WALK-THROUGH SURVEY REPORT:

CONTROL TECHNOLOGY FOR MINE ASSAY LABORATORIES

AT

Pinson Mine
Winnemucca, Nevada

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PLANT SURVEYED:	Pinson Mine P.O. Box 129 Winnemucca, Nevada 89445
SIC CODE:	8734
SURVEY DATE:	March 19, 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 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 their respective NIOSH recommended exposure limits (RELs) and OSHA/MSHA permissible exposure limits (PELs) for workers in mine assay laboratories. The study 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 the mine assay laboratory located on the Pinson Mines site. 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

Pinson Mine is a gold and silver mining operation. The entire mining operation employs 110 workers. A total of ten workers are employed in the assay laboratory operation covering two shifts: day shift is seven days per week and swing-shift is five days per week. The assay laboratory performs approximately 10,000 determinations per month. Of these, 2,500 to 3,000 are fire assay analysis. Samples analyzed in the mine assay laboratory are obtained from exploration holes and blast holes samples as well as from the mineral ore recovery processes. Exploration samples are taken at 5 feet intervals down to a depth of 500 feet. Rayrock Yellow Knife is the operating company for Pinson Mine site. Outdoor temperatures at the mine site range from -40°F to 100°F during the year.

PROCESS DESCRIPTION

Rock, ore, dirt, and core samples are brought to the sample receiving area of the assay laboratory in individual bags weighing 5 to 10 pounds. Samples that are too wet are dried in an oven located in a room separate from the rest of the sample prep operations. The samples are crushed, split, and pulverized. Samples are crushed in either a jaw crusher or a cone crusher and then ground to 85 percent less than 200 mesh size in one of two identical pulverizers. This crushed material is then poured into envelopes. Each sample from the pulverizer weighs 200 grams.

The sample splitter is located in an enclosed ventilated hood with an exhaust opening in the back of the hood and a downdraft opening located near the splitter. Pulverizers are each located in ventilated hoods with glass doors. There are 4 inch high openings between the sashes of the glass doors and the tables to allow supply air into the hoods. To prevent cross contamination between samples, the pulverizer is cleaned off with compressed air after each sample is ground. Fixed nozzle compressed air jets for cleaning the pulverizer are located in the hood above the pulverizer. Next to each pulverizer hood is another ventilated hood where the crushed samples are poured into envelopes. Using a compressed air gun, the worker cleans off the table after each sample is poured. The worker spends about one hour per shift at the splitter and half the shift at the pulverizer. The current sample preparation operation was installed in 1986.

Three 200 to 300 pound mill feed samples are brought to the assay laboratory for analysis each day. These samples, contained in 55 gallon drums, are fed by overhead cranes to a crusher and a large sample splitter. This operation is performed outside because of the bulk of the samples. The moisture content of the dust is generally sufficient to minimize dust levels. Several slurry samples from the mill stream also are analyzed. These samples, containing 30 to 40 percent solids (60 to 70 percent moisture), are separated in a filter press, which is located inside the laboratory, and the liquid and solid portions are analyzed separately.

The samples are then mixed with lead oxide, borax, flour, silica sand, and soda ash in a process called fluxing. Mixing is done by hand or with an automated mixer. In the fire assay room the fluxed samples are placed into an oven that operates at a temperature of approximately 2000 degrees Fahrenheit (°F). 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 cone molds. A lead button is formed in the bottom of the metal cone. After cooling, the material in the metal cone is removed and the worker breaks excess slag away which frees up the lead button.

The lead buttons, which contain the precious metals, are placed into a bone ash or magnesium oxide cupel. The cupel is placed in another oven where the different melting points of lead and the precious metals are exploited for extraction of the metals. The lead is absorbed by the cupel, leaving the precious metals at the bottom of the cupel. Sometimes, controlled amounts of silver are added to the samples in order to obtain a visual amount of precious metals in the bottom of the cupel. The remaining material is taken to the balance room and weighed to determine the amount of precious metal. Pinson has three gas-fired fusion furnaces, each with a ventilated hood, and one electric cupellation furnace with an exhaust hood in the fire assay room. The laboratory also has a process room called the high grade prep area. This room contains a pulverizer and is used only a few times per month.

Alternate recovery techniques involve wet chemistry with acidic or cyanide digestion. These procedures are performed in the wet chemistry laboratory.

POTENTIAL HAZARDS

Workers in this mine assay laboratory are potentially exposed to lead, crystalline silica, respirable dust, mercury, and arsenic. Because mining is presently done in an oxide pit, arsenic and mercury exposures are generally low. Oxide ore bodies tend to be low in arsenic and mercury while refractory ore bodies can be much higher in these metals.

