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PEERLESS ALLOY, INC.
DENVER, COLORADO

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I. SUMMARY

In July, 1989, the National Institute for Occupational Safety and Health (NIOSH) received a request from management to evaluate employee exposures to lead at Peerless Alloy Inc., Denver, Colorado. The company recovers lead from scrap metal and mixes this lead with high grade pure lead to manufacture leaded alloys. Small amounts of other metals are added to the lead to form the alloys. The request was made to determine if changes which were instituted by the company in response to measured elevated lead levels were effective in reducing exposures.

In August 1989, NIOSH investigators conducted an environmental survey at the facility. A review of the company's medical monitoring program was conducted. Under the program, workers have been extensively monitored for blood lead and one of the workers has been removed from lead-contaminated areas for medical reasons. A summary of the blood lead and zinc protoporphyrin (ZPP) values are included in this evaluation.

Personal breathing zone (PBZ) air samples were collected from all workers. These samples were analyzed for lead. An extensive metal analyses was performed on three of the most contaminated air samples. Lead was the only metal found on these samples in concentrations that would pose a health hazard. Traces of calcium, aluminum, iron, copper and magnesium were found. Airborne levels of lead ranged from below the laboratory limit of detection of 0.002 mg/filter to 0.05 mg/M^3. The average concentration was 0.02 mg/M^3. Company blood lead samples taken on all workers and analyzed for lead two weeks before the NIOSH evaluation showed the following levels; 5, 5, 10, 21, 28, 3l, 33, 33, 39, 40, and 63 ug/100g whole blood. NIOSH investigators did not conduct additional blood lead analyses.

All of the employees have a long tenure in this facility, and were unaware that a health hazard existed until OSHA performed a compliance inspection in the spring of 1989. OSHA found numerous violations of the lead standard. The company has been actively correcting areas that were out of compliance with the OSHA standard. None of the workers had medical problems or symptoms that they felt were work-related.

On the basis of data collected, the investigators concluded that a potential health hazard existed at the time of this survey from employees exposure to lead in the lead furnace areas of this operation. Employees in the oil press area were not overexposed. Recommendations designed to reduce exposures are included in this report.

KEY WORDS: SIC 3342 (Secondary Smelting and Refining of Nonferrous Metals) Lead, blood lead, FEP, Ventilation

II. INTRODUCTION

In July of 1989, NIOSH received a management request from Peerless Alloy Inc., Denver, Colorado, to evaluate exposure to lead in the lead furnace and lead press areas. The request was submitted to evaluate if changes which were instituted by the company in response to measured elevated lead levels were effective in reducing exposures.

On August 30, 1989, an evaluation was conducted at the facility. This survey consisted of: 1) obtaining background information on the facility and reviewing the OSHA citations relating to lead exposure, 2) collecting breathing zone air samples on all workers and also collecting time weighted air samples in the office and in the lunch room and 3) reviewing the company's medical data. The environmental data was relayed to the company by telephone upon receipt of the laboratory data on November 9, 1989.

III. BACKGROUND

This facility produces lead alloys and lead tubing. The alloys are produced and sold to various industries that produce lead products ranging from lead for ammunition to linotype lead. Most of the lead tubing is used for stained glass window assembly processes. The alloys are produced by heating the lead to melting temperatures, keeping the lead far below the boiling point of 1755° F. and then adding various amounts of trace metals such as aluminum, iron, magnesium and copper. Exposures are minimized by keeping the lead below the boiling point. In the production of the lead tubing or wire; large cylinders of lead are placed in oil presses and the lead is pressed through the extruder heads and packaged for sale. This process does not heat the lead and exposures are minimum. Good hygiene in this area eliminates most of the exposure. The company also melts down scrap material and recovers lead. This process was not in operation during the time of the NIOSH evaluation.

The alloy shop and the oil press extrusion shop are in separate areas of the plant. It would be possible for cross contamination to occur if lead becomes airborne.

Personal protective equipment which included respirators and work coveralls were provided. Shower facilities were also provided so that workers can shower and remove contaminated clothing before going home.

Monitoring of the employees blood lead was performed by a local physician every six months and monthly on those with excessive blood lead levels. Environmental surveys are conducted by a private consultant; however, these reports were not available.

