U. S. Department of Labor

Mine Safety and Health Administration
4015 Wilson Boulevard
Arlington, Virginia 22203–1984

JUN 24 1994

Mr. Bob Mason
NIOSH
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati, Ohio 45226

Dear Mr. Mason:

As per our conversation, there have been two instances involving Metal and Nonmetal properties where MSHA verified that mercury was taken into employees' cars and homes. In both situations, mercury had not been accurately controlled by the operator and citations were issued.

The first situation involved Cactus Gold (I.D. 0404787) where mercury controls were non-existent or non-functional. MSHA found contamination in workers cars and homes. I have enclosed Technical Support reports on this situation and reviewed investigation notes. Because of sensitivity of some workers, their numbers were not included in these reports. At least 5 additional homes were found contaminated; washer and dryers were the most heavily contaminated ranging from .05mg/m^3 to .005 mg/m_3. MSHA provided information to the employees on cleanup and decontamination. The operator eventually provided help to the employees.

In the second instance, an operator did not provide adequate protection to a technician handling mercury. The technician had worn contaminated clothing home. Traces of mercury were found in her car several months after the fact, but none in the home.

I have also included some abstracts of papers presented at the American Industrial Hygiene Conference which I thought would be useful to you. If I can be of further help, please let me know.

Sincerely,

Margie E. Zalesak

Margie E. Zalesak
Chief, Health Division for
Metal and Nonmetal

Enclosures

1993 American Industrial Hygiene Conference Abstracts

ter, MS 6-4, 21000 Brookpark Rd., Cleveland, OH 44135, C. Cole and M. Bold, Bionetics, 1100 Apollo, Aerospace Park, Brookpark, OH 44142.

Vacuum blasting was selected as the primary engineering control technique to minimize employee exposure to lead during the removal of lead bearing paint from structural steel in a microgravity research facility, a 500 foot vacuum chamber inside a 25 ft by 510 ft deep cylindrical pit. Vacuum blaster operator lead exposures were determined on five separate days using the NIOSH P&CM 73 Method with all samples analyzed by an AIHA accredited laboratory. Operator lead exposures ranged from 235 $\mu g/m^3$ to 2373 $\mu g/m^3$. It is concluded that vacuum blasting is an improvement over conventional abrasive blasting, but not effective in maintaining employee exposures below current exposure limits. Vacuum blasting of lead bearing surfaces must be used in conjunction with a comprehensive lead program that includes employee training, personal air sampling, good hygiene practices, and medical surveillance.

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AN INVESTIGATION OF THE POTENTIAL FOR WORKERS AT A LEAD MINE TO CARRY HOME LEAD DUST Menrath, W. G., Bornschein, R. L., Clark, C. S. University of Cincinnati, Department of Environmental Health, Cincinnati, Ohio 45267-0056.

Workers at lead mines and other lead-related industries where lead dust is readily available have the potential to carry lead home. This could result in elevated exposures for family members who live in those homes. There are numerous examples of children who have elevated blood lead levels as a result of this type of contamination.

Automobile dust samples were collected from sixty-seven automobiles in a community where there was an active lead mine. Eighteen of those samples were collected from the cars of miners who were actively employed at the mine. The samples were collected from the floor of the automobile on the driver's side. Additional dust samples were collected from the exterior and interior of the homes belonging to the automobile owners to determine if a relationship existed between lead carried home by workers and other environmental lead. The interior and automobile dust samples were collected by vacuuming surface dust using a personal monitoring pump. The dust was collected in an air monitoring filter cassette. The exterior dust was collected by brushing and vacuuming with a portable vacuum cleaner.

Analytical results indicate that the concentration of lead in the dust of the miner's autos was higher than that found in the autos of those not employed in the mining industry. The respective averages were 3909 ppm and 917 ppm. The loading of lead on the automobile floors was also higher for the miners, 3539 $\mu g/ft^2$ compared with 565 μ/g ft for non-miners. Lead loadings in the homes of miners was the same as the loadings in the homes of non-miners, approximately 56 $\mu g/ft^2$ for both groups. However, the concentration of the lead in the dust of the miner's homes was higher than that in the homes of the non-miners.

The data suggest that worker carry-home is not a major area of concern at the present time but is an area where some vigilance is warranted.

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PAINT LEAD DETERMINATIONS USING THE PORTABLE SPECTRUM X-RAY FLUORESCENCE LEAD ANALYZER COMPARED WITH USING INDUCTIVELY COUPLED PLASMA SPECTROSCOPY P.A.Weaver, M. Howe, Galson Laboratories, 6601 Kirkville Road, East Syracuse, New York 13057.

Portable X-ray fluorescence (XRF) analyzers are used to detect and determine the amount of lead in paint in accordance with U.S. Department of Housing and Urban Development (HUD) guidelines. The XRF is a field instrument designed to provide quantitative estimations of lead concentrations without destructive analysis of the sample. An alternative, more involved method of lead quantitation can be performed after acid digestion of the sample, followed by analysis using an inductively coupled plasma (ICP).

ICP analysis provides a lead concentration based on weight percent. The HUD action level is 1 milligram lead per square centimeter of surface area, or 0.5% lead content by weight. In an effort to determine the accuracy of XRF testing versus ICP testing, 45 sites of various paint types were analyzed by both techniques. Results were reported as average percent difference for sample concentrations, ranging from non-detected to concentrations greater than the HUD action levels. Depending upon the different types of paint samples encountered, XRF results and ICP results both compared favorably to unsatisfactory. It is concluded that further work is necessary to accurately assess those conditions in which XRF determinations should only be used with the confirmation of ICP analyses.

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EVALUATION OF FIELD METHODS FOR LEAD SCREENING AND ANALYSIS K. Ashley, J.D. Travis, M. Millson, P.M. Eller, and A.L. Sussell, U.S. Department of Health & Human Services, Centers for Disease Control, National Institute for Occupational Safety & Health, 4676 Columbia Parkway, Cincinnati, OH 45226.

Laboratory-based analytical methods for lead are well-established and reasonably straightforward. However, field-portable methods for the screening and analysis of lead in various environmental matrices (such as paint, soil, dust, and airborne particulate) are undergoing development. Also, sampling protocols for lead in certain environmental sources, e.g., surface dust, are not standardized. The efforts of researchers in the Division of Physical Sciences and Engineering, National Institute for Occupational Safety and Health, Centers for Disease Control, have focused on filling gaps in these areas, especially for applications in industrial hygiene. In order to screen for the presence of lead in workplace air on-site, several commercially available chemical spot test kits have been evaluated for potential use by industrial hygienists. Rhodizonate-based spot test kits were used on airborne particulate samples (37 mm dia. cellulose ester filters, 0.8 µm pore size) which were collected during abatement and abrasive blasting of lead-based paint. Positive readings for lead were found if the lead loading was in excess of ~5 µg per filter. Additionally, a proposed wipe sampling method for lead in surface dust that is present at worksites has been evaluated, subject to a set of desired performance characteristics. Desirable characteristics for wipe materials include low, uniform background lead levels (<5 µg Pb) and high recoveries of lead (>80%) from standard reference material spikes. Subjective criteria that are used in choosing wipe materials for field use include completeness of digestion and ease of use on-site. Wipe materials have been identified that meet these performance characteristics, and a surface dust sampling protocol has been proposed and field-tested.

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WORK-RELATED UPPER EXTREMITY MUSCULOSKELETAL DISORDERS IN POULTRY PROCESSING PLANTS T.R. Hales, NIOSH Region VIII, 1961 Stout St., Denver, CO 80294; S. Kiken, 500 Davis St., Evanston, IL 60201; L.J. Fine and K. Henley, NIOSH, 4676 Columbia Pkwy, Cincinnati OH 45226.

According to the Bureau of Labor Statistics (BLS), poultry processing plants, as an industry, have always had one of the highest rates of cumulative trauma disorders (CTD). Despite recognition of the CTD problem within the poultry industry, descriptive studies of the problem have not been done. In 1989, the National Institute for Occupational Safety and Health (NIOSH) conducted a cross-sectional study of the CTD problem within 3 large poultry processing plants. Jobs were classified into higher exposure (HE) and lower exposure (LE) based on cycle time and visually estimated upper extremity (UE) force requirements. Assessment of the UE musculoskeletal system utilized symptom questionnaires and physical examinations. Seventy (18%) employees met our case definition of potentially work-related musculoskeletal disorders. Tendon related conditions were diagnosed in 66 (17%) employees, carpal tunnel syndrome was diagnosed in 17 (4%) employees, and osteoarthritis of the hands was diagnosed in 14 (4%) employees. Using multiple logistic regression analysis, employment in HE jobs had a strong, statistically significant association with these disorders. This study identifies highly repetitive and forceful movements as factors contributing to UE musculoskeletal disorders among employees in the poultry processing industry.

