.4	92.7
Total 18-64	72	134.3±15.8	131.2	88.5±12.*	84.7
Both Race					
18-64	279	129.8±14.0	128.8	84.2±12.0***	81.7

* $p < .05$ 2 tailed t test
** $p < .01$
*** $p < .001$

Table 14

Abnormal Neurologic Findings Among Southwire Employees by Lead Level, 1978

Southwire Company, Incorporated
Carrollton, Georgia

October 4-11, 1978

Neurologic Abnormality	Percent prevalence in 4 lead groups: (ug%)				
	20 N=49	21-40 N=126	41-60 N=84	60 N=27	P Value
Hyporeflexia:					
Achilles tendon	4.1	7.9	14.3	25.9	.0128***
Biceps tendon	6.1	12.7	22.6	11.1	.0484***
Brochioradialis	10.2	16.7	23.8	11.1	.1716
Quadriceps	8.2	7.9	16.7	3.7	.1099
Decreased Muscle Strength:					
Finger extensors	0.0	1.6	4.8	7.4	.1477**
Wrist extensors	2.0	0.8	2.4	3.7	.6891
Ankle dorsiflexors	2.0	0.8	1.2	3.7	.6803
Abnormal sensory-motor findings					
Adiadochokinesia	0.0	3.2	8.3	22.2	.0004*
Abnormal finger to nose test	0.0	5.6	9.5	3.7	.1361
Hand tremor	8.2	11.1	15.5	18.5	.4537

* significant by grouped EP (≤ 800, > 800 ug/l erythrocytes) at p < .01
** significant by grouped EP at p < .05
*** not significant by grouped EP

Table 15a

Mean Erythrocyte Protoporphyrin and Creatinine for Four Groups of Blood Lead Levels, Southwire Copper Division, 1978

Southwire Company, Incorporated
Carrollton, Georgia

October 4-11, 1978

Blood Lead Grouping (ug%)	No. of Employees	Mean erythrocyte protoporphyrin ± S.D. (ug/l of erythrocytes)	Mean creatinine ± S.D (mg%)
0-20	51	523±197	1.13±0.16
21-40	127	773±467	1.16±0.16
41-60	84	1725±1805	1.20±0.20
61-83	28	3913±1971	1.19±0.15
Total	290	1308±1531	1.17±0.18

Table 15b

Mean Blood Lead and Erythrocyte Protoporphyrin by Work Area and Shift, Southwire Copper Division, 1978

Southwire Company, Incorporated
Carrollton, Georgia

October 4-11, 1978

Shift	No. of Employees	Mean Lead ±S.D. (ug%)	Mean erythrocyte protoporphyrin ± S.D. (ug/l of erythrocytes)
High Exposure	48	61.8±12.2	3736±2330
7am-3pm	18	60.3±12.5	3139±1874
3pm-11pm	16	57.4±12.9	5108±2820
11pm-7am	12	69.7± 7.9	3201±1456
8am-8pm	2	63.5± 6.4	1331±1200
Intermediate Exposure	141	38.4±11.0	1024±683
7am-7pm	62	35.9±11.4	886±520
3pm-11pm	11	31.8± 7.5	987±393
11pm-7am	13	42.0±12.4	1241±787
8am-8pm	48	42.1±10.0	1104±736
8pm-8am	7	39.9± 5.0	1362±1386
Low Exposure	99	23.7± 8.2	547±208
7am-3pm	82	23.7± 8.5	548±217
3pm-11pm	6	24.8± 6.4	500±112
11pm-7am	1	30.0± 0.0	1006±0.0
8am-8pm	6	21.0± 7.6	524±142
8pm-8am	4	22.0± 4.7	481±115
Total by Shift	288	37.2±16.4	1308±1531
7am-3pm	162	32.4±15.2	965±1057
3pm-11pm	33	42.9±17.6	2897±2925
11pm-/am	26	54.3±17.8	2137±1498
8am-8pm	56	40.6±12.5	1050±726
8pm-8am	11	33.4±10.1	1042±1163

Table 15c

Mean Blood Lead and Erythrocyte Protoporphyrin by Job Class and Place, Southwire Copper Division, 1978

Southwire Company, Incorporated
Carrollton, Georgia

October 4-11, 1978

Job Class	No. of Employees	Mean Lead ± S.D. (ug %)	Mean Erythrocyte Protoporphyrin ± S.D. (ug/l of erythrocytes)
High Exposure	48	61.8±12.2	3736±2330
Supervisory	9	61.0±11.9	3067±1349
Industrial	39	62.0±12.4	3890±2491
Intermediate Exposure	141	38.4±11.0	1024±683
Office	14	30.0±12.4	857±681
Supervisory	22	32.6± 9.8	982±597
Industrial	105	40.8±10.1	1056±702
Low Exposure	100	23.7±8.2	547±208
Office	39	20.1±7.2	515±159
Supervisory	7	22.7±7.3	511±115
Industrial	54	26.4±8.0	574±245
Total by Job Class	289	37.2±16.5	1308±1531
Office	53	22.7± 9.8	605± 397
Supervisory	38	37.5±16.8	1389±1236
Industrial	198	41.0±15.7	1483±1716

