# WALK-THROUGH SURVEY REPORT:

# CONTROL TECHNOLOGY FOR MINE ASSAY LABORATORIES

AT

Cone Geochemical Inc.
Lakewood, Colorado

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Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Division of Physical Sciences and Engineering
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| PLANT SURVEYED: | Cone Geochemical Inc.<br>810 Qual Street, Suite 1<br>Lakewood, CO 80215 |
| SIC CODE: | 8734 |
| SURVEY DATE: | September 15, 1992 |
| SURVEY CONDUCTED BY: | NIOSH/DPSE<br>Ronald Hall<br>John Sheehy |
| EMPLOYER REPRESENTATIVES CONTACTED: | Steve Cone, President |
| EMPLOYEE REPRESENTATIVES CONTACTED: | No Union |
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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.

A study of assay laboratories is being undertaken by ECTB to provide control technology information for preventing occupational disease in this industry. This study 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-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 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 Cone Geochemical laboratory. The purpose of this study 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

Cone Geochemical is a commercial geochemical and assay laboratory which analyzes samples from various exploration and development projects throughout North and South America. Cone Geochemical operates one shift a day and presently has a work force consisting of 12 to 14 employees. Temporary employees are utilized during heavier workload periods.

## PROCESS DESCRIPTION

A layout of the laboratory is shown in Figures 1 and 2. The majority of samples are shipped to Cone Geochemical from exploration and development projects via commercial carriers. Samples are taken to the sample receiving area of the laboratory in individual bags weighing approximately 10 to 12 pounds. Samples that are wet are dried in an oven at approximately 250 degrees F. The samples are then crushed to 10 mesh size and are split in a riffle splitter. Approximately 300 grams of the sample is taken to a pulverizer.

Samples are placed in one of the ring and puck pulverizers which are located in totally enclosed containers. Samples are pulverized to 90 percent less than 200 mesh size. The ring and puck holder (the part of the pulverizer which contains the sample) is placed under a ventilated hood where the sample is poured out into an envelope. An air hose is then utilized to blow out the ring and puck holder. Sand is then placed in the ring and puck holder and the holder is put back in the pulverizer for approximately 20 seconds. The ring and puck holder is then removed from the pulverizer and the sand is dumped into a bucket. The air hose is utilized again to blow out the ring and puck holder under the ventilated hood. Sand and air hose operations are performed to prevent cross contamination of samples. A new sample is then placed in the ring and puck holder and the process is repeated. After the sample has been pulverized it proceeds to the laboratory areas.

White flux which contains borax, flour, silica sand, and soda ash is mixed (approximately 200 lbs at a time) in a cement mixer. The white flux is put into crucibles under a ventilated hood. In the weigh room, a specific amount of sample is weighed out on top of the white flux. The crucibles (now containing the white flux and sample) are then placed inside a ventilated hood where the litharge (lead oxide) is added by hand to each sample. Food wrap is placed on top of the crucibles to hold the flux and sample inside. Crucibles then are placed in a sample mixer made out of a wood box with a hand crank on the side. The mixer is turned with the hand crank until the sample and flux are thoroughly mixed. After the samples have been mixed they're placed under a ventilated hood again and checked by hand to make sure that the sample has mixed thoroughly with the flux. Silver nitrate and borax are added to the sample before it goes to the fire assay area.

In the fire assay area the crucibles containing the sample and flux material are placed into a furnace 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 furnace 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.