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AN ERGONOMIC EVALUATION OF A FLYWHEEL MILLING DEPARTMENT AT A MOTORCYCLE MANUFACTURING PLANT: AN INTERVENTION STUDY J.D. McGlothlin, R.A. Rinsky and L.J. Fine, National Institute for Occupational Safety and Health, Centers for Disease Control, Public Health Service, U.S. Department of Health and Human Services, 4676 Columbia Parkway - R5, Cincinnati, OH 45226.

Researchers from the National Institute for Occupational Safety and Health (NIOSH) conducted an initial and follow-up health hazard evaluation of musculoskeletal disorders of the upper limbs and back at a motorcycle manufacturing company. The objective of this evaluation was to identify job tasks in the flywheel milling area which may cause, aggravate, or precipitate musculoskeletal injuries, and to provide recommendations to decrease and prevent such injuries.

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properties. Lead is routinely used for for this purpose at the Nevada Test Site. Airborne lead concentrations are evaluated by a monitoring program designed to characterize employee exposures. Solid lead sheets and bricks are cut with a powered saw and/or fused into various configurations to protect scientific instruments. In addition, various types of solid lead shot are poured into steel containers which are configured around instruments. The lead work may be conducted both indoors and outdoors. The magnitude and duration of the lead work varies considerably because the work is customized for each project.

The monitoring program includes the collection of personal breathing zone and general area samples in the lead work areas. In this study, over two hundred air samples were collected and analyzed. All results are reported as calculated eight-hour time-weighted averages. Individual employees pour solid lead shot an average of fifteen days per year; sawing and fusing of lead is performed on a regular basis. Five percent of the personal breathing zone sample results were found to be in excess of the Occupational Safety and Health Administration's (OSHA) Action Level of 30 ug/m^3.

A downdraft table equipped with high efficiency particulate air filters is employed as an engineering control for the lead fusing operation. Personal protective equipment is used to provide adequate protection to the worker during lead operations. The specific personal protective equipment chosen is based on the nature of the operation and the air monitoring results. The personal protective clothing includes coveralls, gloves, and respiratory protection. The historical area sample results have been used to establish control strategies and personal protection requirements for other employees who must be in the lead work area. This paper describes the lead work procedures and control measures implemented to protect employees and comply with the elements of the OSHA Lead Standard (29 CFR 1910.1025).

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THE LEAD CONTENT OF DUST IN THE HOMES OF FOUNDRY WORKERS

Nelson, D. I. and Clift, M. E., University of Oklahoma, Department of Civil Engineering and Environmental Science, 202 West Boyd, Room 334, Norman, OK 73019

OSHA regulations mandate that employers of workers who are exposed to airborne lead concentrations in excess of the PEL must provide for the disposal or cleaning of work clothing, allow access to shower facilities, and provide separate lockers for storage of work and street clothing. However, it is still possible to introduce lead into the home due to wearing work shoes home, walking across lead-contaminated parking areas, or driving vehicles that have fallout from plant emissions on them. The purpose of this study was to compare the lead content of dust in the homes of foundry workers, who may be exposed to lead during manufacture of parts from scrap metals, with homes of non-foundry employed controls.

Samples were collected from selected houses in a small rural town. At each house examined, the following were collected for lead analysis: dust from carpeting, hard-to-reach interior surfaces, the dash of a work vehicle, a swatch of dirty work clothing, topsoil near the house entrance, tap water, and paint chips from peeling woodwork. All of the samples were digested using EPA Method 3050 (Acid Digestion of Sediments, Sludges, and Soils) and analyzed for total lead content using an atomic absorption unit equipped with a graphite furnace. Lead contamination was found to be present in all of the homes examined. For example, the dust samples obtained from the carpets ranged from 105 ppm to 1535 ppm. The ubiquitous nature of the lead in the community where our study was conducted was likely due to airborne emissions from a lead smelter which operated until recently, the presence of four ferrous foundries still in production, and the mobile nature of the work force.

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AVAILABILITY OF LEAD FOUND IN PAINTS, AUTOMOBILE EXHAUSTS AND DUSTS

Que Hee, S.S., Department of Environmental Health Sciences, 10833 Le Conte Avenue, Los Angeles, CA 90024-1772.

The toxic effects of lead are well known in children and in workers in brass foundries. Lead dispersed into the environment as a result of sandblasting the walls of lead-painted buildings as well as that from automobile exhaust have also been major sources of exposure. However not much is known about the availability of the lead in these matrices to biological systems. The present study compared the availability of lead and other elements in some leaded paints, automobile exhausts, and dusts by a modified Tessier leaching method and the EP Toxicity leaching method. The Tessier method involved sequential leachings of water, 1M magnesium chloride, 1M carbonate buffer, 0.04M hydroxylamine hydrochloride/acetic acid, 0.02 M nitric acid/hydrogen peroxide, and hydrofluoric acid/perchloric acid. The EP Toxicity procedure was performed at pH 4.8 in acetic acid. The leachates were analysed for 34 elements by simultaneous inductively coupled plasma atomic emission spectroscopy. Leaching a mixture of leaded automobile exhaust, leaded paint and limestone soil showed that the first two leaching steps of the Tessier method were equivalent to the EP Toxicity results for Al, Ca, Cu, K, Li, and Sr. The first three Tessier leachings were equivalent to the EP toxicity results for Ca, Li, Mn, Pb and Si. The results for the mixture were not additive when each substrate was leached separately.

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EVALUATION AND CONTROL OF LEAD EXPOSURES DURING OUTAGE OPERATIONS AT RESOURCE RECOVERY COGENERATION FACILITIES

Bruun, D.M., Galson Corporation, 5170 Campus Drive, Plymouth Meeting, PA 19462.

The Occupational Safety and Health Administration (OSHA) comprehensive lead standard requires that employers measure airborne concentrations if exposures are expected to exceed the action level. Industry experience suggests that significant exposures to lead may occur in resource recovery facilities that burn municipal solid waste. The presence of lead at two facilities included in this study was confirmed by analysis of the process residue ash. Personal monitoring was conducted to evaluate exposures during outage operations when employees clean or inspect combustor chambers, ash extractors, boiler tubes, and emission control systems. Sampling and analysis for inorganic lead were conducted according to the National Institute for Occupational Safety and Health (NIOSH) Method 7300. Exposure concentrations ranged from less than detectable levels to 1.3 mg/m^3 and were highest when employees worked closely to the fly ash. The transient nature and remote locations of the exposures make control by traditional process local exhaust ventilation impractical. A transient work force of temporary labor made it difficult to implement administrative controls. Work practices and a housekeeping program were designed to limit dispersion of lead dust throughout the facility. A formal compliance program was developed and included periodic air monitoring, requirements for personal protective equipment, training, hygiene facilities and practices, and medical surveillance of exposed employees. It is concluded that outage operations at resource recovery cogeneration facilities create potential employee overexposures to lead. A formal compliance program that considers the unique nature of the operations is needed.

U. S. Department of Labor

Mine Safety and Health Administration
P.O. Box 25367
Denver, Colorado 80225–0367

May 25, 1989 File: D6557-T437

MEMORANDUM FOR: RODRIC M. BRELAND
Supervisor
MSHA, M/NM Mine S&H Subdistrict Field Office
Boulder City, NV

FROM : JOHN W. BARTON
Chief, Toxic Materials Division

SUBJECT : Mercury Vapor Exposure and Engineering Controls
Evaluation Inside the Mill/Refinery Building
Cactus Gold Mine, Kern County, CA

Attached are two copies of technical assistance provided at the Cactus Gold Mine on March 29-30, 1989 and April 11-13, 1989, for your distribution. A copy of this report was not sent to the company. Other distribution of this study is shown below.