IV. MATERIAL AND METHODS

On August 30, 1989, an environmental investigation was conducted to determine employee exposure to lead. During this survey, personal breathing zone (PZB) air samples were collected near the workers' breathing zone and general area air samples were collected in the office and lunch room areas. Samples were collected using battery-powered vacuum pumps operated at 2.0 liters per minute. The pumps were attached by Tygon tubing to the collection medium (37-millimeter (mm), 0.8 micron pore size, mixed-cellulose ester membrane filters contained in 3-piece plastic cassettes). The sampling media was worn for an entire work shift.

Samples were analyzed for lead by atomic absorption spectroscopy according to NIOSH method 7082.[1] In addition, three of the samples were analyzed for 30 trace metals using inductively coupled plasma-atomic emission spectroscopy in accordance with NIOSH method 7300.[1]

Blood lead and zinc protoporphyrin (ZPP) data which was obtained from the company, was reviewed and included in this report.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week, for a working lifetime, without experiencing adverse health effects. It is important, however, to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a preexisting medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects often are not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes and, thus, potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent becomes available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs), and 3) the U.S. Department of Labor/Occupational Safety and Health Administration (OSHA) occupational health standards [Permissible Exposure Limits (PELs)]. Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLVs usually are based on more recent information than are the OSHA standards. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that the company is required by the Occupational Safety and Health Administration to meet those levels specified in an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday.

A. Inorganic Lead

1. Toxicology

Inhalation (breathing) of lead dust and fume is the major route of lead exposure in the industrial setting. A secondary route 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 kidneys, peripheral and central nervous systems, and blood forming organs (bone marrow). Chronic lead exposure is associated with infertility and with fetal damage in pregnant women. There is some evidence that lead can also impair fertility in occupationally exposed men.[2]

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. Adults not exposed to lead at work usually have a blood lead concentration less than 30 ug/dl; the average is less than 15 ug/dl.[3,4] In 1985, the Centers for Disease Control (CDC) recommended 25 ug/dl as the highest acceptable blood level for young children.[5] Since the blood lead concentration of a fetus is similar to that of its mother, and since the fetus's brain is presumed to be at least as sensitive to the effect of lead as a child's, the CDC advised that a pregnant woman's blood lead level be below 25 ug/dl.[5] Recent evidence suggests that the fetus may be adversely affected at blood lead concentrations well below 25 ug/dl.[6] Furthermore, there is evidence to suggest that levels as low as 10.4 ug/dl affect the performance of children on educational attainment tests, and that there is a dose-response relationship with no evidence of threshold or safe level.[7] Lead levels between 40-60 ug/dl in lead-exposed

workers indicate excessive absorption of lead and may result in some adverse health effects. Levels of 60-100 ug/dl represent unacceptable elevations which may cause serious adverse health effects. Levels over 100 ug/dl are dangerous and require medical treatment.

Zinc protoporphyrin (ZPP) levels measure the effect of lead on heme synthetase, the last enzyme in heme synthesis. ZPP levels increase abruptly when blood lead levels reach about 35 ug/dl, and they tend to stay elevated for several months. A normal ZPP level is less than 50 ug/dl.[8]

2. Occupational Exposure Criteria

The current OSHA PEL for airborne lead is 50 ug/m^3 calculated as an 8-hour TWA for daily exposure.[9] In addition, the OSHA lead standard establishes an "action level" of 30 ug/m^3 TWA which initiates several requirements of the standard, including periodic exposure monitoring, medical surveillance, and training and education. For example, if an employer's initial determination shows that any employee may be exposed to over 30 ug/m^3, air monitoring must be performed every six months until the results show two consecutive levels of less than 30 ug/m^3 (measured at least seven days apart). The standard also dictates that workers with blood lead levels greater than 60 ug/dl, or averaging more than 50 ug/dl, must be removed from further lead exposure until the blood lead concentration is at or below 40 ug/dl. Removed workers have protection for wage, benefits, and seniority for up to 18 months until their blood levels decline to below 40 ug/dl and they can return to lead exposure areas.[9]

VI. RESULTS AND DISCUSSION

The results of the environmental survey are contained in Table l and 2. The lead concentration reported in Table 1 indicates exposure levels in the lead furnace area ranged from non-detected to 0.05 mg/M^3. The highest exposure level was measured in the office area, indicating lead contamination and thus potential lead exposure throughout the work area. Table 2 shows that lead concentrations in the oil press area ranged from 0.005 - 0.035 mg/M^3. All levels in this area were below the 0.05 mg/M^3 criteria.

