WALK-THROUGH SURVEY REPORT:

CONTROL TECHNOLOGY FOR METAL RECLAMATION INDUSTRIES

at

Quemetco, Inc.
Indianapolis, Indiana

REPORT WRITTEN BY:
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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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Division of Physical Sciences and Engineering
Engineering Control Technology Branch
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SIC CODE:	3341
SURVEY DATE:	February 24, 1993
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DISCLAIMER

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), a federal agency located in the Centers for Disease Control and Prevention under the Department of Health and Human Services, was established by the Occupational Safety and Health Act of 1970. This legislation mandated NIOSH to conduct research and education programs separate from the standard setting and enforcement functions conducted by the Occupational Safety and Health Administration (OSHA) in the Department of Labor. An important area of NIOSH research deals with methods for controlling occupational exposure to potential chemical and physical hazards.

The Engineering Control Technology Branch (ECTB) of the Division of Physical Sciences and Engineering has been given the lead within NIOSH to study and develop engineering controls and assess their impact on reducing occupational illness and injury. Since 1976, ECTB has conducted a large number of studies to evaluate engineering control technology based upon industry, process, or control technique. The objective of each of these studies has been to document and evaluate control techniques and to determine their effectiveness in reducing potential health hazards in an industry or at specific processes.

This study of metal reclamation is being undertaken by ECTB to provide control technology information for preventing occupational disease in this industry. The goal of this research study is to identify, evaluate, and disseminate practical and cost-effective control methods which reduce exposures to lead. The study will be accomplished by identifying and evaluating existing control methods used in metal reclamation industries. The results of these field evaluations will be presented in in-depth survey reports. The information on control methods will be disseminated in scientific journal articles, trade journal articles, and in handbooks for use by workers, owners, and operators, OSHA consultation programs, and other safety and health professionals.

As part of this overall study, a walk-through survey was conducted at Quemetco, Inc., Indiana Operations. The purpose of this survey was to identify potentially effective control systems including work practices and to familiarize NIOSH researchers with the processes and potential exposures and health risks in secondary lead smelters (battery reclamation).

POTENTIAL HAZARDS

Workers in this secondary lead smelter are potentially exposed to lead and arsenic.

Lead

Lead adversely affects a number of organs and systems. The four major target organs and systems are the central nervous system, the peripheral nervous system, the kidney, and the hematopoietic (blood-forming) system.[1] Inhalation or ingestion of inorganic lead can cause a range of symptoms and signs including loss of appetite, metallic taste in the mouth, constipation, nausea, colic, pallor, a blue line on the gums, malaise, weakness, insomnia, headache, irritability, muscle and joint pains, fine tremors, and encephalopathy. Lead exposure can result in a weakness in the muscles known as "wrist drop," anemia (due to shorter red blood cell life and interference with the heme synthesis), proximal kidney tubule damage, and chronic kidney disease.[2,3] Lead exposure is associated with fetal damage in pregnant women.[1-3] Finally, elevated blood pressure has been positively related to blood lead levels.[4,5]

Inorganic Arsenic

Inorganic arsenic is strongly implicated in respiratory tract and skin cancer and has been determined to be a potential occupational carcinogen by NIOSH.[6,7] Inorganic arsenic has caused peripheral nerve inflammation (neuritis) and degeneration (neuropathy), anemia, reduced peripheral circulation, and increased mortality due to cardiovascular failure in workers who have been exposed to inorganic arsenic through inhalation, ingestion, or dermal exposure.[3]

PLANT DESCRIPTION

Quemetco, Inc. is a secondary lead smelter that operates 365 days a year, 24 hours a day. The facility recycles approximately 30,000 batteries a day. Spent batteries are purchased and brought to the recycling facility by commercial trucks.

Batteries recycled by the plant consist mainly of automobile batteries. Lead and plastic from spent batteries are reclaimed. The lead is recycled on-site by Quemetco, Inc. The plastic (polypropylene) is washed and placed in commercial trailers to be transported to plastic recycling facilities. The reclaimed lead is sold to industries that use it in manufacturing various products.