Attachments (2)

cc: D. Walker (w/attach.)
D. Park "
S. Kneipple "
M. Lynham "

INTRODUCTION

At the request of the Boulder City, NV Field Office, Western District, Metal and Nonmetal Safety and Health Administration, the Toxic Materials Division, Safety and Health Technology Center, Denver, CO, conducted a mercury health hazard survey and evaluation at the COCA Mines, Inc.'s, Cactus Gold Mine, Kern County, CA (MSHA I.D. No. 0404787). It was performed during the periods of March 29-30, 1989 and April 11-13 by the following personnel from the Toxic Materials Division:

Stephen M. Kneipple
Industrial Hygienist

and

Michael L. Lynham
Industrial Hygienist

Earl W. McGarrah, Mine Inspector, Boulder City, NV Field Office, initiated this request after he observed accumulations of liquid mercury on the cement pad outside the mill/refinery building where the refining furnace's exhaust stack, blower, and water scrubber are located.

PURPOSE AND SCOPE

Purpose: To measure (observe) and evaluate:

1. Employee's personal exposure to both mercury vapor and mercury liquid.

2. The effectiveness of existing ventilation and other engineering methods for controlling mercury emissions in the work environment.

3. The levels of mercury contamination on surface areas within and adjacent to the mill and refinery building

and

4. The effectiveness of existing work practices and health and safety plans and practices for controlling harmful exposures to mercury vapor and liquid.

Scope: This survey was mainly limited to the mill and refinery building and storage areas within the facililty's security fence. In addition, other selected locations were also evaluated for mercury exposures.

GENERAL INFORMATION

The Cactus Gold Mine is owned and operated by COCA Mines, Inc. and is located in Kern County, CA, approximately 10 miles southeast of Mojave, CA on state highway 14. It employs approximately 85 office and mining personnel and operates three 8-hour work shifts per day, 5 days per week.

Mining Operations

The company mines gold and silver ores from two open-pit mines, the Middle Butte and the Shumake. Currently, both ores contain appreciable amounts of naturally occuring mercury. The ore from each mine is processed separately.

Milling Operations

Ore materials are crushed and processed in a cyanide heap-leach operation which dissolves gold, silver, and mercury in the cyanide solution. The pregnant cyanide solution is clarified and combined with lead acetate and zinc to remove the cyanide ions and precipitate-out a complex of gold, silver, mercury, and excess zinc and lead. The precipitate is further concentrated in a Shriver Filter Press and removed for further processing.

Refining Process

The concentrated precipitate (locally referred to as "precip") is first heat-dried in drying trays and then melted and formed into dore ingots. During the drying and melting processes, the mercury is vaporized and carried through the furnace/dryer exhaust system along with exhaust gases and accompanying metal fumes.

MERCURY - PHYSICAL AND CHEMICAL PROPERTIES PHYSICAL PROPERTIES (1)

Silver - white metal, liquid

Melting Point: -38.87°C (-37.96°F)

Boiling Point: 356.58°C (673.84°F)

Vapor Pressure: Varies exponentially with changes in temperature.

Vapor Pressure of Mercury for Selected Temperatures (1)

Temperature °C	(°F)	Vapor Pressure of Mercury mm of mercury
0	(32	.000185
6	(42)	.000335
10	(50)	.000490
16	(60.8)	.000846

20 (68)	.001201
30 (86)	.002777
40 (104)	.006079
50 (122)	.012670

Mercury concentrations in air are dependent on temperature and will decrease or increase with changes in temperature.

Chemical Properties (1, 2)

Solubility: Insoluble in either hot or cold water.
Soluble in nitric acid (HNO_3).
Concentrated sulfuric acid (H_2SO_4).
Sodium and potassium cyanide solutions.

Reactivity with metals: Except for iron, readily forms alloys (amalgams) with all metals (esp. gold and silver)

Reactivity with non-metals: Readily combine with halogens (chlorine, bromine, iodine, and fluorine) and sulfur

Mercury Vapor - Health Effects and Symptoms

Warning Properties: Colorless, tasteless, odorless

Chronic Mercury Poisoning

Route of Entry: Inhalation; skin absorbtion
Target Organs: Central nervous system; kidneys; skin and eyes
Development Time: 2-3 months up to 10-15 years

Three Stages of Development - Health Effects and Symptoms:

Stage One: Exhaustion, decreased mental ability, irritability, loss of desire for work, slight swelling of the mucous membrane in the upper nasal passages.

Stage Two: Increased fatigue, feeling of "stupidity"; poor memory for figures, names, and persons; internal unrest; discontent, feeling of pressure in the head; headache between the eyes; numbness; slight dizziness; stopped-up and dry nose; inflammation of the mucous membrane of the mouth and gums; slight tremor of the hands, eyelids, lips, and jaw; and increased pressure to urinate.

Stage Three: Grevious headache, dizziness, slight disturbance of vision, greatly decreased mental ability to work, inability to speak or write correctly, almost complete loss of memory, deep dejection, shyness, whistling in ears, bleeding of gums at slight touch, difficulty in hearing, blisters, and small ulcers on the palate and severe tremor.

Acute Mercury Poisoning

Route of Entry: Inhalation
Target Organs: Respiratory system, esp. lungs; gastro-intestinal track; kidney

Development: Caused by inhalation of 1.2 to 8.5 mg of mercury/M^3 (4)

Health Effects (3): Headaches, cough, chest pains, chest tightness, difficulty in breathing, chemical pneumonitis, soreness of the mouth, loss of teeth, nausea, vomiting, diarrhea, burning in the mouth and throat, thirst, abdominal pain, suppression of urination, discharge of blood in the urine, salivation, metallic taste in the mouth, fever, bronchitis, foul breath and receding of gums; kidney damage.

Evaluation and Interpretation of Mercury Concentrations in Urine and Blood

The following information should be used as a guideline for evaluating and interpreting the biological/medical significance of mercury levels in urine and blood. When using this information, a person should consider the rates of mercury elimination from the body and the lapse of time between exposure and mercury analysis.

International Labor Organization (ILO) - Proposed Maximum Levels of Mercury

Urine:	$\leq$ 50 μg/L
Blood:	$\leq$ 3 μg/100 ml

Mercury Concentrations in Urine and Personal Exposures (5)

Absorption Level	Mercury in Urine (μg/l)
Normal	< 10
Increased Absorption	> 50
Warning Level	>100
Hazardous Level	>200
Poisoning Symptoms	>300

EXPOSURES TO MERCURY VAPOR

Sample Collection and Analysis

SKC Mercury Sorbant Badges and 3M 3600 Mercury Vapor Diffusional Monitors were used to sample both personnel and selected locations for mercury exposures. The SKC samples were analyzed by the Safety and Health Technology Center Laboratory, Denver, CO; the 3M samples were analyzed by the 3M Company. All results are presented in Table 1.

Models 401 and 431 Gold Film Mercury Vapor Analyzer, Arizona Instrument Corp., Jerome Division, were used to measure mercury contamination of surfaces within the mill/refinery building and on employees' work clothing. They were also used to make instant measurements of airborne mercury vapor at selected locations. All results are presented in Table 2.

TABLE 1A

Date	Employee	Job Title	Sample Time (min.)	Shift-Weighted Avg. (mg/m^3)
3/30/89	D. LeBret	Safety Director	455	0.109
3/30/89	P. Owens	Refiner	162	0.182
3/30/89	J. Bettencourt	Mill Operator	455	0.176
3/30/89	P. Owens	Refiner	462	0.271*
3/30/89	J. Bettencourt	Mill Operator	462	0.156*
4/13/89	R. Breedlove	Refiner	502	1.66
4/13/89	G. Franco	Mill Operator	501	0.30

TABLE 1B

Date	Location	Sample Time (min.)	Shift-weighted Average
3/30/89	Refinery (above dryer hood)	456	0.241*
3/30/89	Side doorway next to AA office	468	0.197*
3/30/89	Conference room in main office	480	0.082*

*Samples collected on 3M Mercury Vapor Diffusional Monitors

TABLE 2

Date	Location	Concentration (mg/m^3)
3/29/89	Base of furnace	0.073
3/29/89	Electric switch for furnace	0.162
3/29/89M	Mill office	0.042
3/29/89	Change room	0.046
3/29/89	Slag plate	0.206
3/29/89	Refiner's clothes inside plastic bag	0.564
	Protective clothing	
3/29/89	Outside refiner's aux. heat helmet	0.053
	Inside " " " "	0.071
	Outside " primary " "	0.064
	Inside " " " "	0.354
3/30/89	5 ft. in front of furnace	0.097
"	12 " " " " "	0.140
"	7 ft. behind furnace	0.222
"	Between filter presses	0.165
"	P. Owens truck cab	0.028
"	P. Owens clothes inside plastic bag	0.072
4/11/89	Clarifier area	0.088
"	Mill office	0.180
"	AA room	0.096
"	Mill yard	0.070
4/12/89	G. Franco's company truck	0.060
"	R. Breedlove's car	0.030
4/13/89	Dean's office	0.011

"	Next to scrubber	0.566
"	Clarifying area between tanks	0.024
"	Mill sperse tanks	0.013
"	Bathroom in mill building	0.269
"	AA room	0.128
"	Change room	0.202
"	Lunch room	0.469
"	Pit	0.015
"	Middle of mill yard	0.190
"	Sample prep drier	0.011

Note: The refinery process was operated on 3/30/89 and on 4/13/89. On 4/11/89 the mill/refinery building was being treated with HGX and the ground immediately surrounding the building was being treated with sulfur in an effort to decontaminate the area.