Examination of the blood lead data collected by the company's consulting physician showed that one worker had been removed for medical reasons and to comply with the OSHA standard. Other blood lead levels are presented in Table 3.

VII. CONCLUSIONS

The environmental survey indicates that at the time of sampling one of ten samples was equal to the OSHA standard. The potential exists for other overexposures to occur under different operating conditions as the furnaces were not in full operation during this visit. Conditions may be different from an exposure standpoint if the plant was in full production.

The company's medical monitoring program is sufficient and complies with all provisions outlined in the OSHA standard. The results reviewed indicated 2 of the ten workers have blood lead levels that must be closley monitored. One worker had a blood level of 63, requiring medical removal; two others had blood levels of 40, requiring more frequent testing; another had an elevated ZPP, a medical (though not regulatory) reason for closer monitoring.

The exhaust ventilation over the main scrap furnace was operating effectively. Velocity measurements indicated about 1000 cubic feet per minute is drawn into the furnace. Leaks in the furnace were not observed. There is no other ventilation in the facility other that open doors and windows. This may cause elevated lead exposure during the cold weather when the building is secured and more airtight.

VIII. RECOMMENDATIONS

To ensure that workers are adequately protected from the adverse effects of lead, a comprehensive program of surveillance and prevention is needed. The guidelines for such a program are clearly presented in the OSHA lead standard.[9] 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.[9] 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.

A copy of the OSHA lead standard was provided to the employer and will not be repeated in detail in this report.

A. Air Monitoring

Periodic monitoring for airborne lead is needed to ensure that these controls operate effectively. Air monitoring can also be used to identify the need for further employee protection (i.e., respirators) in certain areas or during certain procedures. When airborne exposures are found to be above the OSHA action level of 30 ug/M^3, as was the case in this survey, 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.[9] Employees should be informed of the monitoring results.

B. Respiratory Protection

Due to their inherent limitations, respirators should not be considered a primary means of employee protection. A more appropriate means of exposure control in this instance would be properly designed engineering controls; i.e., local exhaust ventilation. However, the use of respiratory protection is a suitable means of exposure control in the event that engineering controls can not feasibly reduce the exposure levels. Respirators may also be used as a backup to existing engineering controls when substances of high toxicity are present. In order to ensure the effective use and function of the respirators, a comprehensive respiratory protection plan should be put in place. Such a program is outlined by the American National Standard Institute in the ANSI Standard Z88.6-1984.[18] 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, a copy of which has been provided to the employer.[10]

D. Personal Protective Clothing

Wherever lead dust is present, there is a possibility that the employee's skin and clothing may become contaminated. This can lead to 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. In one recent study, blood lead levels were found to be markedly higher in household members residing in homes of workers with occupational lead exposure compared to members of homes of people not occupationally exposed to lead.[11] In order to prevent this secondary source of lead exposure, the appropriate use of personal protective clothing is required.

E. Hygiene Facilities and Practices

A separate change room, free from lead contamination, should be provided to the employees to store their "street" clothing. Street clothing should be stored separately from clothing worn during work. If available, showers should be taken at the completion of the work shift to remove any lead that may have reached the employee's skin. Clothing worn at work, should not be worn home. Employees should carry necessary personal clothing and shoes home separately, and clean them carefully so as not to contaminate the home.[15]

Food, beverages, or tobacco should not be used or stored in lead contaminated areas. These items can become contaminated with lead and cause subsequent absorption of lead through ingestion or inhalation during eating, drinking, or smoking. Employees should also continue to eat their lunch in a lunchroom separate from the assay lab. All protective clothing should be removed prior to entering the lunchroom, and hands and face should be thoroughly washed.

