WALK-THROUGH SURVEY REPORT:

CONTROL TECHNOLOGY FOR MINE ASSAY LABORATORIES

AT

Skyline Laboratories, Inc.
Wheat Ridge, Colorado

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SIC CODE:	8734
SURVEY DATE:	September 16, 1992
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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. 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 mine assay laboratories is being undertaken by ECTB to provide control technology information for preventing occupational disease in this industry. This project is part of a NIOSH special initiative on small business and will be accomplished by developing and evaluating control strategies and disseminating control technology information to mine assay laboratories nationwide.

The goal of this research study is to identify, evaluate, and disseminate practical and cost effective control methods which reduce exposures to arsenic, cobalt, lead, mercury, and respirable crystalline silica to below the respective NIOSH recommended exposure limits (RELs) and OSHA/MSHA permissible exposure limits (PELs) for workers in mine assay laboratories. This will be accomplished by identifying and evaluating existing control methods used in mine assay laboratories. The results of these field evaluations will be presented in in-depth survey reports for each laboratory. These reports will be summarized in a scientific journal article, trade journal articles, and in handbooks which will be disseminated to the workers, owners, and operators of mine assay laboratories, to the OSHA/MSHA consultation program, and to other safety and health professionals.

As part of this overall study, a walk-through survey was conducted at Skyline Laboratories Inc. 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 mine assay laboratories.

PLANT AND PROCESS DESCRIPTION

Skyline Laboratories is a commercial mine assay laboratory which analysis samples from various mines throughout the world. Skyline Laboratories operates one shift a day and presently has a work force consisting of 15 employees.

PROCESS DESCRIPTION

Assay samples sent to Skyline Laboratories from various mines are delivered to the sample receiving area of the laboratory in individual bags weighing approximately 10-12 pounds. Wet samples are dried in an oven at approximately 200 degrees Fahrenheit. The samples are crushed in one of the two ventilated jaw crushers to approximately 1/4" granules. The crushed samples are reduced to a finer texture in a ventilated roll crusher. The samples are split in a splitter box to obtain a smaller representative portion which is pulverized to approximately 200 mesh in a ring and puck pulverizer. Approximately 200 grams of material are sent to the flux mixing area. The size reduction devices are cleaned out with a paint brush and in some cases compressed air.

Large batches of fluxing agents consisting of borax, flour, silica sand, and soda ash are prepared in a barrel mixer. The barrel is placed in a ventilated hood and 50 lbs of litharge (lead oxide) is added to the fluxing material. The barrel is sealed, removed from the ventilated hood, then placed on a roller and mixed for approximately 30 minutes until the flux and litharge are thoroughly mixed. The fluxing material is approximately 60 percent litharge. The barrel is placed back under the ventilated hood where the seal is removed. Part of the fluxing material is removed from the barrel and placed in a container located inside the hood. The barrel is then resealed, removed from the hood, and placed in storage. Fluxing material and pulverized assay samples are added to crucibles and thoroughly hand mixed in the ventilated hood. The crucibles (containing the sample and fluxing material) are then placed in one of the two fusion furnaces that operate at approximately 2000 degrees Fahrenheit.

The carbon contained in the flour reduces part of the lead oxide to lead which combines with the precious metals released from the ore.[1] The samples are then removed from the oven and the lead is separated from the slag by pouring the samples into metal button molds. A lead button is formed in the bottom of the metal mold. After cooling, the lead button is removed.

Lead buttons, which contain the precious metals, are placed into a bone ash cupel. The cupel is placed in a cupellation furnace where the lead is oxidized and absorbed by the cupel, leaving the precious metals at the bottom of the cupel. In some cases a controlled amount of silver is added to the samples in order to obtain a visual amount of precious metals in the bottom of the cupel. The precious metals are then collected and weighed in a balance room.

POTENTIAL HAZARDS

Workers in this commercial assay laboratory are potentially exposed to lead, crystalline silica, respirable dust, mercury, 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, kidney, and hematopoietic (blood-forming) system.[2] 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.[3-4] Lead exposure is associated with fetal damage in pregnant women.[2-4] Finally, elevated blood pressure has been positively related to blood lead levels.[5-6]

Crystalline Silica

Crystalline silica causes silicosis, a form of disabling, progressive and sometimes fatal pulmonary fibrosis characterized by the presence of typical nodulation in the lungs or chest X-ray.[4] Historically, many silicotic workers had tuberculosis. In some mines up to 60 percent of the workers with silicosis had tuberculosis.[7]

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.[8,10] 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.[4]

Inorganic Mercury

Acute effects of overexposure to inorganic mercury include chest pain, cough, chemical pneumonitis, and bronchitis. Chronic exposures can produce symptoms of weakness, loss of appetite, loss of weight, insomnia, diarrhea, nausea, headache, and excessive salivation. It may also cause metallic taste in the mouth, loose teeth, soreness of the mouth, a black gum line, irritability, loss of memory, and tremors of the hands, eyelids, lips, tongue, or jaw. The four historical manifestations of mercury poisoning are: gingivitis, increased irritability, and muscular tremors. Mercury can also cause allergenic skin rash and is a primary irritant of the skin and mucous membranes.[4,11]

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

Skyline Laboratories Inc. employs local exhaust ventilation and partial enclosures in the sample preparation area, flux mixing, and fire assay areas. In addition, HEPA-filtered half-mask respirators are worn during hazardous tasks.