Evaluation of Mercury Exposures

Use of respirator: Persons sampled were wearing half-mask, air purifying cartridge respirators which are approved for respiratory protection against not more than 0.5 mg/m^3 metallic mercury vapor. The persons had not been fit-tested for respirators nor had they received respirator training. There was no formal, written respirator program at the mine. It is assumed that these respirators provided employees with some degree of protection.

Harmful Personal Exposures

During periods of "precip" refining, mercury vapor concentrations exceeded the American Conference of Governmental Industrial Hygienists' maximum safe exposure limit for mercury vapor of 0.05 mg/m^3, 8-hours time-weighted average.

With the exception of the refiner on April 13, 1989, all other employees would be adequately protected by wearing air-purifying respirators approved for respiratory protection against mercury vapor. The refiner's exposure to mercury vapor for the shift was 3 times the maximum protection level (i. e., 0.5 mg/m^3) approved for his air-purifying respirator. To be fully protected, the refiner needs to use an airline respiratory or a self-contained breathing apparatus.

MEASUREMENTS AND EVALUATION OF ENGINEERING CONTROLS FOR CONTROLLING MERCURY CONCENTRATIONS AT THE MILL/REFINERY FACILITY

Refinery Furnace Exhaust System
An Alnor Electronic manometer, a Kurz heated wire anemometer and pitot tubes were used to obtain the operating characteristics of the exhaust ventilation system used to control mercury vapor within the refinery section of the mill. The results of this survey can be found with the system sketch attached to this report.

Findings and Evaluation
The furnace's exhaust ventilation system contains an in-line water-scrubber to collect zinc fume emissions. The scrubber also captures some mercury vapor emissions. The furnace exhaust ventilation system consists of a size 2608-S New York Pressure Blower Fan rated to delivery 1150 cubic feet per minute of air (cfm) against 4 2.0 inches of static pressure lose and a W. W. Sly Impinjet Gas Scrubber rated for 1200 cfm. The collection system services two emission sources inside the refinery: the furnace and the "precip" drying box.

The refining furnace exhaust ventilation system is ineffective in controlling the mercury vapors within rate exposure limits during the refining process. This is due to the following reasons:

1. The scrubber is not designed to control mercury emissions. Some mercury is being trapped by the scrubber while the rest is sucked through the fan and blown out the exhaust stack. This is evident when large amount of mercury were found on the roof of the mill building. Since April 14, 1989, the company has installed an activated carbon filtering unit to collect mercury. This unit is designed to remove low levels of mercury vapor from the exhaust air stream before the air reaches the exhaust stack.

2. The exhaust ventilation system does not service all the mercury emission sources inside the refinery. Locations such as the slag pour-off plate and the "precip" weighing station which were sources of mercury vapor are not covered.

3. The canopy hood over the furnace captures only the mercury vapor that is carried toward it by the thermal currents generated by the burning process.

Work Area Ventilation - Refinery/Filter Press Room

Observation and Findings:
Within the refinery/filter press room, two sets of wall fans and a swamp cooler provide general dilution ventilation and cooling. The supply air fans are located in upper section of the wall and direct air downward toward the furnace. The exhaust fans are situated in the opposite wall

above the furnace and exhaust the air to the outside the building. The swamp cooler is located between the supply air fans and is intended to provide cool air for the refinery. At the time of this study, the cooler was not operational.

A smoke tube was used to check the direction of the air currents inside the refinery. Tests indicated that the fans created a layer of air approximately 12 feet above the floor which traveled toward the furnace wall. It was found that little or no air movement existed from ground to head level in the area between the filter presses.

The dilution ventilation system was ineffective in controlling mercury vapor concentrations in the refinery for the following reasons:

1. The dilution of air for the refinery did not sweep along the floor where most of the mercury vapor will accumulate.

2. The makeup air for the exhaust and dilution ventilation systems is not cooled.

3. The upper portion of the wall separating the mill and the refinery is open to the mill area and allows short circuiting of the air flow inside the refinery, thus, reducing the systems ability to control the mercury levels within this area.

4. The makeup air for the mill/refinery building's ventilation systems is probably contaminated with mercury from the furnace exhaust emissions.

SOURCES OF MERCURY CONTAMINATION AND MERCURY EXPOSURES

Findings and Observations:

1. The furnace exhaust contaminates the ground around the mill. It may also contaminate the makeup air for the swamp cooler and the wall fans used to supply fresh air to the refinery. In addition, mercury has been found inside the air conditioning unit and ducts which supply air to office, lunchroom, and shower/toilet room within the mill/refinery building.

2. The refiner's protective clothing was contaminated with mercury. Wearing this protective gear in its present condition will greatly contribute to this employee's exposure to mercury.

3. The general refining process involves several steps in which local exhaust ventilation controls are needed to reduce mercury vapor concentrations within the refinery. The following steps are:

    a. The process of pulling the Shriver filter presses was a source of mercury vapor. This task usually took approximately 6 to 7 hours to complete. Depending upon the mercury content of the "precip" and the temperature of the room, this source could be significant.

b. The "precip" was weighed in the drying pan which was hung in the doorway separating the refinery and the mill section of the building. The pan would sometimes hang in the doorway for up to 8 hours.

c. The mixing of the flux material and the "precip" was done in front of the furnace. If this occurs while pre-heating the furnace, the rise in room temperature will increase the mercury vapor concentration in this area.

d. The pouring of the molten metal into the metal cones was a source of mercury exposure for the reasons stated above.

e. The cones containing the molten metal from the furnace were allowed to cool along the wall inside the refinery.

f. The pour-off of the ingots occurs on the metal plate located next to the drying hood. The slag material will contain some mercury and it will add to the mercury concentration within the refinery.

4. Lack of adequate personal hygiene and housekeeping can add to further mercury exposures of mill personnel and result in the contamination of other areas. The lunchroom in the mill building was contaminated with mercury. Employees wearing their work clothes home contaminated their cars and possibly their homes. A sample collected in the conference room of the main office building indicated mercury contamination, possibly from employees' mercury contaminated clothing.

RECOMMENDATIONS

1. As part of an overall effort to get mercury levels under control, the company is in the process of obtaining a mercury retort system to remove mercury from the "precip" prior to refining. The retort should be located away from the mill building. Additional engineering controls may be needed in conjunction with the retort to control the mercury in the mill building. This can only be determined after the following steps have been taken: 1) collection of mercury vapor samples to check the efficiency of the retort in removing the contaminate from the ore, and 2) complete decontamination of the refinery/mill building and its surrounding area.

2. The company should discontinue drying and refining operations until the retort is installed and other controls are established.

3. Management should implement a training program on mercury and its health hazards and symptoms. The program should stress and imple-

ment the following personal hygiene practices:

a. Employees should wash their hand and face before eating or smoking.

b. Food consumption and tobacco usage should only be done in mercury-free areas. Contaminated clothing should not be worn in these areas.

c. Employees should not take their contaminated work clothes off mine property. Employees should shower and change into their street clothes before leaving mine property.

d. The company should supply employees with clean clothes per each shift.

4. The furnace exhaust ventilation system should have a scrubber (or similar device) to capture mercury vapor before it is exhausted into the atmosphere.

