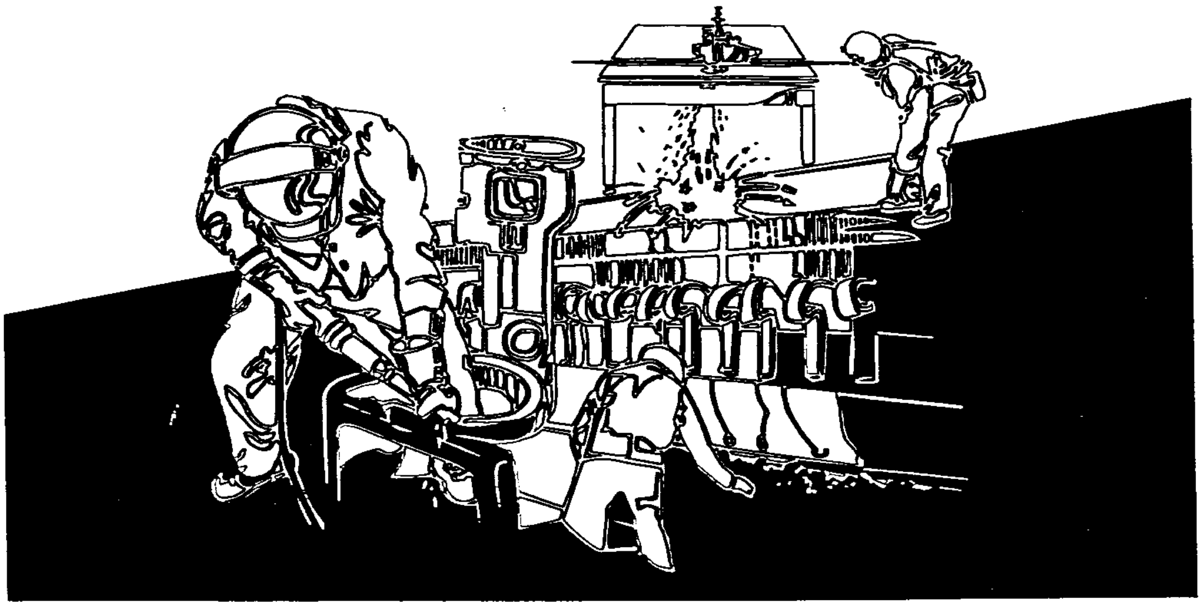
NIOSH

HEALTH HAZARD EVALUATION REPORT

HETA 91-393-2171
GEORGIA METALS, INC.
POWDER SPRINGS, GEORGIA



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

CDC
CENTERS FOR DISEASE CONTROL

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 and 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 91-393-2171
DECEMBER 1991
GEORGIA METALS, INC.
POWDER SPRINGS, GEORGIA

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I. SUMMARY

On September 13, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a technical assistance request from the Occupational Safety and Health Administration (OSHA) Atlanta Regional Office to conduct a health hazard evaluation (HHE) at Georgia Metals, Inc., located in Powder Springs, Georgia. The request was prompted by the report to OSHA of an elevated blood lead level (141 micrograms per deciliter [µg/dl]) in a Georgia Metals' employee.

On October 1 and 2, 1991 NIOSH investigators travelled to Powder Springs, Georgia to collect environmental samples for lead and perform employee medical evaluations. During the two-day NIOSH visit, however, lead operations at the plant had ceased, and only 9 of the 12 current employees (both full-time and part-time) were available for medical evaluations. Subsequent attempts to contact former employees resulted in additional interviews and collection of two additional blood samples.

The mean blood lead level (BLL) among current employees was 32 µg/100 grams whole blood (range 9 to 51). One employee had a BLL over 50 µg/100 grams whole blood, the level at which the OSHA lead standard requires medical removal from areas where lead exceeds 30 µg/m^3. The mean ZPP level among current employees was 134 µg/dl (range 28-263 µg/dl). Five current employees had levels above the upper limit of normal (>50 µg/dl) indicating elevated BLL two to four months previously.

Review of Georgia Metals payroll records and the questionnaire results indicate that lead welding and melting was occurring at least 30 days per year (the minimum number of days needed to invoke the OSHA lead standard). In addition, this exposure was probably above OSHA's permissible exposure limit (PEL) given the environmental sampling performed by OSHA and the estimated exposure levels derived from the employees' blood lead levels. Therefore, this facility should be adhering to the requirements of the OSHA lead standard.

At the time of this survey, the company was not conducting environmental monitoring, routine medical surveillance, and was not providing adequate respiratory protection, housekeeping, hygiene facilities, or training. In addition, adverse health outcomes (hypertension and screening tests for impaired renal function) were documented in five of the nine (56%) employees tested. These adverse health outcomes are possibly due to lead toxicity.

On the basis of the data collected, a health hazard existed at the time of this survey from employee exposure to lead at the Georgia Metals site in Powder Springs, Georgia. Recommendations for reducing lead exposure are included in this report.