PROCESS DESCRIPTION

Trucks are received at the plant by scheduled appointments. The trucks back up to the battery breaking area to be unloaded. Batteries are removed from trucks by hand and placed on a roller conveyor which feeds the batteries to a battery puncher. The battery puncher places holes in the bottom of the battery and allows the electrolyte to drain out. The electrolyte is used in the battery reclamation process to remove sulfur. After the electrolyte is used in the battery reclamation process, it is neutralized, sent through a filter press, and sent to the water treatment facility. The battery breaking operation is automated. Batteries go through a crusher roll and are shredded. The shredded pieces go to a flotation separator were the lead, plastic, and hard rubber are separated. Plastic is washed and blown into the back of a commercial trailer. The commercial trailer then takes the plastic to a plastic recycling facility. The hard rubber goes to a storage bin where it is later fed to the reverbatory furnace. Wet lead-bearing material is conveyed out of the flotation separator and dropped on the floor. A front-end loader picks up the wet lead-bearing material and drops it in a hopper. The wet lead-bearing material is conveyed out of the hopper into a kiln where it is dried. After the lead-bearing material is completely dried, it is conveyed into the reverbatory furnace (operating at 2400 °F) and melted down into elemental lead. Slag drains out of the furnace into molds that are located on a conveyor. The conveyor then transports the molds (full of slag) to a bin room where water is used to cool the slag. The slag is then transported to a hopper and conveyed to another kiln and dried. The slag is then fed to the electric arc furnace (operating at 2200-3000 °F). Lead is tapped off the electric arc furnace and is sent back to the refinery pots. Slag is tapped off into a slag caster (mold) and is allowed to cool. After the slag cools, it is disposed of in a landfill as a nonhazardous waste. Elemental lead is directly poured from the reverbatory furnace into one of the eight refinery alloy pots or is poured into a 4000-pound mold and placed in storage. Caustic soda, nitrate of soda, powdered sulfur, and red phosphorus are used in the treatment of lead in the refinery process.[8] The lead in the refinery process is agitated, skimmed, and drossed. Depending on the antimony, arsenic, or tin content, the lead is alloyed (according to specifications) into hard lead or soft lead.[8] The lead is then pumped from the refinery alloy pots to a casting machine or is cast into 2000-pound blocks. The casting machine consists of a heated ladle that pours three pigs (25-75 pounds) at a time. Pigs are transported on a roll conveyor to an automatic binding machine where they are bound and placed in storage until shipment.

CONTROL TECHNOLOGY

PRINCIPLES OF CONTROL

Occupational exposures can be controlled by the application of a number of well-known principles including engineering measures, work practices, and personal protection. Engineering measures are the preferred and most effective means of control. These include material substitution, process and equipment modification, isolation and automation, and local and general ventilation. Control measures also may include good work practices and personal hygiene, housekeeping, administrative controls, and use of personal protective equipment such as respirators, gloves, goggles, and aprons.

ENGINEERING CONTROLS

Quemetco, Inc. employs local exhaust ventilation, partial enclosures, and enclosed ventilation systems in the reverbatory furnace operations, electric arc furnace operations, and casting and refinery area. In addition, HEPA-filtered half-mask and full-face negative pressure respirators and full-face and PAPR (with HEPA filters) positive pressure respirators are worn in production areas of the plant.

