WALK-THROUGH SURVEY REPORT:

CONTROL TECHNOLOGY FOR MINE ASSAY LABORATORIES

AT

Rabbit Creek Mine
Winnemucca, Nevada

REPORT WRITTEN BY:
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Public Health Service
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SIC CODE:	8734
SURVEY DATE:	March 18, 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 and injury. 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 a small business.

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. 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 Rabbit Creek 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

Rabbit Creek is a gold mining operation employing approximately 230 workers. Eight workers are employed in the assay laboratory operation. Laboratory workers have a schedule that consists of 10-hour shifts with 4 days on and 3 days off. The assay laboratory performs approximately 100 fire assay samples per day. Samples analyzed in the mine assay laboratory are obtained from exploration hole and blast hole samples as well as from the mineral ore recovery processes. Outdoor temperatures at the mine site range from -40°F to 100°F during the year.

PROCESS DESCRIPTION

The rock, ore, dirt, and core samples are brought to the sample receiving area of the assay laboratory in individual bags weighing 10 to 30 pounds. Samples that are too wet are dried in an oven located in the sample prep area. The samples are split, crushed, and pulverized, then ground to 85 percent less than 400 mesh size in one of two identical pulverizers. This crushed material is then poured into envelopes. Each sample from the pulverizer weighs approximately 200 grams.

The sample splitter is located in an enclosed ventilated hood with an exhaust opening in the back of the hood. Pulverizers are located in ventilated hoods with Plexiglass® installed at the face of the hoods to reduce the area of the openings. To prevent cross contamination between samples, the pulverizer is cleaned off with compressed air after each sample is ground. Crushed samples are poured into envelopes inside the ventilated hoods where the pulverizers are located. The worker cleans off the table after each sample is poured using a compressed air gun. Pressure for the compressed air guns is maintained at 60 psi.

The samples are then mixed with mineral oil, lead oxide, borax, flour, silica sand, and soda ash in a process called fluxing. Mixing is done by hand under a ventilated hood. 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 button molds. A lead button is formed in the mold. After cooling the lead buttons, which contain the precious metals, they are removed and placed into a bone ash cupel. The cupel is placed in another oven where the difference in 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. Rabbit Creek has two electric fusion furnaces with ventilated hoods and one electric cupellation furnace with an exhaust hood, which are located in the fire assay room.

Alternate recovery techniques involve wet chemistry with acidic and 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]

Inorganic Arsenic

Inorganic arsenic is strongly implicated in respiratory tract and skin cancer and has been determined to be a 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 [inflammation of the gums], increased irritability, muscular tremors, and sialorrhea [salivation]. Mercury can 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

Rabbit Creek 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 is located in a ventilated hood. A crusher is equipped with down draft local exhaust ventilation. The average face velocity and air flow into the sample splitter hood and the face velocity at the mouth of the crusher with the down draft system are shown in Table 1. The ring and puck pulverizers have their own ventilated hoods with plexiglass installed at the face to reduce the face area. A ventilated hood used for sample preparation operations was located beside the pulverizer hoods. The face velocity and air flow into these hoods are presented in Table 1.

Table 1. Ventilation Measurement in Sample Preparation Laboratory

LOCATION	FACE VELOCITY (fpm)	AIR VOLUME (cfm)
Sample Splitter Hood	163	3211
Crusher with Down draft	240	--
Right Pulverizer Hood	333	3057
Left Pulverizer Hood	372	3415
Sample Preparation Hood	204	3244

The flux including lead oxide (litharge), silica sand, and other ingredients are mixed in an exhaust hood. Mineral oil is added to the flux before mixing to help control dust levels - especially lead. The average face velocity and the total air flow into the hood are shown in Table 2.

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

LOCATION	FACE VELOCITY (fpm)	AIR VOLUME (cfm)
Flux Mixing Hood	142	1534
Fusion Furnace (left)	744	2790
Fusion Furnace (right)	724	2715
Cupellation Furnace	1525	1258
Cupellation Gassing off Hood	183	1922

Each of the two fusion furnaces has an exhaust hood on top of the furnace above the door measuring 15" wide by 36" long. The primary purpose of these hoods is to exhaust fumes when the doors are open. The cupellation furnace has an exhaust hood that is above the furnace and has an opening of 4" wide by 30" long. A ventilated hood, used to gas off the cupolas, was also located in the fire assay area. This hood has a face opening of 48" wide by 31.5" high. Ventilation measurements taken during the survey are shown in Table 2. Exhaust air from all the local exhaust ventilation units is discharged directly outside.

WORK PRACTICES

Operators in the sample preparation area use compressed air at 60 psi to clean dust off the work area and equipment. This is above the OSHA standard for air hose pressure which is 30 psi for cleaning purposes.[12] It is recommended that Rabbit Creek reduce air pressure from 60 psi to 30 psi.

PERSONAL PROTECTIVE EQUIPMENT

Half-mask respirators equipped with HEPA filters were worn in the fire assay room. In addition, the fire assayer wore either welding, aluminum backed, or Xetex gloves and a laboratory coat. Ear plugs or ear muffs must be worn in the sample prep room.

CONCLUSIONS AND RECOMMENDATIONS

The Rabbit Creek mine assay laboratory analyzes samples from blast holes and exploratory drill holes as well as mineral ore recovery processes. 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. Rabbit Creek 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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