KEY WORDS: SIC 3443 (Fabricated Plate Work), Tank Construction, Lead, Inorganic Lead, Lead Lining, Lead Burning, Lead Burners, Blood Lead, Zinc Protoporphyrin

II. INTRODUCTION

On September 13, 1991 the National Institute for Occupational Safety and Health (NIOSH) received a request from the Occupational Safety and Health Administration (OSHA) Region IV office to conduct a health hazard evaluation (HHE) at the Georgia Metals, Inc. facility in Powder Springs, Georgia. The request was prompted a local physician report to OSHA of an elevated blood lead level (BLL) in a plant employee.

On October 1 and 2, 1991 a walk-through survey of the facility and a medical evaluation of employees was conducted. The medical evaluation consisted of a questionnaire and a blood specimen to determine blood lead levels (BLL), zinc protoporphyrin (ZPP) levels, blood urea nitrogen (BUN) levels, and creatinine (CR) levels. Blood test results were mailed to the employees on November 6, 1991, and reported to OSHA without personal identifiers on November 5, 1991.

III. BACKGROUND

A. GENERAL DESCRIPTION OF OPERATIONS

Georgia Metals, Inc. (formerly the Southern Lead Burning Company) operates a facility in Powder Springs, Georgia, where it primarily relines newly fabricated or refurbished steel tanks with lead or polyvinyl chloride (PVC)-polypropylene. The relining process takes place both at the Georgia Metals facility and occasionally at their customers' locations. In addition to lining tanks, the company also produces "came lead," lead pipe, lead anodes, and lead burning rods from lead pigs and recycled scraps.

1. Tank Lining

The tank lining process consists of cleaning prefabricated steel tanks (the company does not fabricate steel), and lining them with either polyvinyl chloride (PVC) or lead to provide protection against corrosive agents. Although the company previously fabricated its own lead sheets, it now fabricates lead products or tank liners from purchased lead sheets. Both the lead and the PVC lining operations are performed in a building called the "upper yard" (Figure 1).

a. Korosealing

This process involves applying a PVC liner to pre-fabricated steel tanks using Koroseal, an adhesive which contains ethyl acetate, carbon tetrachloride, toluene, methyl-ethyl-ketone, xylene, and naphtha. Two employees are usually needed in this process. It is occasionally necessary to sandblast the metal prior to applying Koroseal.

b. Lead Lining

The lead lining process consists of cutting or burning lead sheets to the correct size and hoisting them into the pre-fabricated tank where additional cutting or burning can occur. The sheets are welded into place using lead as a filler to form the seam. An oxygen-acetylene torch is used to melt the lead.

2. Lead Extrusion and Processing

Lead processing takes place in the lower yard of the plant (Figure 1). Recycled lead and pig lead are lifted into large metal pots, which are heated by natural gas to temperatures above 700°F. Molten lead is poured off through a manually operated valve on the side of the pot either into a "button" (a small mold) or a hydraulic extrusion press. The semi-solid lead is then forced through a die, which forms either lead pipe, came lead or lead rod. Lead rods used to fabricate anodes are then fitted with copper hooks, end caps, and reinforcement bars.

3. Lead Specialty Work

The company does some specialty lead work in the upper yard (Figure 1). This includes soldering and welding of lead pipes and bars for various items such as the repair of lead heat-exchange coils.

B. WORKFORCE

Most of the employees at the Georgia Metals facility are non-union. However, two of the employees are members of the Lead Burners Local 153, headquartered in Murphy, North Carolina. At the time of this survey Georgia Metals had twelve full-time or part-time employees. Current wages for lead burning are about $20/hr, vs $10/hr for non-lead burning work.

C. OSHA INSPECTIONS

In the spring and summer of 1991, OSHA conducted an inspection of the facility and cited the company for:

(1) overexposure to carbon tetrachloride,
(2) lack of a respirator program for the carbon tetrachloride,
(3) lack of safety guards on machines,
(4) lack of initial exposure monitoring for lead,
(5) lack of a hazard communication program,
(6) lack of hazard training, and
(7) recordkeeping violations.

OSHA was unable to perform environmental sampling for lead due to the lead process being shut down when OSHA inspectors arrived.