5. The present exhaust ventilation system should be enhanced to handle the mercury emission sources outlined above.

a. The use of downdraft hoods, when possible, to capture the mercury vapor at the source.

b. Drains in the ductwork to remove condensed mercury vapor.

c. Limiting the use of horizontal runs in the design of the ventilation system to ease the removal of trapped mercury inside the duct.

6. The area encompassing the mill building should be decontaminated so that the makeup air for the ventilation systems inside the mill/refinery building is free of mercury.

7. The temperature inside the mill/refinery building should be kept below $72^{\circ}F$. This will help prevent some of the mercury from readily vaporizing into the room air.

8. The upper portion of the wall separating the mill from the refinery should be sealed to prevent short circulating the dilution ventilation system inside the refinery.

9. The dilution air from the wall fans should be directed to sweep along the floor of the refinery.

10. The refiner should wear adequate respiratory protection when wearing his heat-protective helmet which is contaminated with mercury. Such

equipment should periodically be decontaminated or replaced.

11. Presently, it is recommended that the entire yard surrounding the mill building remain classified as an area requiring respirators. If employees plan to work in the yard or are involved in the mercury decontamination process they should wear coveralls and protective gloves in addition to their respirators.

12. The current respirator program should be maintained in accordance with ANSI Standard Z88.2-1969. In addition, the refiner should wear a supplied air respirator until the mercury concentrations inside the refinery are well below 0.500 milligrams per cubic meter of air.

13. The mill/refinery building and surrounding areas should be completely decontaminated of mercury. The following steps should be taken to accomplish this goal:

    a. Install engineering controls to eliminate mercury emission sources inside and outside the refinery/mill building.

    b. This should also include the removal of the insulation which was wrapped around the duct. Decontaminate all equipment including air conditioners, coolers, air ducts; clean or replace all mercury contaminated equipment.

    c. Vacuum all surfaces.

    d. Wash surfaces with mercury-absorbent cleaning agents.

    e. Rinse and collect mercury solutions.

    f. Re-vacuum all surfaces.

    g. Seal porous wood, walls, concrete, and cinder block with an epoxy paint. It also may be necessary to remove the tile floors inside the change room and bathroom to complete the job.

    h. Use a mercury detector to selectively determine levels of mercury contamination within the mill/refinery facility.

Note: The above basic steps involved in the decontamination process were obtained from the procedural manual drawn up by the Northumberland Mill of Cyprus Mines Corporation.

14. Employees who work in the mill or the refinery should have their personal vehicles and homes examined for possible mercury contamination.

15. Consideration should be given to establishing a personal mercury vapor monitoring program. A sampling schedule should be established and the

location and the results kept in a permanent record.

16. Biological monitoring for elemental mercury should be conducted for each employee who works in the mill/refinery compound. This can be done through either blood or urine tests. It is recommended that these tests be run at least every 30 days and records kept of the employee's exposure.

17. The conference room inside the main office building should be examined for mercury contamination. The 8-hour sample collected during the first visit indicated that this room contained unacceptable levels of mercury.

18. The company should determine the amount of mercury in the ore so that this information can be used to ascertain the efficiency of the retort.

ACKNOWLEDGEMENT

The authors wish to express their appreciation for the cooperation and assistance of management and operation personnel during the study.

Michael L. Lynham
Industrial Hygienist

Stephen M. Kneipple
Industrial Hygienist

Approved:

~~May 25,~~ 1989
John W. Barton
Chief, Toxic Materials Division

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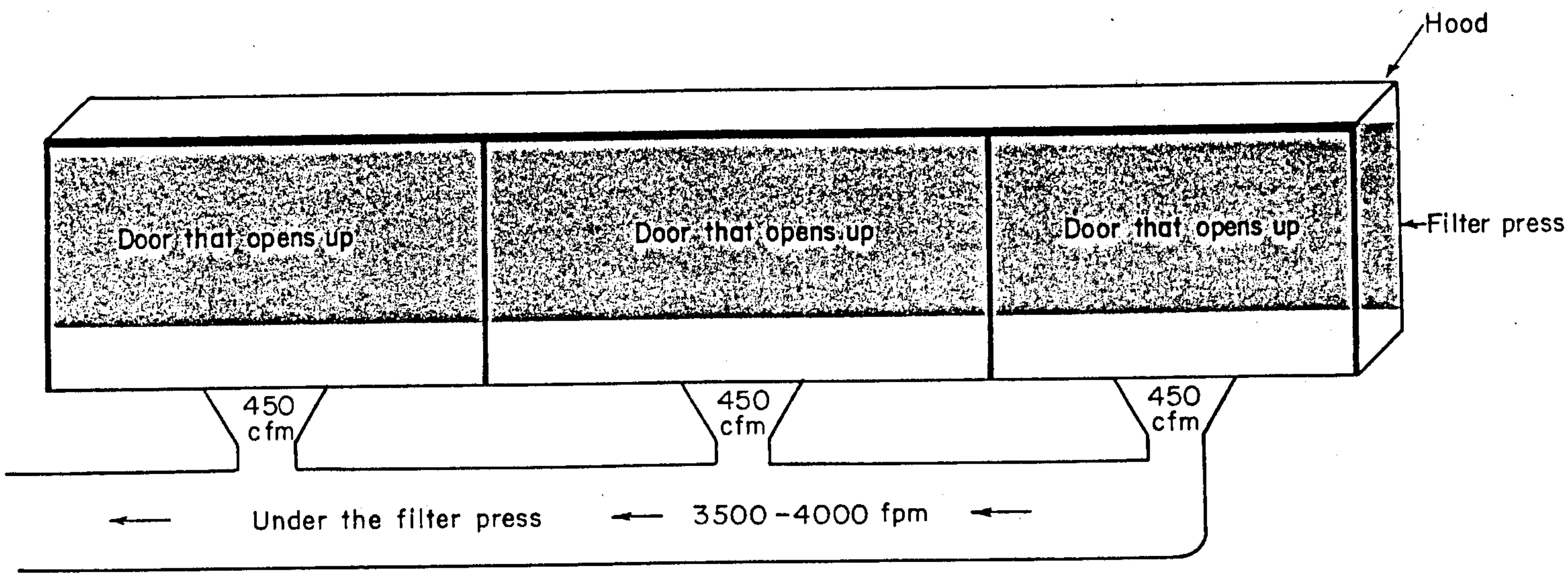
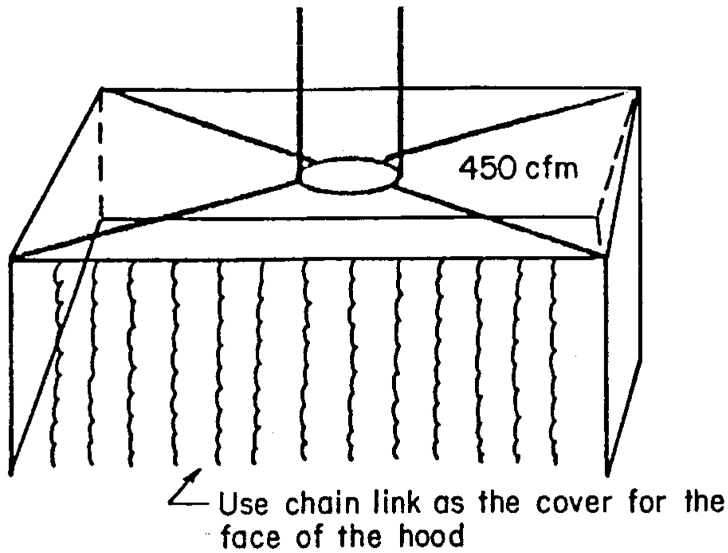
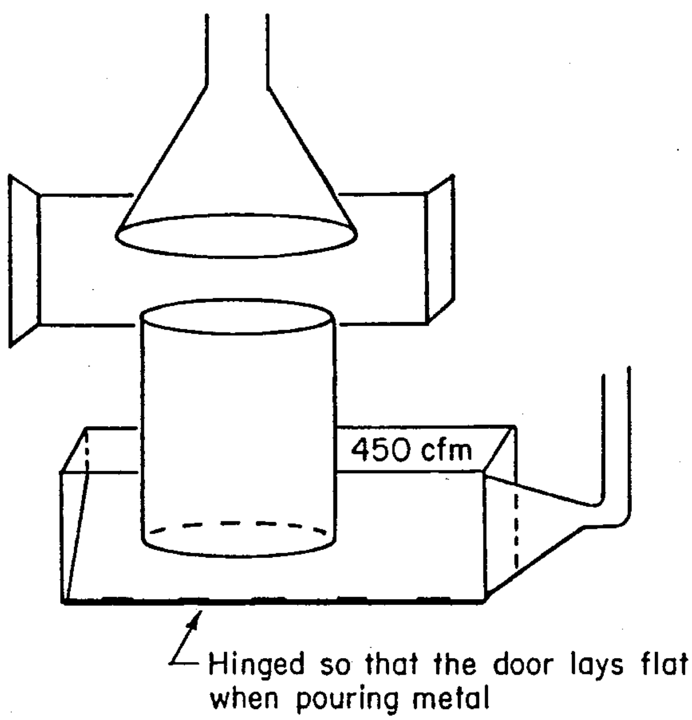