The battery breaking operation is an automated system that shreds the batteries whole, then feeds the material to a flotation separator. The flotation separator is an automated system that separates the lead-bearing material, rubber pieces, and plastics. The lead-bearing material is picked up with a front-end loader that is equipped with an enclosed air-conditioned cab. The feed hopper is enclosed with a ventilated booth. A totally enclosed conveyor feeds the material from the feed hopper to the kiln. A totally enclosed conveyor feeds the dried lead material from the kiln to the reverbatory furnace. The reverbatory furnace has ventilation systems on the feed chute, lead trough, lead well, slag tap, slag caster, and where hog molds (2000 pounds) are poured. The reverbatory furnace also is enclosed with a ventilation system that exhausts 40,000 cfm of air from around the furnace in order to collect fine particles that are emitted through the bricks (located on the furnace). In the refinery area, canopy hoods cover the top of each of the refinery and alloy pots. The refinery and alloy pots are equipped with automated skimmers that remove approximately 90-95% of the dross off the top of the lead in the pots. Workers use a shovel to remove the other 5-10%. A dross pan (one located at each refinery and alloy pot) collects the dross that is skimmed off the lead. The dross pan is located in an enclosed ventilated booth. A pump is used to pump lead from the refinery alloy pots to a casting machine. An automated stacking and banding machine is used to stack and bind the pigs. At the facility, there are eight bag houses (equipped with high efficiency filters) that handle 320,000 cfm of exhaust air. A separate bag house is used to filter 200,000 cfm of general ventilation air from inside the plant. Air that flows into the bag house goes through bag filters before being released into the atmosphere.

RESPIRATOR PROTECTION PROGRAM

A respirator protection program, that has been set up according to Indiana Occupational Safety and Health Administration's (IOSHA) lead standard, is in place at the facility. This program was set up to reduce employee exposure to lead to below the mandated PEL.

The following guidelines for respirator protection requirements are outlined in the plant respirator protection segment of the IOSHA lead standard compliance program.[8] Employees in the plant that are exposed to air lead levels less than 500 $\mu g/m^3$ are required to wear half-mask, air-purifying respirators with HEPA filters. Employees exposed to air lead levels greater than 500 $\mu g/m^3$ and less than 2500 $\mu g/m^3$ are required to wear full-face, air-purifying respirators with HEPA filters. Employees exposed to levels greater than 2500 $\mu g/m^3$ and less than 50,000 $\mu g/m^3$ must wear a powered, air-purifying respirator with HEPA filters or a supplied-air, half-mask respirator operated in the positive pressure mode. Employees exposed to greater than 50,000 $\mu g/m^3$, but less than 100,000 $\mu g/m^3$, must wear supplied-air respirators (equipped with full facepiece, hood, helmet, or suit) operated in a positive pressure mode. Employees with exposures greater than 100,000 $\mu g/m^3$ or unknown concentrations or during firefighting must wear a full facepiece Self-Contained Breathing Apparatus (SCBA) operated in positive pressure mode.

All new employees that have the potential to be exposed to lead above the action level of 30 $\mu g/m^3$ receive a qualitative fit test prior to entering exposure areas. Quantitative fit testing is performed on all employees that wear negative pressure, air-purifying respirators. A Dynatech Frontier System 1000/2000 is used to quantitatively fit test employees. An initial fit test is performed for all employees and each employee receives a semi-annual test thereafter.[8] Employees required to wear respirators receive respirator protection training. Respirator protection training elements are outlined in the company's IOSHA Lead Standard Compliance Program.[8]

WORK PRACTICES AND HYGIENE

Quemetco, Inc. has strict policies on personal hygiene. When employees arrive at work, they enter the clean area of the locker room where they are supplied a clean uniform and a clean respirator for the day. After the work shift, employees enter the dirty side of the locker room where they remove the dirty uniform. Respirators are not removed until the employee leaves the dirty side of the locker room. Uniforms are laundered on-site everyday so that clean ones are provided for each shift. Respirators are also cleaned after each shift. Mandatory showers are taken by each employee before entering the clean side of the locker room. No eating is permitted in the work areas. Smoking is permitted only in the parking lot after employee showers and changes out of the uniform into street clothes. Employees vacuum clothes and wash their hands and face thoroughly before entering the break room. Employees must change excessively dirty uniforms before entry into lunchroom. No tools or safety equipment may be brought into the lunchroom. Disposable table covers are changed after each lunch shift and break period. Lunchrooms and locker rooms have HEPA-filtered ventilation systems. Employees are trained to stay out of dirty areas of the plant (if possible) in order to help reduce their air lead exposures.