In August 1991, approximately 2 weeks after the OSHA closing conference, the OSHA office was notified by a physician of an elevated BLL of a Georgia Metals employee. The employee's BLL was 142 µg/dl, and he required hospitalization for chelation therapy. This report prompted OSHA to open another inspection of the Georgia Metals facility. OSHA also required the owner of the facility to check BLLs on all current employees. BLLs were obtained for ten of the twelve workers employed at that time. These samples were sent to a laboratory certified by OSHA to perform BLLs. BLLs ranged from 11 to 79 µg/dl (mean 38). Two of the ten employees (20%) had BLLs above 50 µg/dl, the level at which the OSHA lead standard requires medical removal from lead exposure. An additional two employees had BLLs above 40 µg/dl, the level above which the standard requires bimonthly blood lead testing. During OSHA's most recent inspection, wipe samples at the facility taken on September 4, 1991 revealed extensive lead contamination of the upper and lower yards. In the upper yard, contamination ranged from 5.6 $\mu g/cm^2$ on the shear control buttons to 1,400 $\mu g/cm^2$ in the sink of the men's restroom (Figure 1). In the lower yard, contamination ranged from 83 $\mu g/cm^2$ at the water fountain push-button to 4,300 $\mu g/cm^2$ on the floor between the two presses (Figure 1).

On October 11, 1991, OSHA succeeded in obtaining environmental lead samples. Personal breathing zone (PBZ) samples were collected on two employees working in the lower yard for approximately 4 hours. Sampling results showed time-weighted average (TWA) lead exposures of 95 and 87 $\mu g/m^3$. One employee working in the upper yard was sampled for about 3 hours and another employee for 1 hour, revealing TWA lead exposures of 79 and 35 $\mu g/m^3$, respectively.

IV. MATERIALS AND METHODS

A. ENVIRONMENTAL

On October 1, 1991 an environmental survey to measure airborne lead levels was planned; however, the plant's lead operations were not running the day of the NIOSH survey. A bulk dust sample was taken from the vacuum cleaner used in the upper yard. The sample was analyzed for lead by atomic absorption spectroscopy according to NIOSH method 7082.[1]

B. MEDICAL

On October 1 and 2, 1991, a medical evaluation of all available current and former employees was attempted. A list of all employees since 1986 was obtained from the company. According to the list, there were seven full-time employees, five part-time employees, and 14 former employees. Consenting employees were administered a questionnaire addressing exposure, work practices, protective equipment, hygiene practices at work, symptoms, and other pertinent medical information. Employees were interviewed either in person or by telephone. In addition, all employees were offered the opportunity to have (1) their blood pressure taken, (2) their blood drawn and analyzed or lead and ZPP levels, and (3) their kidney function assessed by measuring blood levels of urea nitrogen (BUN) and creatinine (CR).

The blood samples were analyzed by a laboratory approved for blood lead analysis by the Occupational Safety and Health Administration based on proficiency testing.[2] The blood lead levels were determined utilizing anodic stripping voltimetry, and ZPP levels were determined by photofluormetric techniques.[3] NIOSH's contract laboratory reported the blood lead levels as microgram (μg) per deciliter (dl). These values were converted to μg per 100 grams whole blood (units used in the OSHA lead standard), using 1.052 as the specific gravity of blood. The blood creatinine was used to estimate creatinine clearance (CrCl) for men based on their age, weight, and height.[4] The reference range for CrCl is 80-120 milliliters per min (ml/min).

C. WALK-THROUGH SURVEY

A walk-through survey of the upper and lower yards was conducted (Figure 1) to assess work practices, hygiene facilities, and housekeeping.

V. EVALUATION CRITERIA

A. INORGANIC LEAD

1. Toxicity

Inhalation (breathing) of lead dust and fume is the major route of lead exposure in the industrial setting. A secondary source of exposure may be from ingestion (swallowing) of lead dust deposited on food, cigarettes, or other objects. Once absorbed, lead is excreted from the body very slowly. Absorbed lead can damage the peripheral and central nervous systems, gastrointestinal system, kidneys, reproductive system, hematopoietic system (blood-forming organs), and virtually all other systems of the body.[5] The acute effects may manifest as weakness, tiredness, irritability, reduced intelligence, slowed reaction times, abdominal pain, or high blood pressure.[6] Chronic lead exposure can cause infertility, kidney damage, and, in pregnant women, fetal damage manifested as prematurity, reduced birth weight, reduced red blood cell production, and reduced intelligence.[7-11] The blood lead test is one measure of the amount of lead in the body and is the best available measure of recent lead absorption. The mean serum lead level for US men between 1976 and 1980 was 16 µg/dl;[12,13] however, with the implementation of lead-free gasoline and reduced lead in food, the 1991 average serum lead level of U.S. men will probably drop below 9 µg/dl.[5] A summary of the lowest observable effect levels of lead are listed in Table 1.