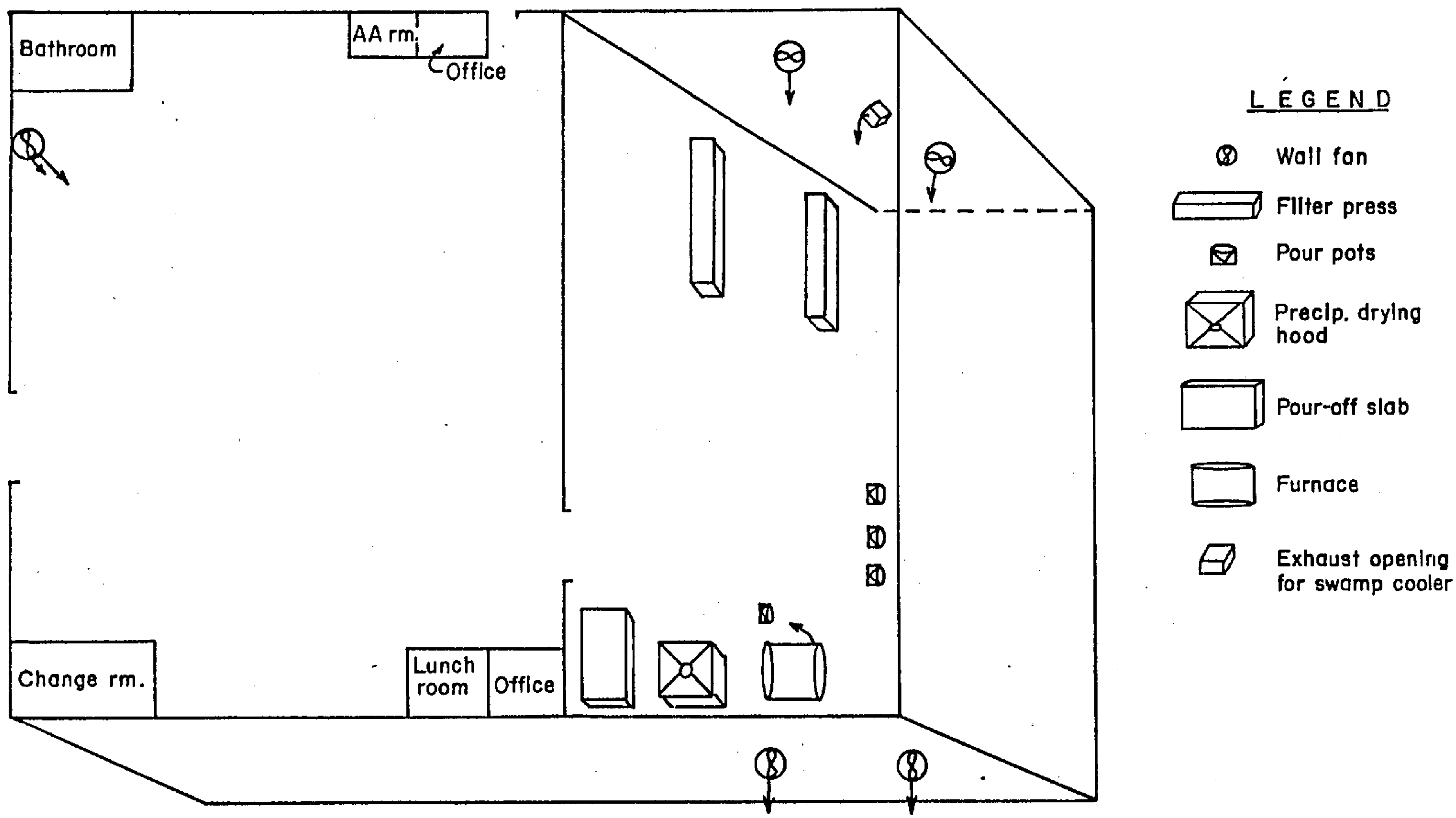
Exhaust hood for filter presses



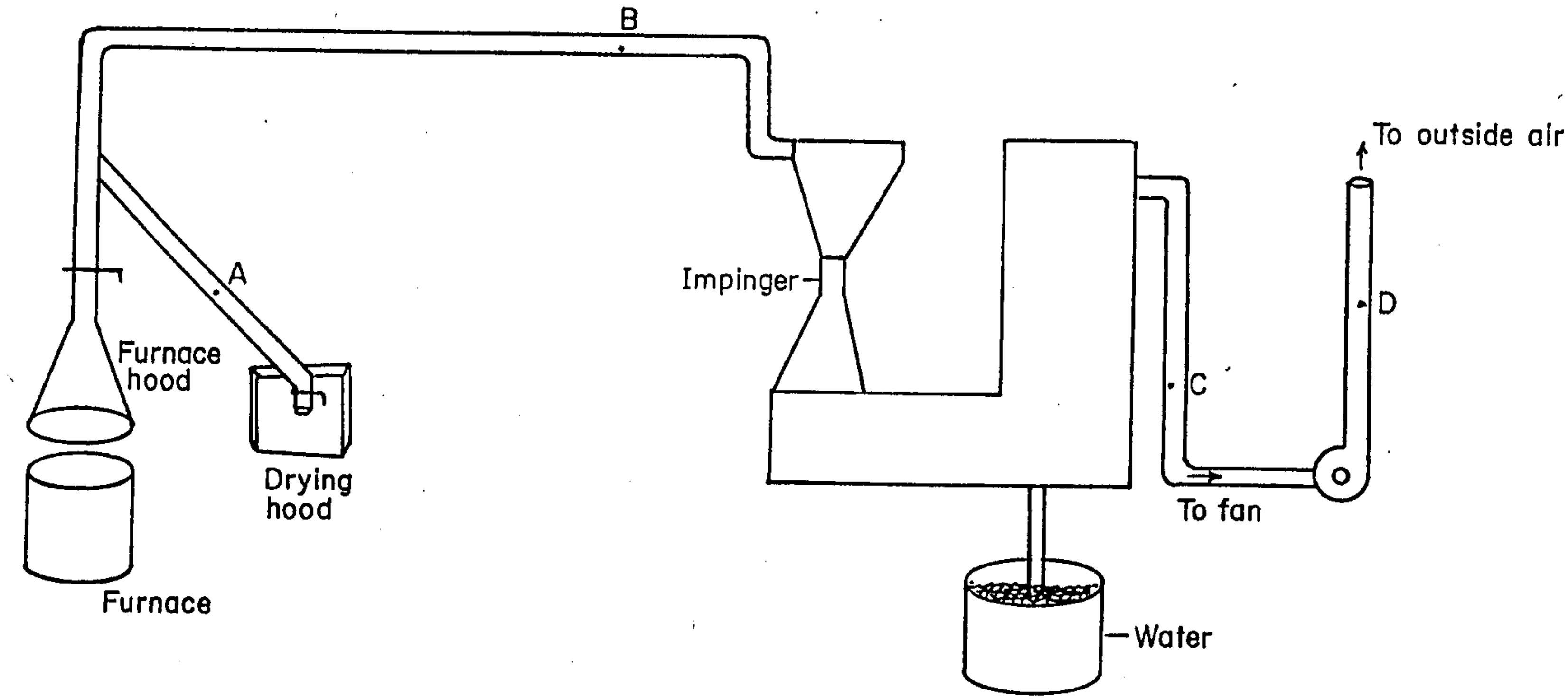
Canopy hood for cones during cooling process



Canopy and downdraft hoods for furnace



MILL BUILDING & REFINERY
COCA MINES INC.
CATUS GOLD MINE



Exhaust Ventilation Measurements
Refinery

Location	Velocity (fpm)	Quantity (cfm)
Branch "A"- Dryer hood	1183	466 *
Branch "B"- Main line to scrubber	2851	2238 *
Scrubber exhaust "C"	5849	2304 *
Fan exhaust "D"	3266	2564 *

* These values were corrected for temperature and pressure.