In the sample preparation area, pulverizers are located in ventilated hoods; in addition, lids are utilized to cover the pulverizers during operation. There are two jaw crushers located in the sample preparation area with local exhaust ducts attached to them (see Table 1 for ventilation measurements). The roll crusher is located in a ventilated enclosed hood. Blast gates are installed on the ventilation system in the sample preparation area to control direction of air flow to each system.

The litharge, fluxing agents, and sample are added to the crucible under a ventilated exhaust hood (Figure 1). The face opening of the hood is 14" high by 4'6" wide. Velocity measurements at the face of the litharge hood were taken with the door to the litharge mixing area open and closed. The average face velocity and air flow into the litharge hood and jaw crusher are shown in Table 1.

Table 1: Average Face Velocity an Air Flow into Litharge Hood and Jaw Crusher

	Average Face Velocity (fpm)	Air Volume (cfm)
Jaw crusher (upper opening)	730	180
(lower opening)	80	121
Litharge Hood (door open)	134	700
(door closed)	150	790

Each of the two fusion furnaces has an exhaust hood on top of the furnace above the door. The primary purpose of these hoods is to capture fumes when the doors are open. The cupellation furnace also has an exhaust hood located on top of the furnace above the door. With the furnaces operating it was too hot to take ventilation measurements. All ventilation controls at this facility seemed to be in good condition at the time of our survey.

WORK PRACTICES

A paint brush is utilized to clean out ring and puck pulverizers, and in some cases, compressed air is utilized.

MONITORING

Normally blood lead analysis is conducted on a quarterly basis. A hearing conservation program is in place for employees working in the sample preparation areas.

PERSONAL PROTECTIVE EQUIPMENT

In the fire assay area aluminum lined gloves, lab coats, aprons, safety glasses, and safety shoes were utilized by employees. HEPA-filtered half mask respirators are worn during sample preparation operations. Ear plugs or ear muffs must be worn in the sample preparation areas.

HYGIENE

A shower facility and a separate break area are available for employees at the laboratory. No eating, drinking, or smoking is permitted in the laboratory areas.