2. Medical Monitoring of Lead-Exposed Workers

The OSHA lead standard requires annual blood lead testing for employees exposed to lead above the action level (30 µg/m^3).[14] If an employee's blood lead level is at or above 40 µg/100 grams of whole blood, the employee must have his or her blood lead checked every 2 months. If an employee's blood lead level averages 50 µg/100 grams of whole blood or more, he or she must be removed from areas containing more than 30 µg/m^3 airborne lead, and have monthly blood lead tests.[14] For employees removed from lead exposure, the OSHA lead standard requires the employer to maintain the earnings, seniority, and other employment rights and benefits of an employee as though the employee had not been removed. For an employee to return to work in the area with lead exposure above 30 ug/m^3, the blood lead level must be below 40 µg/100 grams of whole blood on two consecutive tests if the original blood lead was between 50-60, or drop at least 20 µg/100 grams of whole blood on two consecutive tests if the original blood lead was greater than 60.[14] The blood samples must be analyzed by a laboratory that has been approved by OSHA.[2]

Zinc protoporphyrin (ZPP) levels measure the effect of lead on the red blood cell enzyme ferrochelatase, the last enzyme involved in the process of heme synthesis. In men, ZPP levels increase abruptly when blood lead levels rise above 35 µg/dl, and they tend to stay elevated for several months.[15] In women, ZPP level rise at a BLL of 25 µg/dl. ZPP levels above 50 µg/dl suggest iron deficiency or lead exposure.

3. Occupational Exposure Criteria

The current OSHA PEL for airborne lead is 50 µg/m^3, calculated as an 8-hour TWA for daily exposure. The standard also specifies that if more than 8 hours are worked in any work day, the PEL should be adjusted accordingly, e.g., the PEL for a 10-hr work day is 40 µg/m^3.[14] In addition, the OSHA lead standard establishes an "action level" of 30 µg/m^3 TWA. If this action level is exceeded, several requirements of the standard, including periodic exposure monitoring, medical surveillance, and training and education are triggered.[14] If the initial determination shows that any employee's 8-hr TWA PBZ results are above 30 $\mu g/m^3$, air monitoring must be performed every six months until the results show two consecutive levels of less than 30 $\mu g/m^3$ (measured at least seven days apart).

VI. RESULTS

A. ENVIRONMENTAL SAMPLING

Lead operations were shut down during NIOSH's site-visit; therefore, no personal breathing zone samples were taken. One bulk dust sample was taken from the bag of a vacuum cleaner (non-HEPA) located in the upper yard. This sample contained 6.2% lead by weight.

B. MEDICAL

Nine of the twelve (75%) current full- and part-time employees completed the questionnaire, and 7 (58%) consented to have their blood drawn. Only five of the 14 (36%) former employees could be reached by telephone to complete the questionnaire. Only two (14%) former employees consented to have their blood drawn.

1. Blood Lead Levels (BLL)

The mean BLL for the nine current employees was 32 μg/100 grams of whole blood (range = 10 to 51, std dev = 17). One employee had a BLL above the level for medical removal by the OSHA lead standard. Another employee had a BLL above 40 μg/gram of whole blood, the level requiring bimonthly blood lead testing. The BLLs for the two former employees were 9 and 27 μg/100 grams of whole blood.

2. Zinc Protoprophrin (ZPP) Levels

The mean ZPP level for the current employees was 134 $\mu g/dl$ (range = 28 to 263, std dev = 91). Five (71%) had levels above the upper limit of normal (50 $\mu g/dl$), suggesting much higher BLLs three to four months ago. The two former employees had ZPP levels less than 50 $\mu g/dl$.

3. Estimates of Renal Function

The mean BUN level for the current employees was 16 $\mu g/dl$ (range = 12 to 22, std dev = 15.9). One employee had a level above the upper limit of normal (20 $\mu g/dl$). The BUN levels for the former employees were both less than 20 µg/dl. The mean Cr level for the current employees was 1.3 µg/dl (range = 1.1 to 1.8, std dev = 0.4). Four (57%) had levels at or above the upper limit of normal (1.3 µg/dl). The two former employees had CR levels of 1.0 and 1.1 µg/dl. The mean estimated creatinine clearance (CrCl) among current employees was 80 ml/min, (range 39 to 111, std dev = 23). Two employees had a CrCl below the lower limit of normal (80 ml/min). The two former employees had CrCls of 67 and 87 ml/min.

6. Systolic and Diastolic Blood Pressure Measurements

The mean systolic blood pressure for the current employees was 143 mm Hg (range = 118 to 180, std dev = 25). Two employees had measurements at or above the upper limit of normal (140 mm Hg). The two former employees had measurements of 124 and 170.

The mean diastolic blood pressure for the current employees was 86 mm Hg (range = 70 to 110, std dev = 12). Two employees (the same two current employees with elevated systolic blood pressure) had measurements at or above the upper limit of normal (90 mm Hg). The two former employees had measurements of 80 and 104.

7. Gums

None of the current or former employees had lead lines.

C. **WALK-THROUGH SURVEY AND QUESTIONNAIRE RESULTS**

UPPER YARD (Figure 1)

The upper yard is composed of a single-story building containing administrative offices and production areas. The production areas are divided into three sections: metal fabrication (weld shop); tank lining (koroseal area), and two storage areas. There is no local exhaust ventilation present in the main building other than one or two small fans. The owner insisted that lead is rarely processed in the upper yard; however there was evidence of recent lead work in this building (lead coil undergoing repair) and considerable storage of lead products ("Virgin" lead ingots, scrap lead, lead pipe and sections of lead sheets). In addition, two current employees stated that they worked between 84-120 days in the past six months lining tanks with lead in the upper yard. No environmental monitoring for lead had been done by the company.