REFINERY EXHAUST VENTILATION SYSTEM
COCA MINES, INC.
CATUS GOLD MINE

U. S. Department of Labor

Mine Safety and Health Administration
P.O. Box 25367
Denver, Colorado 80225–0367

August 11, 1989

File: D6642-T447

MEMORANDUM FOR: RODRIC M. BRELAND
Field Office Supervisor
MSHA, M/NM Mine S&H Field Office
Boulder City, NV

FROM : JOHN W. BARTON
Chief, Toxic Materials Division

SUBJECT : Mercury Health Hazard Surveys & Evaluations
Cactus Gold Mines Company Mill
Kern County, CA
(MSHA I. D. No. 04-04787)
May 2-4, 1989 & July 18, 1989

Attached are two copies of above named report. Copies have been distributed internally as shown below. Copies of this report have been requested by the Cactus Gold Mines Company.

Attachments (2)

cc: D. Walker (w/attach.)
D. J. Park "
M. Zalesak "
S. Kneipple "
M. Lynham "

D6642-T447

UNITED STATES DEPARTMENT OF LABOR
MINE SAFETY AND HEALTH ADMINISTRATION

TECHNICAL SUPPORT

Mercury Health Hazard Survey and Evaluation

Cactus Gold Mines Company Mill
Coca Mines, Inc.
Kern County, CA
(MSHA I. D. No. 04-04787)

May 2-4, 1989

and

July 18, 1989

by

Stephen M. Kneipple
Industrial Hygienist

Issuing Office
Toxic Materials Division
John W. Barton, Chief

SAFETY AND HEALTH TECHNOLOGY CENTER
D. K. Walker, Chief

P. O. Box 25367, Denver Federal Center
Denver, Colorado 80225

INTRODUCTION

At the request of the Boulder City Field Office, Western District, Metal and Nonmetal Mine Safety and Health, Mine Safety and Health Administration (MSHA), Boulder City, NV, I conducted mercury health hazard surveys and evaluation at the gold and silver processing mill, Cactus Gold Mines Company, Kern County, CA (MSHA I. D. NO. 0404787), during the periods of May 2-4, 1989 and July 18, 1989. These surveys were a follow-up to surveys conducted during the periods of March 29 and 30, 1989 and April 11, 12, and 13, 1989.

PURPOSE

The purpose of these surveys was to review and evaluate the Cactus Gold Mines Company's efforts to:

1. Control and manage employees' exposures to harmful concentrations of mercury vapor and liquid.

2. Remove mercury from the gold/silver precipitate prior to drying or refining operations.

and

3. Clean-up, decontaminate, and dispose of mercury contamination within the interior and exterior of the mill building and its surrounding compound area.

MERCURY HEALTH HAZARD

Evaluation of Mercury Vapor Exposure During Refining Process

As of July 18, 1989, during the refining of precipitate from the Shumake ore, mercury vapor exposures were less than the current threshold limit value, time-weighted average (TLV-TWA) for mercury of 0.05 mg/m^3*. The precipitate refiner had the greatest exposurer: 0.010 mg/m^3, 8-hour TWA.

Refining Room: During actual smelting and pouring of gold/silver precipitate (from 10:55 a.m. to 1:04 p.m.), mercury vapor concentrations varied from 0.009 mg/m^3 to 0.039 mg/m^3. These measurements were instant and analyzed using a Gold Film Mercury Vapor Analyzer, Model 411, Jerome Instrument Corporation, Jerome, AZ.

* Threshold Limit Values and Biological Exposure Indices for 1986-1987, American Conference of Governmental Industrial Hygienists.

Mercury Management and Control Program

This program is excellent. The mining company has done an outstanding and conscientious job in controlling mercury exposure in the mill and in protecting mill personnel.

BACKGROUND

Based on mercury vapor measurements at the Cactus Gold Mines Company's gold/silver processing mill prior to July 18, 1989, harmful levels of mercury vapor were released into mill's atmosphere during both the drying and refining (i.e., smelting) of gold/silver precipitate. At a number of locations at the mill, mercury vapor exposures exceeded the threshold limit value, 8-hour time-weighted average (TLV 8-hour TWA) for mercury of 0.05 mg/m^3. Inside the mill building, the mercury vapor contaminated floors, walls, and equipment. Outside the building, the mercury vapor condensed and collected as droplets and puddles of liquid mercury on the mill's roof, surrounding soil, and other surfaces. Work clothing and protective equipment became contaminated with mercury. Contaminated work clothing was normally worn home by mill employees and proved to be a source of mercury contamination in their personal vehicles and homes.

Mercury Source

The mercury is in the gold/silver bearing ore. It is readily complexed by cyanide solution and forms amalgams with the gold and silver in the precipitate. Until recent changes were made in the processing of the precipitate, the mercury was not controlled but allowed to vaporize out of the precipitate during the drying and smelting processes and to freely contaminate the mill and its personnel.

Mercury Contamination Process

Most of the mercury vapor was drawn through the refining furnaces' exhaust system. While the in-line scrubber was able to remove some of the mercury, large quantitites were still exhausted into the mill's outside work areas. And, because of a combination of inadequate interior area ventilation and inadequate capture capacity of the furnace exhaust hood, some mercury escaped into and permeated to other areas of the mill.

OBSERVATIONS AND FINDINGS

MEASUREMENT OF EXPOSURES TO MERCURY VAPOR

Sampling/Analytical Method - OSHA Method 140

1. Sample Collection

    a. SKC Passive Mercury Dosimeter
    b. Passive diffusion rateL 0.02 lpm
    c. Sampling time: full-shift

2. Sample Analysis

    a. Flameless atomic adsorption
    b. All samples analyzed by:

~~Analytical Laboratory~~
U. S. Dept. of Labor
Mine Safety and Health Administration
Safety and Health Technology Center
Denver, CO

Mercury Vapor Exposure Concentrations:
Full-shift mercury vapor exposures were measured only during work shifts when the mill was refining gold/silver precipitate. The results are presented in Table I.

Note: The high mercury exposures on May 4, 1989 reflect the refining of unretorted precipitate. Mercury exposures on July 18, 1989 are within acceptable safe exposure concentrations and reflect the refining of precipitate from which the mercury has been removed by retorting.

Note: When working in areas with high concentrations of mercury vapor, all mill employees and service persons were required to wear appropriate respiratory protection.

PROGRAM FOR MANAGING AND CONTROLLING MERCURY AT THE MILL

The Cactus Gold Mines Company has developed and implemented the following program for managing and controlling mercury at its gold/silver processing mill.

PERSONAL PROTECTION

Respirator Program - Cactus Gold Mines Company

Application: All mill/mine employees and service persons who work in designated respirator-use areas.

Design: Consistent with requirements of "American National Standards Practices for Respiratory Protection ANSI Z88.2-1969"

1. Written program

2. Selection of appropriate mercury respirators:

    a. Glenaire MX/PF 9500 Series Respirator with C-27 cartridges (MSHA-NIOSH Approval TC-23C-916).
    b. MSA Comfo II - sizes small, medium, and large - with Mersorb cartridges (MSHA-NIOSH Approval TC-23C-629).
    c. National Draeger, Inc. full-face supplied-air respirator, pressure-demand type C with 5 to 15 minutes SCBA for escape, for use when refining gold/silver precipitate and other operations where mercury vapor may exceed 0.5 mg/m^3.

3. Individually issued respirators
4. Respirator fit-testing
5. Respirator training and instruction

    a. Proper wearing, maintenance, cleaning, and storage.
    b. Appropriate use and limitations.

6. Respirator maintenance and repair

    a. Specific person(s) assigned for following tasks.
    b. Respirators cleaned, decontaminated, sanitized, dried, and stored after each shift.
    c. Worn and defective parts are replaced with new ones as necessary.
    d. Air purifying cartridges are replaced as needed.

