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Case Studies

Lead Exposure During Lining of Tanks with Lead Sheeting

Dawn Tharr, Column Editor

Case Reported by Charles McCammon, William Daniels, Thomas Hales, and Steve Lee

Background

On July 5, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request to conduct a health hazard evaluation (HHE) at a construction site in Salt Lake City, Utah. The requestor was concerned about lead exposure among workers who installed lead sheeting in large steel vessels.

On July 10, an environmental and medical evaluation was conducted at the Salt Lake City location. Environmental samples were collected for lead, hydrogen chloride, noise, and temperature. An occupational physician 1) distributed a symptom questionnaire, 2) interviewed employees, and 3) collected blood specimens to determine lead and zinc protoporphyrin (ZPP) levels. A follow-up environmental and medical evaluation was conducted on September 26, 1991, to determine the effectiveness of the changes in engineering controls, work practices, and personal protective equipment put in place after the initial NIOSH visit.

Process Description

The employees working at the Salt Lake City location are members of Lead Burners Local 153, headquartered in North Carolina. There are about 100 members of the local who travel across the country to various jobs which may last a week to several months. All of these jobs generally involve some degree of lead exposure.

The specific job in Salt Lake City involved the lining of two 85-foot long, 14.5-foot diameter steel tanks with lead sheets. The tanks being lined were to be used for the processing of copper ores where acids are used to extract the metal from the ore. The purpose of the lead lining in the tanks was to provide an acid-resistant coating. Lead sheets (18 inches by 48 inches by 5⁄16 inch thick) were bonded to the steel tank, and the 0.5-inch wide seams between the sheets were filled-in with lead to the same depth. All areas around the intakes to the tanks (nozzles) had to be covered with an 8-inch diameter homogeneous layer of melted lead. The job of lining a tank with lead involved three steps: grinding, tinning, and bonding/burning.

The first step involved grinding the inside surface of the tank down to bare metal. These ground areas then had to be soldered quickly in order to avoid reoxidation of the steel. The term "tinning" is derived from the solder used on the newly ground surfaces which contained a mixture of lead and tin diluted in muriatic acid. The surface to be soldered was first generally heated for 30 minutes with gas-fired torches. When the tank surface was hot, the specific area to be soldered was directly heated with a hand-held torch, the solder applied, and the excess wiped off. This was repeated until a uniform coating of solder covered the newly ground areas. Once the outline for the lead sheets had been tinned, the lead sheets were laid in place and bonded to the seam. This was accomplished by simply melting the edge of the lead sheet to the soldered area. The seam left between the juncture of two sheets was filled to a uniform depth by melting lead rods and dripping the material into the seam. This was referred to as "lead burning." Those areas that required homogeneous linings with lead were completely filled in by lead burning.

Methods

Environmental

On July 10, 1991, an environmental survey was conducted to determine employee exposures to lead, trace metals, noise, and acid gases. During this survey, personal breathing zone (PBZ) air samples were collected near the workers' breathing zone for lead and trace metals, and general area air samples were collected at locations throughout the work area. Samples were obtained using battery-powered sampling pumps operating at 2.0 liters of air per minute and collected on 37-mm, 0.8-μm pore size, mixed-cellulose ester membrane filters. The sampling media for the personal samples were replaced between each break during the work shift (except during the tinning operation). Wipe samples for lead contamination were collected on table and floor surfaces and on workers' clothing and cars using the same 37-mm filter media that had been wetted with isopropyl alcohol.

The air and wipe samples were analyzed for lead by atomic absorption spectroscopy according to NIOSH Method 7082.[1] In addition, the samples collected during grinding and tinning operations were analyzed for 30 trace metals using inductively coupled plasma–atomic emission spectroscopy in accordance with NIOSH Method 7300.[1]

Area samples were collected for hydrogen chloride (hydrochloride acid) using Draeger #1/a Hydrogen Chloride (HCl) indicator tubes as per the manufacturer's instructions. The measurement range on these tubes was 0–10 ppm for HCl.

Sound level measurements were determined with a general sound level meter. All measurements were made on the A-scale, with slow response. The calibration of the sound level meter was checked just prior to use. Limited personal monitoring for noise was conducted using personal noise dosimeters, which were also calibrated just prior to and after use.