1. Respiratory Protection

Thirteen of the 14 (93%) employees stated they wore respirators while at work. Of these 13, seven (54%) stated they wore dust masks, and six (46%) stated they wore half-face cartridge respirators. The half-face respirators were provided to employees in the spring or summer of 1991. The NIOSH approved half-mask respirators in the Koroseal area were equipped with organic vapor/acid gas cartridges (TC-23C-318). The NIOSH approved half-mask respirators used in other areas of the upper yard were equipped with dust/fume/mist cartridges (TC-21C-244). None of the employees had been fit-tested prior to using their respirators, and two (15%) employees stated they wore their respirators over their beards. Two employees stated they received training on how to properly use their respirator. Only two employees reported cleaning their respirator every day. There was no designated location for respirator storage. In addition one respirator was missing an inhalation valve.

2. <u>Medical Surveillance</u>

Georgia Metals has not conducted routine employee medical surveillance. BLLs were performed on two Georgia Metals employees in 1989 when a contractor required BLL on all employees working on its premises. The two values were 44 and 59 µg/dl. According to the OSHA lead standard, one of these values would require medical removal, and both would require repeat testing. Neither of these actions were taken. In addition, employees working with lead were never given routine physical examinations as required by the standard. The BLLs performed in August 1991 on all current employees would require repeat testing on four employees, but only one was repeated. This employee was medically removed and should retain his wages as required by the OSHA lead standard until his treating physician releases him for duty.

3. <u>Housekeeping</u>

Many surfaces appeared extensively contaminated with lead, a fact confirmed by wipe samples collected by OSHA on September 4. The vacuum cleaner used in this building was not a high efficiency particulate air (HEPA) filter and its collection bag was made of canvas. A bulk sample of dust collected from the vacuum bag contained 6.2% lead by weight.

4. <u>Hygiene</u>

It appears that beverage consumption was permitted in this area (a soft drink machine is present in the metal fabrication room). Two (14%) of the employees reported eating at their workstation. According to the owner, cigarette smoking is discouraged; however, there was an absence of "No Smoking" signs, and cigarette butts were found on the floor. Of the seven employees who smoked cigarettes at work, five (71%) stated they smoked at their workstation.

Workers were not provided work clothes, disposable coveralls, a changing room, or a shower facility. The company offered a laundry service for employees' work clothing, but charged employees $11.00 per month for this service. Only one employee used this cleaning service. Only two employees (14%) reported changing their work clothes before leaving work, and only four (29%) reported changing shoes before leaving work.

5. Health and Safety Training

Three employees (21%) said they received training on the potential health effects of lead and the early signs of lead poisoning.

LOWER YARD (Figure 1)

The lower yard is a single story building housing three large gas fired lead melting pots, two smaller portable pots, and two extrusion presses.

1. Engineering Controls

A local exhaust system was installed during September, 1991 in preparation for initial lead monitoring (OSHA abatement date - October 11, 1991). The ventilation system consisted of an in-line axial fan and branch ducts attached to the top of each melting pot. Each branch of the exhaust ducts is equipped with a chain-operated control damper to block off exhaust air pots not in use. According to the installation contractor, the capacity of the fan is 1500-2000 cubic feet per minute. No measurements were taken during the NIOSH survey. Smoke tests were used to qualitatively evaluate capture efficiency. The tests indicated that there was "draw" or pulling through the opening where lead is loaded into the pot. No air pollution control equipment had been installed on the exhaust discharge stack. A flexible duct was connected to the exhaust system for use on portable melting pots. There was no local exhaust ventilation present for the lead pour off or extrusion processes.

2. Housekeeping

Evidence of dross skimmings and other lead contamination was present throughout the building. Two brooms were found, indicating that dry sweeping is allowed. There was no HEPA-filtered vacuum. Like the upper yard, there was evidence of beverage consumption and cigarette smoking in the lower yard, and OSHA wipe samples revealed extensive (up to 4,300 $\mu g/cm^2$) lead contamination on walking and working surfaces.

VII. DISCUSSION

A. ENVIRONMENTAL

While there are no standards for surface contamination of lead, the lead levels found are substantially above background levels and indicate extensive lead work is or was being performed in both the upper and lower yards. Housekeeping is also grossly inadequate. OSHA obtained payroll statements from March 1991 to September 1991. These records indicate one employee welded lead for more than 420 hours during that 6-month period, and two other employees welded for at least 95 and 52 hours during that period. This confirms the questionnaire results indicating that three employees welded with lead for at least 80 days in the past 12 months. This does not include employees working in the lower yard, where recycled and pig lead are melted and extruded into lead pipe, came lead, or lead rod.

