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ALUMINUM COMPANY OF AMERICA
POINT COMFORT, TEXAS

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SUMMARY

In September 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Mine Safety and Health Administration (MSHA) for technical assistance in evaluating workers' potential exposure to mercury at the Aluminum Company of America's (ALCOA) alumina plant located in Point Comfort, Texas. On October 14-15, 1992, investigators from NIOSH conducted a site visit, during which plant processes and potential sources of mercury exposure were reviewed, and urine samples were collected to assess biological absorption of mercury among workers thought to have the greatest potential for mercury exposure.

The industrial hygiene investigation included a review of general work practices and worker activities, and area air sampling at various locations throughout the plant. In all areas sampled, mercury concentrations measured by an Arizona Instruments Corporation Gold Film Mercury Analyzer, Model 411, ranged from none detected to 0.004 milligrams per cubic meter (mg/m^3). For comparison, the NIOSH Recommended Exposure Limit (REL) to mercury vapor is 0.050 mg/m^3. The highest concentration measured during the survey (0.004 mg/m^3) represents approximately 1/12 of the REL.

Biologic monitoring was performed on 30 workers identified as being most likely to be occupationally exposed to mercury. Levels of inorganic mercury, total mercury, and creatinine were measured in urine samples from each participant. Total mercury was analyzed using a cold vapor atomic absorption technique which has a limit of detection of four micrograms per liter (ug/L). Inorganic mercury was analyzed using the same basic method, with a modified sample digestion procedure to eliminate the organo-mercury compounds.

None of the workers tested had detectable levels of inorganic mercury in the urine. Five workers had detectable total mercury in the urine. All of these were below 10 ug/L, and all were below 13 ug/g creatinine. These levels are well below the WHO recommended and ACGIH proposed guidelines (50 micrograms per gram creatinine (ug/g creatinine) and 35 ug/g creatinine, respectively) for inorganic mercury in the urine.

Analysis of urine samples of 30 production workers at the ALCOA Point Comfort plant revealed no detectable levels of inorganic mercury. The NIOSH investigators conclude that production workers tested at the ALCOA Point Comfort plant have not had mercury exposure above usual background levels within the past two to four months. The NIOSH investigators recommend that proper industrial hygiene practices be followed to prevent potential over-exposure to mercury in the future.

KEYWORDS: SIC 2819 (Industrial Inorganic Chemicals, Not Elsewhere Classified), mercury, urine mercury levels, biological monitoring, alumina production.

INTRODUCTION

On September 18, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Mine Safety and Health Administration (MSHA) for technical assistance in evaluating workers' potential exposure to mercury at the Aluminum Company of America's (ALCOA) alumina plant located in Point Comfort, Texas. On October 14-15, 1992, investigators from NIOSH conducted a site visit, during which plant processes and potential sources of mercury exposure were reviewed, and urine samples were collected to assess biological absorption of mercury among workers thought to have the greatest potential for mercury exposure. This report will discuss the purpose, methods and results of the NIOSH investigation.

BACKGROUND

The ALCOA Point Comfort plant produces alumina from bauxite ore. Four million metric tons of bauxite ore are processed per year utilizing a high- and low-temperature digestion process. The bulk of the bauxite (Boke ore) is imported from Western Africa. According to MSHA data, Boke ore contains approximately 0.11 micrograms (ug) of mercury (Hg) per gram (g) of ore.

Within the Point Comfort plant is a warehouse, building R-300, which is the site of a chloralkali facility which ceased operation in 1979. It was in this warehouse that MSHA observed visible mercury contamination on the ground while investigating a hazard complaint at the plant. Building R-300 is open on three sides, and is primarily used for storage. Few workers spend brief periods of time delivering or picking up materials from R-300. In the course of their investigation, MSHA reviewed other areas of the plant, primarily in the digestion department, where mercury accumulates. These areas include building R-30, where mercury accumulates in heaters and traps, and building R-25, where mercury also accumulates in traps. Operators and maintenance personnel in these areas, particularly the heater cleaners, were identified as being potentially exposed to mercury.

MSHA performed an extensive industrial hygiene survey of the plant in August and September, 1992, utilizing area sampling. This survey revealed detectable mercury vapor in several areas, with the highest levels being found in the R-25 and R-30 areas. Because of these findings, which suggested potential worker exposure to mercury, MSHA requested technical assistance from NIOSH in conducting medical evaluations of potentially exposed workers.

METHODS

Industrial Hygiene

The industrial hygiene investigation included a review of general work practices and worker activities, and area air sampling at various locations throughout the plant. The industrial facility was toured to observe plant processes specifically related to potential mercury contamination. Worker activities were also observed to determine the job classifications of individuals working in and around mercury contamination and the specific job activities which might elevate individual risk of exposure.