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] Evidence indicates that crystalline silica is a potential occupational carcinogen and NIOSH is in the process of reviewing the data on carcinogenicity.[8-11]

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.[12-14] 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. Three historical manifestations of mercury poisoning are: gingivitis, increased irritability, and muscular tremors. Mercury can cause allergenic skin rash and is a primary irritant of the skin and mucous membranes.[4,15]

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

Pinson Mine 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 laboratory the sample splitter hood, cone crusher and jaw crusher are equipped with downdraft local exhaust ventilation. Flexible hoses from the three units connect into a distribution box which is tied into a single exhaust fan. The average face velocity and air flow into the sample splitter hood and the face velocity at the mouth of the jaw crusher are shown in Table 1. Each pulverizer has its own ventilated hood with a glass door in front. The sash of the glass door is positioned 4 inches above the bench so that make-up air flows under the door into the hood. The glass door prevents dust from being blow into the room while the pulverizer is being cleaned with compressed air. Next to both pulverizer hoods are pouring stations with ventilated hoods. The face velocity and air flow into these hoods are presented in Table 1. Each hood has a 2 HP fan with a 1725 rpm motor.

Table 1. Ventilation Measurement in Sample Preparation Laboratory

LOCATION	FACE VELOCITY (fpm)	AIR VOLUME (cfm)
Sample Splitter Hood	110	2480
Jaw Crusher	830	--
Left Pulverizer	1450	1200
Left Pour Station	260	2260
Right Pulverizer	1040	840
Right Pour Station	220	1990

Premixed flux including lead oxide (litharge), silica sand, and other ingredients are mixed in an exhaust hood made of plexiglass with the exhaust opening in the table. The premixed flux contains a mineral oil which helps control dust levels - especially lead - during mixing. The face opening of the hood is 14 inches high by 94 inches wide and the downward exhaust opening in the table is 48 by 3½ inches. The average face velocity and the total airflow into the hood are shown in Table 2. There is also an automatic mixer that is sometimes used to mix the flux with the samples which helps reduce the workers exposure compared to hand mixing.

Table 2. Ventilation Measurement in Flux Mixing and Fire Assay Area

LOCATION	FACE VELOCITY (fpm)	AIR VOLUME (cfm)
Flux Mixing Hood	40	370
Fusion Furnace (left)	640	180
Fusion Furnace (center)	400	110
Fusion Furnace (right)	240*	60*
Cupellation Furnace	300	1060

*heat from furnace appeared to affect hot-wire anemometer readings.

Each of the three fusion furnaces has an exhaust hood on top of the furnace above the door. The primary purpose of these hoods is to exhaust fumes when the doors are open. The cupellation furnace has a large hood that is above the furnace and extends 17 inches in front as well as along both sides. Ventilation measurements taken during the survey are shown in Table 2. Exhaust air from all the local exhaust ventilation units is discharged directly outside.

The local exhaust ventilation hoods were fabricated by an outside contractor but were installed by company staff. Ventilation ducts were installed by a contractor. The sample prep hoods are rolled sheet metal that is painted for appearance. The current sample prep operation was built in 1986. A glass company was hired to put in the glass doors in the sample prep hoods. Hoods over the furnaces in fire assay are made of stainless steel and are in good condition after 11 years.

WORK PRACTICES

Operators in the sample preparation area use compressed air at 50 psi to clean dust off the work area and equipment. Operators are able to do a good job of cleaning at this reduced air pressure. However, this is still above the OSHA standard for air hose pressure which is 30 psi for cleaning purposes.[16] It is recommended that the air hose pressure for cleaning be reduced to 30 psi.

MONITORING

The company air monitoring program consists of personal sampling for lead and total dust along with periodic sampling for mercury using a Jerome mercury sniffer. Biological monitoring consists of weekly collection and analysis of urine for mercury; and quarterly analysis of blood for lead and mercury. Company records show the highest blood lead level among assay laboratory workers from April 1990 to March 1992 was 28 μg/dl.

PERSONAL PROTECTIVE EQUIPMENT

Half-mask respirators for dusts, fumes, mists, radionuclides, radon daughters, and asbestos (Glendale model #C50A) were worn in the fire assay room. In addition, the fire assayists wore either welding, aluminum backed, or Xetex gloves and coveralls. The company provides each worker five sets of coveralls and there is a laundry service to take care of the coveralls. Ear plugs or ear muffs must be worn in the sample prep room.

HYGIENE

The laboratory includes shower and locker room facilities. Workers in the fire assay area must take showers after work; others can if they want. No eating, drinking, or smoking is permitted in the fire assay area.

The laboratory also uses administrative controls to limit exposures in the fire assay room.

CONCLUSIONS AND RECOMMENDATIONS

The Pinson mine assay laboratory analyzes samples from blast holes and exploratory drill holes as well as surface grab samples. The assay 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, during litharge mixing, and in the fire assay room. Pinson Mine employs local exhaust ventilation and partial enclosures in sample prep and litharge mixing. In the fire assay operation, local exhaust ventilation is employed and HEPA half-mask respirators are worn. Because of the apparent effectiveness of the controls, this mine assay laboratory operation would be a suitable site for an in-depth evaluation.

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