Environmental monitoring by OSHA documented exposure levels in the upper yard up to 79 $\mu g/m^3$, and up to 95 $\mu g/m^3$ in the lower yard. Estimates of environmental exposure can be made from BLLs.[17] Several studies of occupational exposures (much above 10 $\mu g/m^3$) and BLLs (above 40 $\mu g/dl$) estimate the environmental exposure by dividing the BLL by a value between 0.03 to 0.20.[18-21] Using this formula and the mean BLL for all current workers (32 $\mu g/dl$), this would predict lead exposures between 160 and 1067 $\mu g/m^3$ as an 8-hr TWA.

B. MEDICAL

All BLLs obtained by NIOSH and Georgia Metals, except the initial test of 141 $\mu g/dl$, were analyzed by a laboratory approved by OSHA for blood lead analysis. The approval list is updated quarterly, and laboratories with 89% or more acceptable sample reports for two consecutive quarters are approved.[2] The laboratory performing the initial test was certified by the American College of Pathologists to perform lead testing; however, this lab began lead testing only in the preceding quarter. Therefore, this laboratory did not qualify for the OSHA approval due to their recent initiation of the test, rather than a lack of quality control.

Individual sample result acceptance is dependent on the sample's mean lead level. For samples less than 40 $\mu g/dl$, results can vary up to 6 $\mu g/dl$; for samples more than 40 $\mu g/dl$, samples can vary up to 15%.[2] This individual sample result variation could explain some of the blood lead discrepancies between laboratories.

Four of the nine (44%) employees whose blood samples we analyzed had elevated serum creatinine. Three of these four employees also had decreased estimated creatinine clearances, while the fourth was borderline normal with a value of 83 ml/min. Although our creatinine clearance calculations are only estimates and renal impairment is not specific for lead poisoning, finding 44% of a lead exposed workforce with potential renal impairment suggests the possibility of chronic lead toxicity.

Three of the nine (33%) employees measured had elevated blood pressure (both systolic and diastolic). Two of these three also had decreased estimated creatinine clearances. As with renal impairment, hypertension is not specific for lead poisoning, however this may represent chronic lead toxicity.

VIII. CONCLUSIONS

Review of Georgia Metals payroll records and the questionnaire results indicate that lead welding and melting was occurring at least 30 days per year (the minimum number of days needed to invoke the OSHA lead standard). In addition, this exposure was probably above OSHA's permissible exposure level (PEL) given the environmental sampling performed by OSHA and the estimated exposure levels derived from the employees blood lead levels. Therefore, this facility should be adhering to the requirements of the OSHA lead standard.

At the time of this survey, Georgia Metals was not conducting environmental monitoring or routine medical surveillance, and was not providing adequate respiratory protection, housekeeping, hygiene facilities, or training. In addition, adverse health outcomes (hypertension and screening tests for impaired renal function) were documented in five of the nine (56%) employees tested. These adverse health outcomes are possibly due to lead toxicity.

IX. RECOMMENDATIONS

To ensure that workers are adequately protected from the adverse effects of lead, a comprehensive program of prevention and surveillance is needed. The requirements for such a program are contained in the OSHA lead standard.[14] In addition to specifying PELs for airborne exposure, the OSHA lead standard also contains specific provisions dealing with mechanical ventilation, respirator usage, protective clothing, housekeeping, hygiene facilities, employee training, and medical monitoring.[14] The implementation of the provisions of this standard will help to ensure that the employees are protected against any potential adverse health effects of lead exposure.

To assist the employer in implementing key provisions of OSHA's lead standard, a brief overview related to the findings of this survey follow.

A. ENGINEERING CONTROLS

The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that capture velocities for substances released at low velocity into moderately still air be at least 100 to 200 feet per minute (fpm), and that the upper end of this range be used for contaminants of high toxicity (eg, lead).[22] The workers need to be reminded to use the flexible ducts and to ensure the ducts are moved as close as practical to the work area. All local exhaust ducts should be equipped with flanged or tapered openings to increase the collection efficiency. Periodic testing of all local exhaust ventilation systems is necessary to ensure their continued efficiency. Such systems should be tested every three months, and following major modifications.[14] A complete discussion of specific details regarding ventilation system testing, as well as information regarding the design, construction, and operation of local exhaust ventilation systems, is contained in the ACGIH Industrial Ventilation, A Manual of Recommended Practice.[22]

B. EXPOSURE MONITORING

All activities involving the use of lead (cutting, fabricating, pouring, burning) should be characterized by personal air monitoring. Despite the presence of engineering controls, periodic monitoring for airborne lead is needed to ensure that these controls operate effectively. Air monitoring can also be used to pinpoint the need for further employee protection (i.e., respirators) in certain areas or during certain procedures. When airborne exposures are found above the OSHA action level of 30 $\mu g/m^3$, the standard calls for repeat monitoring every six months. This monitoring should be continued until such time as concentrations are found to be below this level in two consecutive measurements conducted at least one week apart.[14] Employees should be informed of the monitoring results.