INCENTIVE PROGRAMS

In an effort to reduce blood lead levels and promote good personal hygiene and work practices among employees, Quemetco, Inc. has incentive bonus programs in place at the plant.

At the time of our survey, an employee with no unexcused absences and a blood lead level (BLL) below 34 μg/100 g for a 13-week period receives a bonus of $500. If the employee has a BLL below 34 μg/100 g for a 26-week period, an additional $500 bonus is awarded. An additional $700 is rewarded to the employee if their BLL is below 34 μg/100 g for a 39-week period. If the employee has a BLL below 34 μg/100 g for a total of 52 weeks, an additional bonus of $800 is rewarded. If the plant has maintained the number of samples of all employees below a specified target level, each employee will receive an additional 10% of bonus money they earned over the past 12 months.[9] In June of 1993, the target BLL for the incentive program was lowered to 29 μg/100 g.

The plant also sponsors a program to test the BLLs of children of employees. Employees and their children are encouraged to participate in the program. Gift certificates are awarded to the families who participate in the program. In the small percentage of cases where BLLs were above 20 μg/100 g, they investigated the worker's residence to identify the source of lead exposure. Lead paint was found in some cases in the home, but other exposures have been caused by lead contamination of car interiors from dust at the plant. The company has implemented various hygiene programs to reduce the possibility of this contamination. A few of the hygiene programs implemented at the plant to control take-home lead include locker rooms (equipped with a clean and a dirty side), mandatory showers, vacuum cleaners installed in the parking lot (to clean car interiors), and the BLL program for children of employees.

AIR MONITORING

The company has their own air monitoring program that consists of personal air sampling conducted at the plant. Averages of the personal exposure lead data (for 1992 and the first quarter of 1993) were calculated for the departments in the plant. These averages for lead ranged from 17-639 $\mu g/m^3$. Averages of the personal exposure lead data are listed by department in Table 1.

Table 1. Averages of Personal Exposure Lead Data.

Department	Lead Exposure Data $\mu g/m^3$
Bag House	402
Battery Wrecker	314
Electric Furnace	384
Laboratory	17
Maintenance	113
Refinery	428
Reverb	639
Sanitation	90
Shipping	93
Water Treatment	21

Averages for arsenic air sampling data in the plant (for 1992 and the first quarter of 1993) were collected. Arsenic air sampling averaged 2 $\mu g/m^3$, with a range from 0-44 $\mu g/m^3$ for the various departments in the plant.

PERSONAL PROTECTIVE EQUIPMENT

Half-mask, full-face, and PAPR respirators (with HEPA filters) or supplied-air respirators and uniforms are worn by employees in all production areas of the plant. In addition, hearing protection, hard hats, safety shoes, safety glasses, face shields, and gloves are worn by employees in production areas. Face shields and heat protective clothing are worn during furnace operations and casting and alloy pot operations.

CONCLUSIONS AND RECOMMENDATIONS

Workers throughout the production areas of the plant are potentially exposed to high concentrations of lead and arsenic. Quemetco, Inc. employs local exhaust ventilation, enclosed ventilated booths, partial enclosures, and automated operations throughout production areas of the plant. Various occupational health and safety programs are in place at the plant including occupational health and safety training, respirator protection program, various hygiene programs, and blood lead monitoring programs.

Further evaluation of the air lead data (collected during the walk-through survey) will be conducted. The results of the air lead data will be compared to other air lead data collected in the industry. The results of this data will be used to identify plants with the most effective controls for in-depth evaluation. Blood lead data (BLL) collected during this walk-through will be evaluated and compared to other BLL collected in the industry. The results of the BLL will be used to identify plants in the industry with the most effective occupational programs.

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