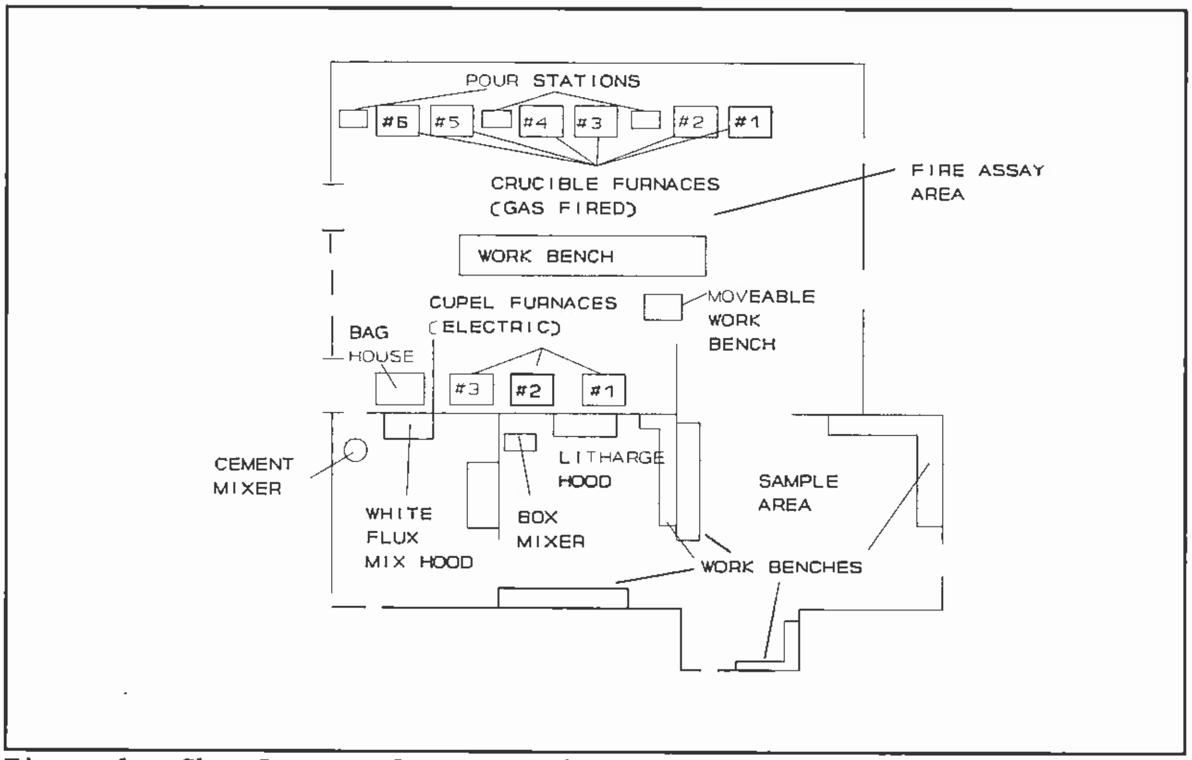


**Figure 1.** Shop Layout of Cone Geochemical.

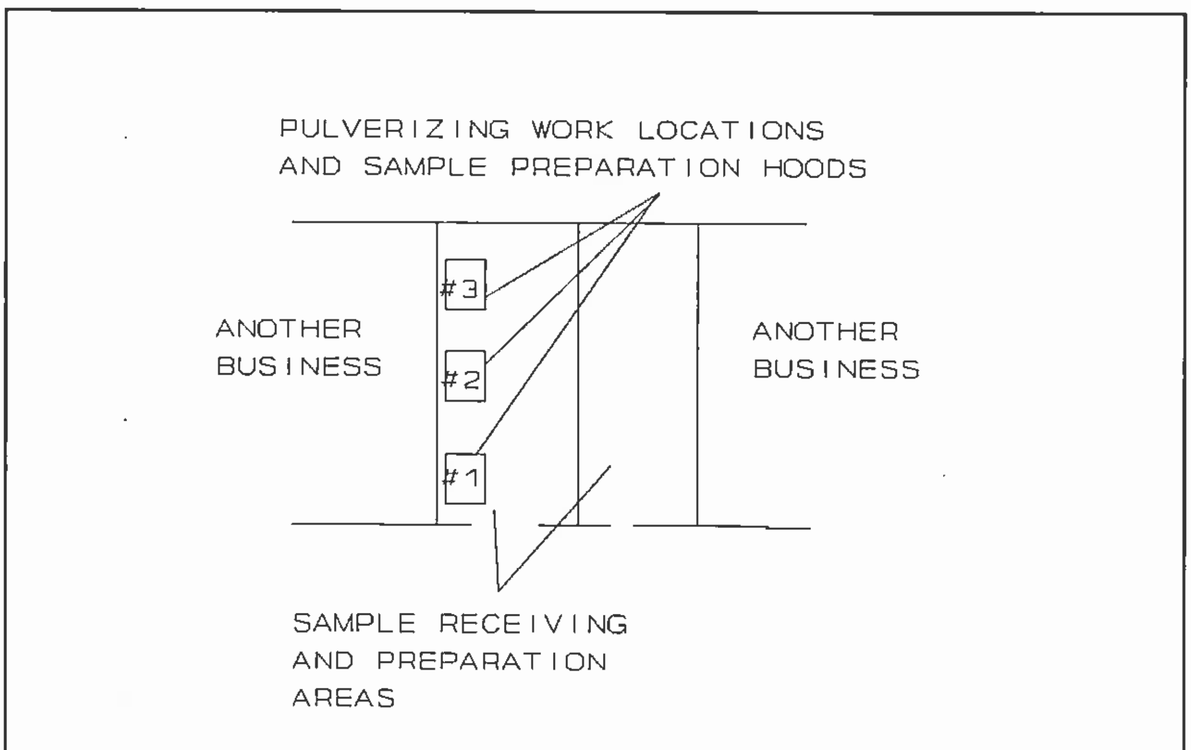


**Figure 2.** Sample Receiving and Sample Preparation Areas Located in Separate Building.

Lead buttons, which contain the precious metals, are placed into a magnesite 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 the fire assay area, there are six gas-fired fusion furnaces with ventilated hoods and three electric cupellation furnaces with ventilated hoods. Precious metals are taken to the balance room and weighed. 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. Nitric acid is added to the precious metal (under a hood) in order to dissolve all the silver so only the gold is left. The gold is then weighed or determined by flame atomic absorption spectrophotometry.

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] 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. The 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

Cone Geochemical 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 the ring and puck pulverizers are located in totally enclosed containers. The pulverizers were not ventilated. Three enclosed ventilated hoods are utilized in the sample preparation area during operations that involve pouring of samples into envelopes and blowing out the ring and puck holders. Ventilation measurements were taken at two of the three hoods during our survey. The average face velocity and airflow into hoods are shown in Table I (see Figure 2 for hood locations). The hoods in the sample preparation area are each 18" high by 4' wide.

The litharge is added to the crucible containing the white flux and sample under a ventilated exhaust hood. The face opening of the hood is 15" high by 3'4" wide. The average face velocity and the total airflow into the hood are shown in Table I (see Figure 1 for litharge hood location). After the litharge has been added to the samples, food wrap is placed on the top of the crucibles and taken to a sample box mixer. The box mixer is totally enclosed and is not ventilated.

| Table I. Ventilation measurements on sample preparation hoods and litharge hood. | | |
|---|---|---|
| | Average Face Velocity (fpm) | Air Volume (cfm) |
| Sample Prep Hood #1 | 140 | 840 |
| Sample Prep Hood #2 | 140 | 840 |
| Litharge Hood | 290 | 1207 |