C. MEDICAL SURVEILLANCE

The OSHA lead standard requires annual blood lead testing for employees exposed to lead above the action level (30 $\mu g/m^3$).[14] If an employee's blood lead level is at or above 40 μg/100 grams of whole blood, the employee must have his or her blood lead checked every 2 months. If an employee's blood lead level averages 50 μg/100 grams of whole blood or more, he or she must be removed from areas containing more than 30 $\mu g/m^3$ airborne lead, and have monthly blood lead tests.[14] For employees removed from lead exposure, the OSHA lead standard requires the employer to maintain the earnings, seniority, and other employment rights and benefits of an employee as though the employee had not been removed. For an employee to return to work in the area with excessive lead exposure, the blood lead level must be below 40 μg/100 grams of whole blood on two consecutive tests if the original blood lead was between 50-60, or drop at least 20 μg/100 grams of whole blood on two consecutive tests if the original blood lead was greater than 60.[14] The blood samples must be analyzed by a laboratory that has been approved by OSHA.[2]

D. RESPIRATORY PROTECTION PROGRAM

Properly designed engineering controls (e.g., local exhaust ventilation) should be the primary means of exposure prevention. If, however, the engineering controls cannot feasibly reduce the exposure, the use of respiratory protection is needed. A comprehensive respiratory protection program is outlined in the OSHA Respiratory Protection Standard, 29 CFR 1910.134.[23] Air monitoring data to support the use and selection of respirators should be collected for all activities where respirators are used. The program should include a written standard operating procedure which addresses respirator selection, training, fitting, testing, inspection, cleaning, maintenance, storage, and medical examinations. A detailed discussion of these key program elements is provided in the NIOSH Guide to Industrial Respiratory Protection.[24]

E. HOUSEKEEPING

The company should establish a housekeeping program for lead. This should include the purchase and use of a HEPA-filtered vacuum cleaner and approved waste containers, and the elimination of dry sweeping and use of non-HEPA-filtered vacuum cleaners. The lower yard should be thoroughly cleaned to eliminate the obvious lead contamination. Workers conducting this decontamination should wear protective clothing (e.g. Tyvek suits) and respiratory protection (HEPA filter). The use of dry sweeping or cleaning with compressed air should be prohibited.

F. HYGIENE

Wherever lead dust is present, there is a possibility that the employee's skin and clothing may become contaminated. This can result in subsequent inhalation or ingestion of the lead, which can substantially increase the employee's overall absorption of lead. In addition, lead contamination on skin or clothing may be transported to other areas of the facility, and possibly to the worker's homes, where secondary exposure of co-workers or family members can occur.

The facility should implement and enforce a no-eating, no-drinking, and no-smoking policy in areas where lead is used. Employees should be provided work clothing (coveralls, boots, gloves), and the clothing should be kept in lockers and laundered at the facility or an off-site industrial laundry. A shower/change room should be made available to employees.

G. **TRAINING**

All employees should be trained regarding the hazards of lead, including the potential for take-home contamination.

X. REFERENCES

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A. Occupational Safety and Health Administration - Smyrna Area Office
B. Occupational Safety and Health Administration - Region IV
C. Georgia Metals, Inc., Powder Springs, Georgia
D. Lead Burners Local 153, Murphy, North Carolina
E. 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

Summary of Lowest Observed Effect Levels for Key Lead-Induced Health Effects in Adults and Children@

BLL* (μg/dl)		HEALTH EFFECT
>100	Adults:	Encephopathic signs and symptoms
>80	Adults:	Anemia
	Children:	Encephopathic signs and symptoms Chronic nephropathy (aminoaciduria, etc)
>70	Adults:	Clinically evident peripheral neuropathy
	Children:	Colic and other Gastro-Intestinal (GI) symptoms
>60	Adults:	Female reproductive effects CNS symptoms: sleep disturbances, mood changes, memory and concentration problems, headache.
>50	Adults:	Decrease hemoglobin production Decreased performance on neurobehavioral tests Altered testicular function GI symptoms: abdominal pain, constipation, diarrhea, nausea, anorexia
	Children:	Peripheral neuropathy
>40	Adults:	Decrease peripheral nerve conduction Elevated blood pressure (white males, 40-59 years old) Chronic nephropathy
	Children:	Reduced hemoglobin synthesis
>25	Adults	Elevated zinc protoporphyrin levels in males
15-25	Adults	Elevated zinc protoporphyrin levels in females
	Children:	Decreased IQ and Growth
>10**	Fetus:	Pre-term Delivery Impaired Learning Reduced Birth Weight Impaired Mental Ability

@ Adopted from ATSDR[7], and Goldman et al.[26]

* Blood lead level (BLL) in micrograms per deciliter (μg/dl).