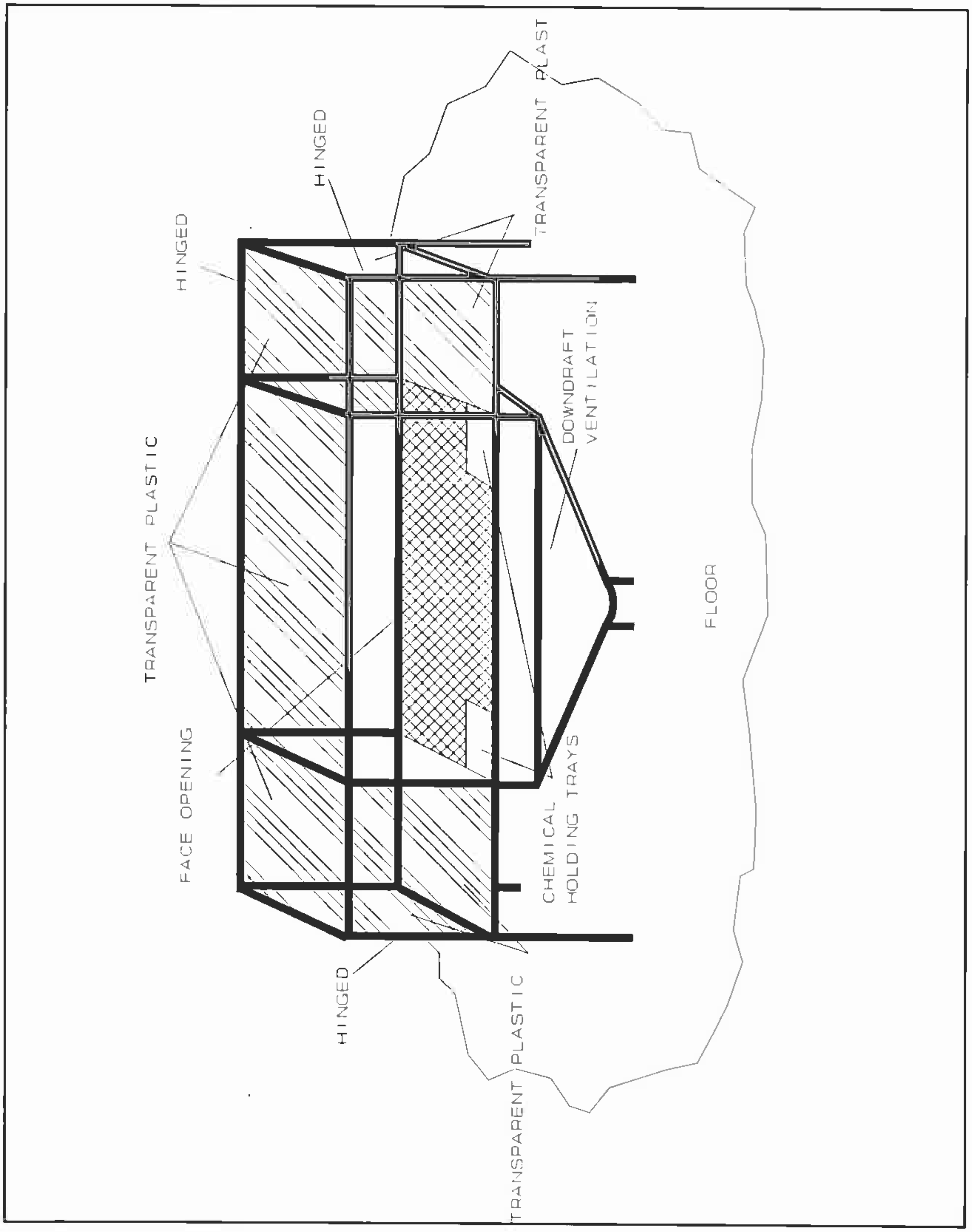

Figure 1. Litharge mixing ventilated hood.

CONCLUSIONS AND RECOMMENDATIONS

Skyline Laboratories is a commercial assay laboratory that analyzes samples from various parts of the world. Laboratory workers are potentially exposed to a variety of chemical agents such as lead, arsenic, mercury, and respirable crystalline silica. The greatest potential for excess exposures is in the sample preparation area, litharge mixing area, and fire assay area. Local exhaust ventilation and partial enclosures in the sample preparation area, litharge mixing area, and fire assay area are used to control worker exposures. When compressed air is used to clean equipment, the pressure at the nozzle should not exceed 30 pounds/square inch.[12] HEPA half-mask respirators are worn during sample preparation operations. Because of the apparent effectiveness of the controls, this assay laboratory operation would be a suitable site for an in-depth evaluation.

REFERENCES

1. Daniels W, Hales T, Lee S, Gunter B, Goldfield J [1991]. Case Studies: Lead Exposures in Gold Fire Assay Laboratories. Appl Occup Environ Hyg 6(4):252-4.

2. Doull J, Klaassen CD, Amdur MD [1980]. Casarett and Doull's Toxicology 2nd Ed. MacMillan Publishing Co., Inc., New York.

3. NIOSH [1972]. NIOSH criteria for a recommended standard...occupational exposure to inorganic lead. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. HSM 73-11010.

4. NIOSH [1981]. Occupational health guidelines for chemical hazards. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH)/DOL (OSHA) Publication No. 81-123 and supplements 88-118, 89-104.

5. Kristensen TS [1989]. Cardiovascular Diseases and the Work Environment--A Critical Review of the Epidemiologic Literature on Chemical Factors. Scand J Work Environ Health 15:245-264.

6. Pirkle JL, Schwartz J, Landis JR, Harlan WR [1985]. The Relationship Between Blood Lead Levels and Blood Pressure and Its Cardiovascular Risk Implications. Am J Epidemiol 121:2(246-58).

7. Silicosis in the Metal Mining Industry--A Revaluation--1958-1961. U.S. Department of Health, Education, and Welfare and U.S. Department of the Interior. Public Health Service Publication No. 1076, Washington, D.C.

8. NIOSH [1975]. Criteria for a Recommended Standard-Occupational Exposure to Inorganic Arsenic; New Criteria-1975. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 75-149.

9. NIOSH [1987]. NIOSH Alert: request for assistance in reducing the potential risk of developing cancer from exposure to gallium arsenide in the microelectronics industry. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 88-100.

10. NIOSH [1982]. NIOSH testimony to U.S. Department of Labor: comments at the OSHA arsenic hearing, July 14, 1982. NIOSH policy statement. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health.

11. NIOSH [1977]. Occupational Diseases - A Guide to Their Recognition, Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-181.

12. CFR. Code of Federal Regulations [29 CFR 1910.242(b) (Rev. July 1, 1990)]. U.S. Department of Labor. Occupational Safety and Health Administration.