On July 18, a return visit was made to collect additional wipe samples from previously sampled surfaces and to perform personal noise monitoring. The same noise dosimeters were used. The wipe samples were collected with a baby wipe (Scott Paper Company Wash a-bye Baby) which had been tested by other NIOSH personnel and shown to contain very low levels of background lead contamination. The samples were analyzed according to NIOSH Method 7802.(1)

Medical

On July 10, 1991, employees working the day and evening shifts completed a symptom questionnaire designed to elicit symptoms of lead poisoning and were interviewed by an occupational physician, who also obtained a blood sample for lead and zinc protoporphyrin (ZPP) determination. Sixteen employees and the one job superintendent participated in the survey, for a total of 17 participants.

The blood leads and ZPPs were analyzed by a laboratory approved for blood lead analysis by the Occupational Safety and Health Administration (OSHA) based on proficiency testing.(2) The blood leads were determined utilizing anodic stripping voltimetry, and ZPPs were determined by photofluormetric techniques.(3) The 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.

Results

Time-weighted average (TWA) exposures for lead ranged from 141 to 307 μg of lead per cubic meters of air (μg/m^3). These concentrations are above the OSHA Permissible Exposure Limit (PEL) of 50 μg/m^3 as an 8-hour TWA. The short-term lead concentrations for the three major jobs ranged from 215 to 307 μg/m^3 during lead burning, 280–390 μg/m^3 during tinning, and from 27 to 42 μg/m^3 for grinding. The employees were wearing both full- and half-mask air purifying respirators; therefore, the actual exposures may have been less than these values, provided that the respirators were properly fitted and maintained. Wipe sampling revealed the presence of lead contamination on table surfaces in the lunchroom, on workers' clothes and shoes which they wore home, in the workers' cars, and on the floor of the change room. Detector tube samples showed hydrogen chloride levels from 3 to >10 ppm. The results of area air samples analyzed for trace metals revealed that no other metals were present in significant amounts when compared to their exposure criteria. Average noise levels for all jobs were greater than 90 dB(A). Dry bulb temperatures ranged from 115° to 125°F during tinning operations.

All 17 of the employees working the day and evening shifts on July 10, 1991, completed the symptom questionnaire and provided a blood specimen. No employees reported symptoms suggestive of lead poisoning. The mean blood lead level was 34 μg/100 grams whole blood (range, 11–77 μg/100 grams whole blood). Two employees (12%) had blood lead levels over 50 μg/100 grams whole blood, the level requiring medical removal from areas where lead exceeds 30 μg/m^3 by the OSHA lead standard. The mean ZPP level was 58 μg/dl (range, 26–139 μg/dl). Seven employees (41%) had ZPP levels above the upper limit of normal (> 50 μg/dl).

Conclusions

The environmental sampling indicated that exposure to lead was consistently in excess of the OSHA PEL of 50 μg/m^3 for general industry. Although this work was considered construction, the State of Utah had recently (July 15, 1991) eliminated the construction exemption from their state lead plan, thus, requiring all exposures to lead be consistent with the OSHA general industry lead standard, i.e., 50 μg/m^3. Noise levels were also consistently above the OSHA 8-hour limit of 90 db(A); thus, the company needed to comply fully with the hearing conservation standard.

Many deficiencies were noted in the company's respirator program (routine fit testing, training of employees on use and care, proper cleaning procedures, and any medical testing for ability to wear respirators). The workers wore street clothes and boots home although some wore Tyvek suits over their work clothes. No change room or shower facilities were available. Wipe sampling indicated contamination of the lunch room, work clothes, and worker vehicles. Employees often ate or smoked without first washing. Limited wash facilities were available to the workers.

Numerous recommendations were made to the company relative to coming into compliance with the general industry lead standard, the respirator standard, and the hearing conservation standard. It was also recommended that they develop a heat stress program and a confined space entry program.(4)

Follow-up Evaluation

A follow-up site visit with environmental and medical monitoring was conducted on September 26, 1991. Since the previous NIOSH site visit, the company had made many changes including the addition of a change room/shower trailer, separate work clothes for all employees, the addition of air-supplied hood respirators in both tanks, additional training on lead and respirators, additional ventilation on the tanks, and more air and blood monitoring. The overall blood levels were reduced to an average of 22 μg/100 grams of whole blood (range, 4–39 μg/100 grams). All employees retested (including one of the individuals initially over 50 μg/100 grams) had lower blood lead levels as compared to the initial NIOSH visit and no employees were over 50 μg/100 grams of whole blood. Environmental results are not yet available.

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