** "Safe" blood lead level have not been determined for fetuses.

APPENDIX 1

VACUUM CLEANING SPECIFICATIONS*

The following specifications may be used as a guide in selecting industrial vacuum cleaning equipment:

1. Hose and tools may be 1-1/2 inch or 2 inch. 1-1/2 inch equipment requires 75 CFM and 2 inch equipment requires 150 CFM per nozzle. The smaller hose is easier to use and less expensive but does not clean as fast.

2. The exhaust blower should be capable of developing about 1 inch of mercury (13.6 inches of water) static pressure at the cleaning nozzle.

3. The dust container should have adequate holding capacity so that it does not have to be emptied frequently.

4. The filter should be made of standard industrial filter cloth. The ratio of air to cloth should not exceed four to one.

5. An after-filter similar to HEPA filters should be used where toxic dusts such as lead are being handled.

*Adopted from NIOSH [1989].[25]

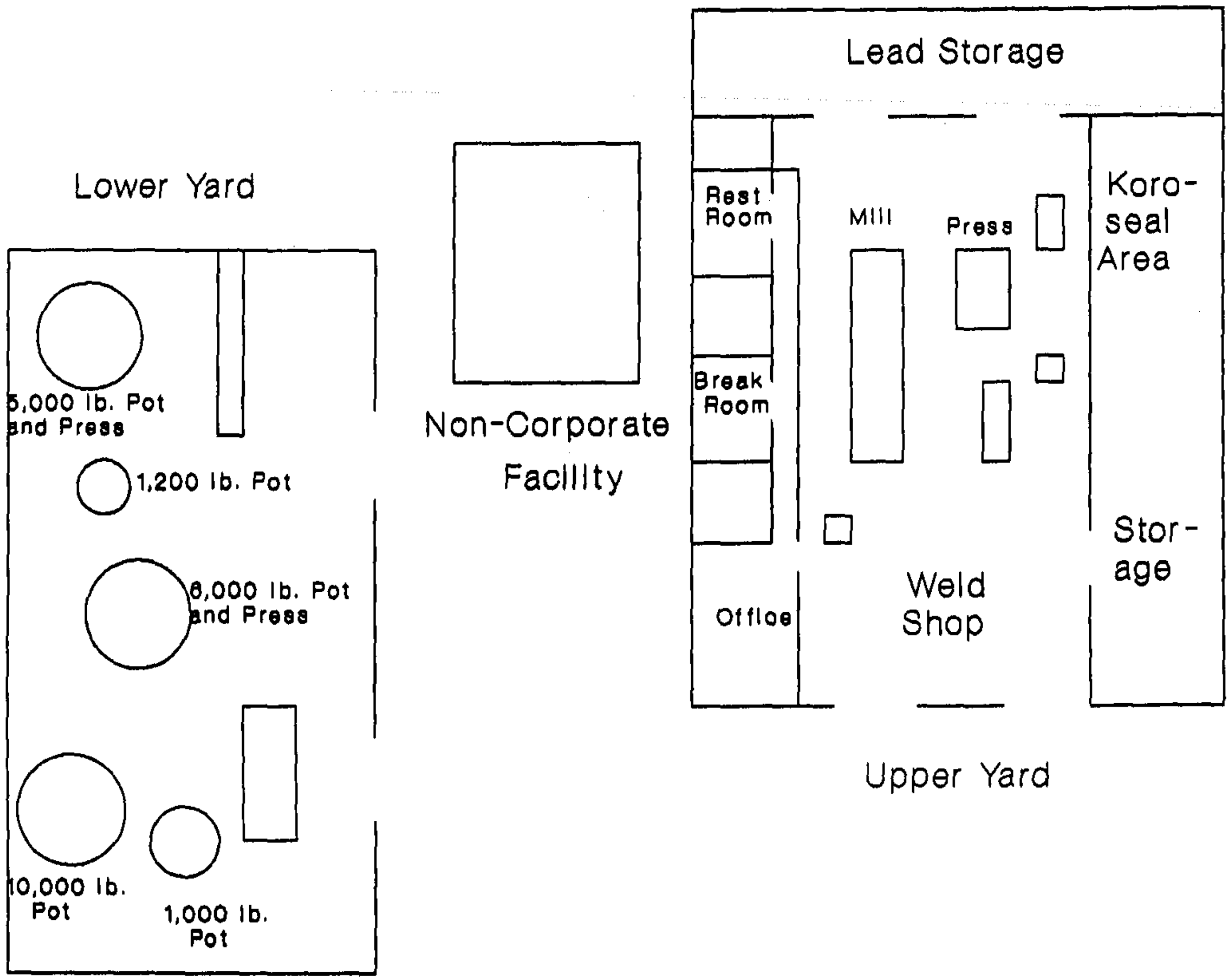

Figure 1. Schematic of Georgia Metals, Inc. (not to scale)