Table 15d
Mean Blood Lead and Erythrocyte Protoporphyrin by Smoking Habit and Place, Southwire Copper Division, 1978

Southwire Company, Incorporated
Carrollton, Georgia

October 4-11, 1978

	No. of Employees	Mean Lead ± S.D. (μg %)	Mean Erythrocyte Protoporphyrin ± S.D. (μg/l of erythrocytes)
High Exposure			
Smokers	26	64.1±11.1	4359±2596
Non-smokers	21	58.2±12.6	3010±1798
Intermediate Exposure			
Smokers	85	39.3±11.2	1042±743
Non-smokers	56	37.2±10.6	998±586
Low Exposure			
Smokers	48	24.4±7.9	528±189
Non-smokers	48	23.0±8.5	556±230

APPENDIX I

ENVIRONMENTAL EVALUATION CRITERIA*

Southwire Company, Incorporated
Carrollton, Georgia

October 2-6, 1978

SUBSTANCE	NIOSH RECOMMENDED STANDARD	SOURCE	OSHA STANDARD	SOURCE
Inorganic Lead	50 ug/M^3	Reference 6	**50-200 ug/M^3	Reference 7
Inorganic Lead	2 ug/M^3	Reference 4	10 ug/M^3	Reference 3
Inorganic Nickel	15 ug/M^3	Reference 5	1000 ug/M^3	Reference 8
Copper Dusts	------	------------	1000 ug/M_3	Reference 8
Copper Fume	------	------------	100 ug/M^3	Reference 8
Cadmium	40 ug/M^3	Reference 9	200 ug/M^3	Reference 8
Zinc Oxide Fume	5000 ug/M^3	Reference 10	5000 ug/M^3	Reference 8
Sulfuric Acid	1000 ug/M^3	Reference 11	1000 ug/M^3	Reference 8
Carbon Monoxide	35 ppm	Reference 12	50 ppm	Reference 8

* The NIOSH criteria refer to the Time-Weighted Average (TWA) concentrations for up to a 10-hour workday, 40-hour workweek, except that for Inorganic Arsenic which is a ceiling concentration. The OSHA standards or Permissible Exposure Limits (PEL's) refer to a TWA concentration for an 8-hour workday, 40-hour workweek.

** The 8-hour TWA PEL for inorganic lead has been reduced from 200 ug/M^3 to 50 ug/M^3 (29 CFR 1910.1025). Pending current litigation of the 50 ug/M^3 lead standard, employers must achieve the 200 ug/M^3 level through engineering and administrative controls, and must protect workers at the 50 ug/M^3 PEL through any combination of controls, including the use of proper respirators.

APPENDIX II

Baghouse Operations - Personal Exposures to Metallic Aerosols

Southwire Company, Inc.
Carrollton, Georgia

October 3-5, 1978

Date	Worker	Total Sample Time Hours	Airborne Concentration - ug/M^3 Lead	Copper	Zinc	Nickel	Cadmium
10-3	Baghouse Attendant No. 1	7.42	164	179	595	9.0	4.5
10-5	Baghouse Attendant No. 1	7.85	105	120	368	4.3	LLD[A]
10-3	Baghouse Attendant No. 2	6.19	2012	790	8446	LLD	45
10-4	Baghouse Attendant No. 2	7.83	184	156	624	5.7	LLD
10-5	Baghouse Attendant No. 2	7.85	991	467	3822	LLD	24
10-3	Baghouse Attendant No. 3	7.25	129	80	536	LLD	3.1
10-4	Baghouse Attendant No. 3	5.33	271	333	854	LLD	6.3
10-4	Baghouse Attendant No. 4	7.83	82	88	298	4.3	LLD
10-5	Baghouse Attendant No. 4	7.92	182	118	604	LLD	5.6
10-4	Baghouse Attendant No. 5	6.67	283	233	850	LLD	6.7

[A]Lower Limit of Detection. The LLD for nickel and cadmium is 3 and 2 ug per sample, respectively.

APPENDIX III

Blast/Converter Furnace Areas - Personal Exposures to Metallic Aerosols

Southwire Company, Inc.
Carrollton, Georgia

October 3-5, 1978

Date	Worker	Sample Time Hours	Airborne Concentration - ug/M3 Lead	Copper	Zinc	Nickel	Cadmium
10-4	Hot Metals Asst. No. 1	7.90	183	120	1688	LLD[A]	LLD
10-5	Hot Metals Asst. No. 1	7.83	212	270	511	LLD	LLD
10-3	Hot Metals Asst. No. 2	7.68	127	607	202	LLD	LLD
10-3	Hot Metals Asst. No. 3	5.28	180	988	1304	LLD	LLD
10-4	Hot Metals Asst. No. 3	7.90	103	169	478	LLD	LLD
10-3	Hot Metals Asst. No. 4	7.80	70	299	199	4.3	LLD
10-5	Hot Metals Asst. No. 4	8.00	114	153	153	LLD	LLD
10-3	Blast Furnace Charger	7.75	105	344	387	LLD	LLD
10-4	Blast Furnace Charger	7.98	86	153	292	LLD	LLD
10-5	Blast Furnace Charger	8.03	166	373	526	5.5	2.8

[A] Lower Limit of Detection. The LLD for nickel and cadmium is 3 and 2 ug per sample, respectively.