Area sampling was accomplished with an Arizona Instruments Corporation Gold Film Mercury Vapor Analyzer, Model 411. This device was calibrated prior to and after the site survey using calibration procedures specified by the manufacturer. Samples were taken in several areas in the alumina production plant. Area samples were taken at locations in the digestion process where the naturally occurring mercury in the raw bauxite was concentrated and trapped along the steam lines. Additionally, samples were taken at several locations in the plant to determine the extent of mercury cross contamination. These locations included personal clothing, workboots, tool boxes, breakrooms and wash areas.

Medical

In order to determine if over-exposure to mercury was occurring, we performed biologic monitoring on 30 workers identified as being most likely to be occupationally exposed to mercury. This group of workers was identified after plant processes and MSHA industrial hygiene sampling data were reviewed and through discussions with MSHA, management, and union representatives. Agreement was reached that workers from the digestion department, particularly R-30, had the greatest risk for exposure to mercury. All seven of the heater cleaners who were working the day of the survey were included in the survey. Other workers in R-30 who were surveyed included area operators, general maintenance personnel, scalers, a senior operator, and an electrician. R-300, the warehouse, was determined to pose less of a mercury exposure risk, as worker presence in that area was minimal. In addition to the 30 workers mentioned above, a group of five other employees who worked in various areas of the plant were chosen to participate in the study. These employees were judged to have minimal or no exposure to mercury and were included to provide a sample of "background" levels of urine mercury.

On October 14, 1992, NIOSH personnel held a meeting with workers chosen to participate in the survey. At this meeting the purpose of the investigation was explained, consent was obtained, and self-administered questionnaires were filled out. All 35 workers completed the questionnaires. The questionnaires provided identifying information, a brief work history, and questions pertaining to possible non-occupational mercury exposures which might influence mercury testing results, such as recent fish ingestion and dental work.

Participants were given urine specimen containers the evening of October 14; they returned the urine samples the morning of October 15 prior to entering the plant. The urine samples were first void samples. Two of the 35 participants did not pick up their specimen bottles in the evening but did provide urine samples (not first void) before entering the plant on the morning of the 15th.

Levels of inorganic mercury, total mercury, and creatinine were measured in each sample. Creatinine is used to correct for normal variation in degree of dilution of urine by the kidney. Total mercury was analyzed by a NIOSH contract laboratory using a cold vapor atomic absorption technique[1-3], a method with a limit of detection of four micrograms per liter (ug/L). Inorganic mercury was analyzed using the same basic method, with a modified sample digestion procedure to eliminate the organo-mercury compounds. Individual workers received confidential reports of their own test results in letters dated December 7, 1992. Mercury levels were reported in the standard form of ug Hg/g creatinine[4], as well as in ug/L.

The urine mercury records of workers from the environmental department, whose duties

included mercury clean-up from collection sites, were also reviewed during the site visit.

EVALUATION CRITERIA

Mercury can enter the body through the lungs by inhalation of vapor, through the skin by direct contact, or through the digestive system. Occupational exposure most commonly occurs through inhalation of mercury vapor, where about 80% of the inhaled mercury will be absorbed[5]. Skin absorption through dermal contact with mercury can also increase biological levels, however, quantification of this type of uptake is poor[4]. Mercury trapped in articles of clothing can potentially subject workers to hazardous levels of mercury because of persistent skin contact and dermal absorption[6].

Chronic exposure to mercury can result in symptoms of weakness, fatigue, loss of appetite, loss of weight, gingivitis, metallic taste, kidney disfunction, discoloration of the lens of the eye, and nervous system effects[7]. Early nervous system effects include a complex of symptoms termed "erethism," which includes increased irritability, loss of memory, loss of self-confidence, emotional instability, and insomnia. Later central nervous system effects include a tremor, which may progress in severity with duration of exposure. Nervous system effects may be irreversible in cases of long term exposure. The biologic half-life of elemental mercury, which is the time it takes the body to eliminate or metabolize into a less toxic form one-half of the mercury in the body, is approximately 40 days[8].

Although occupational exposures to mercury are usually biologically assessed by monitoring urine mercury levels[9], individual variations in mercury uptake and metabolism may result in different urine mercury values among workers with similar exposures[5]. Urine mercury concentrations reflect average mercury uptake over the previous two to four months[8]. People without occupational or unusual environmental exposure usually have urine inorganic mercury levels below three ug/g creatinine[4]. The World Health Organization has recommended that an inorganic mercury level in urine of 50 ug/g creatinine not be exceeded[10]. In 1990, the American Conference of Governmental Industrial Hygienists (ACGIH) proposed a Biological Exposure Index (BEI) for inorganic mercury in urine of 35 ug/g creatinine[4]. Presently, the BEI for mercury is in the ACGIH's "Notice of Intent to Establish List". If no presented evidence questions the appropriateness of this standard, it will be considered for inclusion in the "Adopted" list[11].

The Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) and ACGIH threshold limit value (TLV) for mercury are 8-hour time weighted average (TWA) exposure levels of 50 ug/m^3 [11,12]. The NIOSH recommended exposure limit (REL) is 50 ug/m^3 for up to a 10-hour exposure, 40 hours per week[13]. A TWA exposure refers to the average airborne concentrations of a substance during a normal 8- to 10-hour workday.

RESULTS

Industrial Hygiene

In all areas sampled, mercury concentrations measured by the mercury vapor analyzer ranged from none detected to 0.004 milligrams per cubic meter (mg/m^3). The measured concentrations were at the limit of sensitivity for this instrument (±0.003 mg/m^3). For example, an instrument reading of 0.004 mg/m^3 would mean the actual mercury

concentration ranged between 0.001 mg/m^3 and 0.007 mg/m^3. Table 1 presents the locations and mercury concentrations measured on October 14, 1992. During the sampling, the probe tip of the instrument was held 2-4 inches from the ground or specified item.

Medical

The company records of two workers from the environmental department involved in mercury clean-up were reviewed. These workers had their urine tested for mercury in July of 1992. The levels of total mercury in urine were both less than 2 ug/L.

Age and work history data from the self-administered questionnaire are shown in Table 2. None of the participating individuals reported exposure to any of the other sources of mercury mentioned above.

None of the workers tested had detectable levels of **inorganic** mercury in the urine (Table 2). Five workers had detectable **total** mercury in the urine. All of these were below 10 ug/L, and all were below 13 ug/g creatinine. These levels are well below the WHO recommended and ACGIH proposed guidelines for **inorganic** mercury in the urine.

DISCUSSION

The environmental data from sampling at selected sites indicate very low concentrations of mercury vapor. For comparison, the NIOSH Recommended Exposure Limit (REL) to mercury vapor is 0.050 mg/m^3. The highest concentration measured during the survey (0.004 mg/m^3) represents approximately 1/12 of the REL. The area sampling represents single points in time and does not characterize daily, weekly or monthly worker exposures. It was intended, however, to establish "worst case" potential exposures.

Urine mercury testing indicated that the workers tested have not had mercury exposure above usual background levels within the past two to four months. Because the workers tested were identified as those most likely to be exposed to mercury in their work, we conclude that occupational mercury exposure is not occurring among production workers at the ALCOA Point Comfort plant.

RECOMMENDATIONS

1. Proper industrial hygiene practices should be followed to prevent potential over-exposure to mercury in the future. These practices have been outlined by MSHA in a report dated September 22-23, 1992.

2. Biological monitoring of employees for mercury exposure should continue to be available to employees upon request. Although a urine inorganic mercury level below 50 ug/g creatinine (WHO) or 35 ug/g creatinine (ACGIH proposed) might be considered "acceptable" for occupational exposure control purposes, any level above background suggests occupational or other unusual exposure and should be investigated.

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DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report have been sent to:

1. MSHA, Administrator for Metal/Non-metal
2. President, USWA Local 4370
3. Safety Representative, USWA Local 4370
4. Plant Manager, ALCOA, Point Comfort, Texas
5. Safety/Industrial Hygiene Manager, ALCOA, Point Comfort, Texas
6. Manager, Health and Safety - Compliance and Services, ALCOA

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

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TABLE 1

Mercury Vapor Measurements
ALCOA
Point Comfort, Texas

AREA	SPECIFIC LOCATION	CONCENTRATION (mg/m^3)
R 25	Base of mercury collection trap	0.002
R 25	North berm of collection area	0.001
R 25	End of used heater tubes	0.004
R 30	Base of knockout pot	0.004
R 30	Top of heater #13	0.003
R 30	Top of heater #14	0.002
R 35	Tricycle tool boxes *	ND**
R 35	Drain in wash area	ND
R 35	Wet vacuum adjacent wash area ***	0.002
R 35	Bottom of investigator's shoes	0.002

* Average of three individual tool boxes
** None Detected
*** Measurement taken from exit port of vacuum during operation

TABLE 2

Urine Mercury Testing
ALCOA
Point Comfort, Texas

Job Title*	Number	Mean Age	Mean # Yrs. at Job	Mean # Yrs. at ALCOA	Inorganic Hg (ug/L)
AO	3	37	2.7	3.3	ND**
GM	15	48	16.0	23.7	ND
HC	7	39	2.7	5.7	ND
S	3	49	15.6	25.3	ND
O	2	47	10.0	23.0	ND
U	5	46	5.6	16.2	ND

* AO - Area Operator; GM - General Mechanic; HC - Heater Cleaner; S - Scaler; O - Other Job Titles; U - Employees with less potential for mercury exposure.

** Non-detectable. Limit of detection of method 4 ug/L.

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