Personal Protective Clothing

1. Mercury-free, sanitized coveralls provided daily to each mill employee
2. Mercury-contaminated coveralls are:

    a. Collected at the end of each shift.
    b. Not worn outside designated work areas or off mine property.
    c. Cleaned (or disposed of) by the mine's management.

Personal Hygiene Facilities

1. Special room to remove mercury-contaminated clothing
2. Shower room
3. Mercury-safe locker room for changing into and out of street clothes
4. Sink for washing hands and face
5. Mercury-safe area/facility for eating, drinking, or smoking

Personal Hygiene Practices

During each work shift, mill personnel are:

1. Not permitted to eat, drink, use tobacco products, or chew gum within mercury-respirator areas
2. Required to remove coveralls and respirator, and wash hands and face before eating, drinking, or using tobacco products outside mercury respirator areas

<u>and</u>

At the completion of each work shift, mill personnel are required to remove all contaminated clothing and equipment in the designated change facility and shower before changing into street clothes and leaving mine property.

Medical Surveillance

1. Weekly analysis of mercury in urine.
2. Scheduled physical examinations.

Mercury Vapor Monitoring

Mercury vapor is measured as necessary with a portable, direct reading Gold Film Mercury Vapor Analyzer Model 431, Jerome Instruments Corp., Jerome, AZ.

ENGINEERING CONTROLS AND MANAGEMENT PRACTICES FOR MERCURY

Clean-up and Disposal of Mercury Contamination and Waste Mill Building and Mill Equipment

1. Rain gutters installed collect mercury from roof

2. All interior and exterior surfaces cleaned with a mercury-complexing agent and washed down with water to remove mercury contamination as necessary. Surfaces include walls, floors, windows, doors, the mill's roof and ceilings, milling and refining equipment, toilet and lavatory fixtures, and furniture and counter space
3. A special vacuum cleaner acquired to remove liquid mercury
4. Mercury-contaminated wash water drained into barren pond; solid mercury waste stored in sealed containers until disposed of

Mercury-Contaminated Soil

Scraped-up and removed to cyanide-leach piles; replaced with mercury-free soil.

Ventilation of Mercury Vapor from the Mill Building Refining/Filter Press Room (Figure 1)

Local area ventilation system redesigned, more effective.

a. Air flow is more laminar and directed away from other inside areas
b. Doors are closed for more effective directional ventilation
c. Any mercury vapor is vented directly outside to retort area and leach piles and away from work areas

Control of Mercury Vapor in the Refining Furnace Exhaust System Removal of Mercury from Gold/Silver Precipitate

Elective retort furnace with condensor and collector storage reservoir

a. Completely enclosed process
b. Replacement for open-tray drying of precipitate
c. <200 ppm mercury in retort-processed precipitate

Removal of Mercury from the Refining Furnace Exhaust

1. Special, iodine-treated chracoal filter

    a. Removes small amounts of mercury
    b. Easily cleaned and recharged
    c. Part of exhaust system

2. Water scrubber

    a. Designed to remove metal fume
    b. Removes and retains some mercury from the furnace exhaust

ACKNOWLEDGEMENT

The cooperation and assistance of the Cactus Gold Mines Company's management and employees in helping MSHA personnel conduct these surveys is gratefully acknowledged.

Stephen M. Kneipple
Industrial Hygienist

Approved:

August 11, 1989

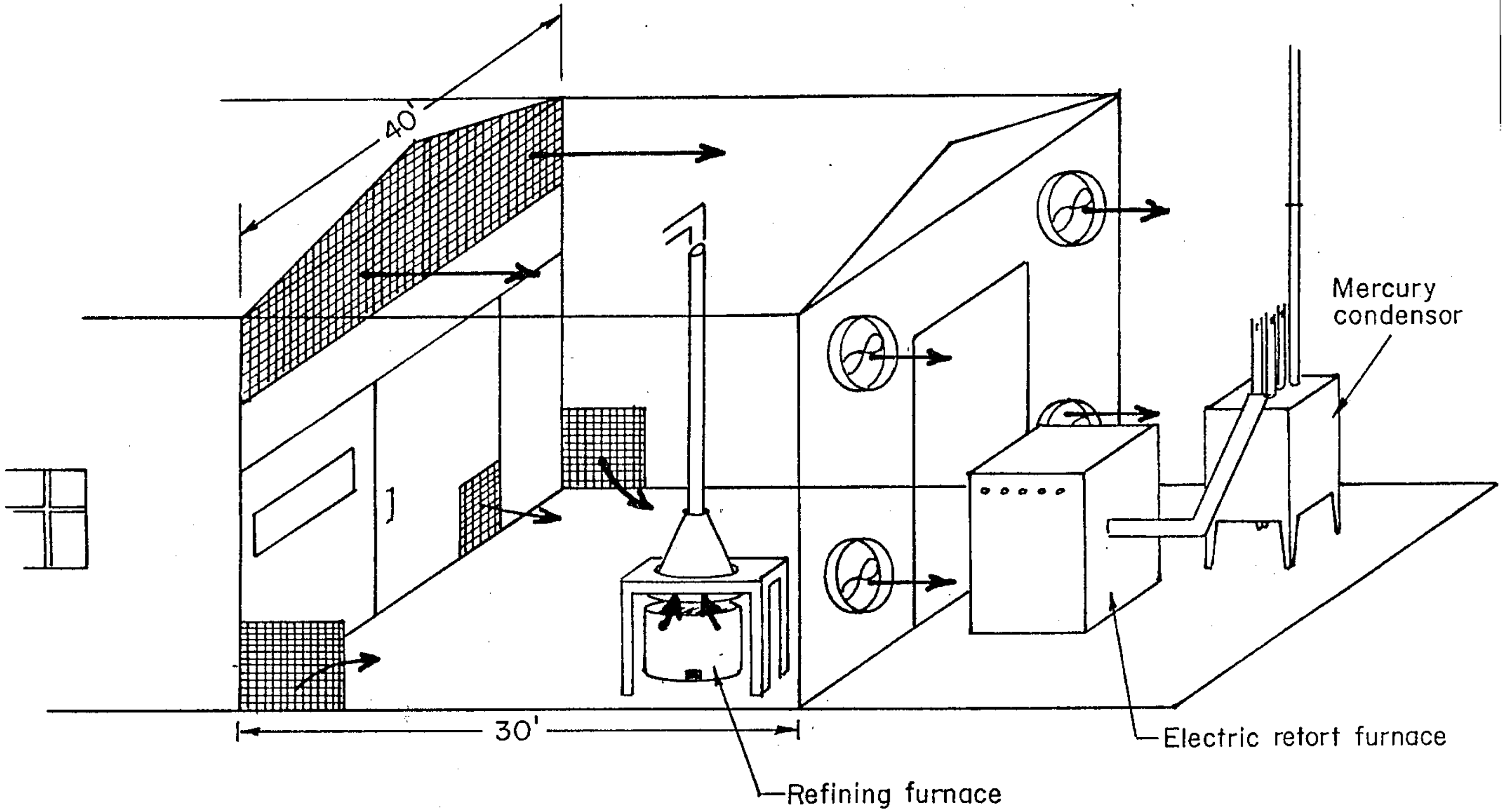
John W. Barton
Chief, Toxic Materials Division

TABLE 1

Mercury Exposures During Refining Operations

Date	Sampling Location/ Person	Exposure Time (min.)	Exposure (mg/m^3) 8-hr. Time-Weighted Avg.	Shift-Weighted Avg.	Comments
5/04/89	R. Breedlove, refiner	386	0.111	0.138	Refining operation Middle Butte precipitate; moisture removed
	R. Suipizio, mill operator	428	0.031	0.035	
	R. Ruiz, mill laborer	323	0.109	0.162	
	R. Soto, mill laborer	322	0.169	0.253	
7/18/89	P. Owen, refiner	417	0.010	0.012	Refining operation
	J. Bettancourt, mill operator	406	0.002	0.002	Shumake precipitate; mercury and moisture removed during retort operation
	Mill-40' from ext. stack	381	0.002	0.003	
	Mill-20' from stack	380	0.002	0.003	
	Exhaust/scrubber pad	379	0.003	0.004	

FIGURE 1



AREA VENTILATION SYSTEM - JULY 18, 1989
REFINING/FILTER PRESS ROOM
CACTUS GOLD MINES CO. MILL, KERN COUNTY, CA.
MSHA I.D. No. 0404787