F. Medical Monitoring

While the previously discussed NIOSH recommendations have been aimed at preventing or minimizing lead exposure, NIOSH believes that medical monitoring plays a necessary supplemental role in that it ensures that the other provisions of the program have effectively protected the individual. The OSHA standard for inorganic lead places significant emphasis on the medical surveillance of all workers exposed to levels of inorganic lead above the action level of 30 ug/M^3 TWA. Even with adequate worker education on the adverse health effects of lead and appropriate training in work practices, personal hygiene and other control measures, the physician has a primary responsibility for evaluating potential lead toxicity in the worker. It is only through a careful and detailed medical and work history, physical examinations to rule out other potential causes of symptoms, and appropriate laboratory testing that an accurate assessment can be made. Many of the adverse health effects of lead toxicity are either irreversible or only partially reversible and therefore early detection is very important.[9]

The OSHA lead standard provides detailed guidelines on the frequency of medical monitoring, the important elements in medical histories and physical examinations as they relate to lead, and the appropriate laboratory testing for evaluating lead exposure and toxicity. This standard should be consulted by plant management and the local physician for guidance in carrying out an ongoing medical monitoring program.[9]

G. Ventilation

Consideration should be given to installing a general ventilation system for the facility including provision for make-up air. General ventilation should help reduce overall lead levels in the facility. In addition a make-up air system should increase the overall efficiency of the local exhaust system for the furnace.

IX. REFERENCES

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XI. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Hazard Evaluations and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Services (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from the NIOSH publications office at the Cincinnati, address. Copies of this report have been sent to:

A. Blue Range Engineering, Butte, Montana
B. Occupational Safety and Health Administration - Region VIII
C. Montana Department of Health
D. 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

BREATHING ZONE AND GENERAL ROOM AIR CONCENTRATIONS
OF LEAD, ZINC, AND ALUMINUM

Peerless Alloy Co., Denver, Colorado

August 30, 1989

SAMPLE No.	JOB/AREA	SAMPLING TIME	mg/M^3 LEAD	ZINC	ALUMINUM
12	Lunch Room/Geneal Area	7:50A-3:30P	*	*	0.01
02	Casting zinc/Personal	7:45-3:50	0.02	0.01	0.01
03	Casting line/Personal	7:43-3:30	0.02	0.01	0.01
01	Casting pot/Personal	7:58-3:30	*	*	0.005
06	Casting pot/Personal	8:00-9:45	*	*	0.02
11	Casting Pot/Personal	8:00-11:10	0.04	0.007	0.02
10	Office/General Area	9:00-3:30	0.05	0.006	0.007
Evaluation Criteria			0.05	5.0	**
Laboratory limit of detection mg/filter =			0.001	0.0004	0.004

* - Below detection limits
** - No evaluation criteria

TABLE 2

BREATHING ZONE AND GENERAL ROOM AIR CONCENTRATIONS
OF COPPER, IRON, MAGNESIUM LEAD, AND ZINC

Peerless Alloy Co., Denver, Colorado

August 30, 1989

Sample	Job	Area	Sampling time	Cu	Fe	Mg	Pb	Zn
						mg/M^3		
08	Lead Person	all	7:30-3:30	*	0.006	0.002	0.015	0.002
04	Oil mechanic	all	7:30-3:30	0.002	0.02	0.003	0.035	0.02
24	Oil mechanic	all	7:55-3:30	*	0.003	*	0.005	*
Evaluation Criteria				1	5	10	0.05	**
Laboratory limit of detection mg/sample				0.001	.001	0.002	0.002	0.001

* Below laboratory limit of detection

** No evaluation criteria

Table 3

WORKERS BLOOD LEAD AND ZINC PROTOPORPHYRIN (ZPP) LEVELS

(Taken by Company Consultant)

DATE	JOB	BLOOD LEAD(ug/dl)	ZPP
3/02/89	Office Worker	5	7
3/02/89	Lead Worker	21	28
3/02/89	Lead Worker	10	24
3/11/89	Lead Worker	5	51
3/02/89	Lead Worker	28	35
6/22/89	Lead Worker	63	430
5/02/89	Lead Worker	40	33
3/02/89	Lead Worker	33	116
6/22/89	Lead Worker	33	30
3/02/89	Lead Worker	40	27
3/02/89	Lead Worker	31	33
3/02/89	Lead Worker	39	48