APPENDIX IV

Personal Exposures to Metallic Aerosols by Laborers Involved with Tear Down of the Maerz Furnace

Southwire Company, Inc.
Carrollton, Georgia

October 3-4, 1978

Date	Worker	Sample Time Hours	Airborne Concentration - ug/M3				
			Lead	Copper	Zinc	Nickel	Cadmium
10-3	Laborer No. 2	10.60	78	979	153	4.1	LLD[A]
10-3	Laborer No. 3	10.80	77	854	192	7.1	LLD
10-4	Laborer No. 4	9.95	221	2702	435	8.7	3.3
10-4	Laborer No. 6	10.38	91	438	221	5.5	LLD

[A]Lower Limit of Detection. The LLD for nickel and cadmium is 3 and 2 ug per sample, respectively.

APPENDIX V

Exposures to Metallic Aerosols by Laborers while Cleaning the Maerz Furnace Waste-Heat Boiler (Economizer)

Copper Division of Southwire
Southwire Company, Inc.

Carrollton, Georgia

October 3 and 4, 1978

Date	Worker[A]	Sample Time Hours	Airborne Concentration - ug/M^3 Lead	Copper	Zinc	Nickel	Cadmium
10-3	Laborer No. 7	10.38	2076	13165	1541	33	37
10-4	Laborer No. 7	10.47	4812	36209	6049	40	33
10-3	Laborer No. 8	10.37	536	5358	781	9.7	6.4
10-4	Laborer No. 8	10.40	1614	15605	6702	23	15

[A]Samples were collected at external surface of person wearing a half-face or an air-line supplied respirator. The type of respirator worn varied during the work-day depending on the nature of the worker's cleaning responsibility; i.e., the worker wore the air-line supplied respirator when he blew dust off the heat exchanger fins.

APPENDIX VI

Sampling Area - Personal Exposures to Metallic Aerosols

Southwire Company, Inc.
Carrollton, Georgia

October 4-5, 1978

Date	Worker	Sample Time Hours	Airborne Concentration - ug/M^3				
			Lead	Copper	Zinc	Nickel	Cadmium
10-4	Furnace Operator	6.42	47	260	190	LLD[A]	LLD
10-4	Furnace Tender	7.75	46	846	215	4.3	LLD
10-5	Weigher	7.92	34	491	224	LLD	LLD

[A]Lower Limit of Detection. The LLD for nickel and cadmium is 3 and 2 ug per sample, respectively.

APPENDIX VII

Scrap Handling (Bedyard) - Personal Exposures to Metallic Aerosols

Southwire Company, Inc.
Carrollton, Georgia

October 3-5, 1978

Date	Worker	Sample Time Hours	Airborne Concentration - ug/M^3 Lead	Copper	Zinc	Nickel	Cadmium
10-3	Small Equipment Auxillary Operator	11.27	192	4158	260	2.9	LLD[A]
10-4	Small Equipment Auxillary Operator	9.83	38	259	330	9.0	LLD
10-5	Small Equipment Auxillary Operator	9.10	60	244	220	LLD	LLD
10-3	Large Equipment Auxillary Operator	11.40	360	1590	1190	16	6.5
10-4	Large Equipment Auxillary Operator	9.93	43	257	123	5.6	LLD
10-3	Large Equipment Auxillary Operator	11.25	36	191	117	4.7	LLD
10-4	Large Equipment Auxillary Operator	10.53	127	422	475	4.2	LLD
10-5	Auxillary Operator	11.53	33	202	125	LLD	LLD
10-5	Auxillary Operator	11.43	91	311	321	LLD	1.9

[A]Lower Limit of Detection. The LLD for nickel and cadmium is 3 and 2 ug per sample, respectively.

APPENDIX VIII

Brick Plant (Bedyard) - Personal Exposures to Metallic Aerosols

Southwire Company, Inc.
Carrollton, Georgia

October 4-5, 1978

Date	Worker	Sample Time Hours	Airborne Concentration - ug/M3				
			Lead	Copper	Zinc	Nickel	Cadmium
10-3	Press Brick Operator	11.70	138	664	452	7.5	2.8
10-3	Press Brick Operator	11.58	85	365	307	LLD[A]	LLD
10-4	Press Brick Operator	10.73	52	269	163	3.1	LLD
10-4	Press Brick Operator	11.66	35	218	128	LLD	LLD
10-5	Press Brick Operator	11.50	46	155	155	LLD	LLD
10-5	Press Brick Operator	11.45	612	2330	2427	17	12
10-5	Press Brick Operator	10.98	162	577	577	6.1	3.0

[A]Lower Limit of Detection. The LLD for nickel and cadmium is 3 and 2 ug per sample, respectively.

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