Each of the six fusion furnaces and each of the three cupellation 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 fusion furnace hoods extended 2.25" out in front of the door. The cupellation furnace hoods extend 14" out in front of the door. At the time of our survey three of the fusion furnaces and two of the cupellation furnaces were being operated. The furnaces in operation were too hot to take ventilation measurements on, however ventilation measurements were obtained on cold furnaces. Ventilation measurements were taken with the make-up air system on and with it off as requested by the laboratory owner. The results of the ventilation measurements are listed in Table II (see Figure 1 for furnace locations). All ventilation controls at this facility seemed to be in good condition at the time of our survey.

| Table II. Ventilation measurements on furnaces. | | |
|---|---|---|
| Location | Face Velocity (fpm) | Air Volume (cfm) |
| Make-up System On | | |
| Fusion Furnace #2 with furnace door open and closed | door open 340<br>door closed 360 | door open 190<br>door closed 200 |
| Cupellation Furnace #3 with door open and closed | door open 90<br>door closed 125 | door open 220<br>door closed 310 |
| Make-up System Off | | |
| Fusion Furnace #2 with door open and closed | door open 260<br>door closed 320 | door open 150<br>door closed 180 |
| Cupellation Furnace #3 with door open and closed | door open 70<br>door closed 90 | door open 170<br>door closed 220 |

WORK PRACTICES

Operators in the sample preparation area used compressed air to blow out ring and puck holders. This operation is performed in order to prevent cross contamination of the samples. The air hose pressure was 80 psi. This is above the OSHA standard for air hose pressure which is 30 psi for cleaning purposes.[16] It is recommended that Cone Geochemical reduce air hose pressure from 80 psi to 30 psi.

MONITORING

Biological monitoring consists of quarterly analysis of blood for lead and zinc protoporphyrin (ZPP). Blood lead levels at the shop average 18 to 19 $\mu$g/dl.

PERSONAL PROTECTIVE EQUIPMENT

In the fire assay area gloves, coveralls, aprons, safety glasses, and safety shoes were utilized by employees. HEPA filtered half mask respirators are not worn during normal operations; however, they are worn during special operations such as rebuilding a furnace. The company provides coveralls to the workers and utilizes a laundry service. Ear plugs or ear muffs must be worn in the sample prep areas.

HYGIENE

There is a separate lunchroom area available for employees. No eating, drinking, or smoking is permitted in the laboratory areas. There are no shower or locker room facilities at the laboratory.

## CONCLUSIONS AND RECOMMENDATIONS

Cone Geochemical is a commercial assay laboratory that analyzes samples from exploration and mine sites in North and South America. 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 area. Cone Geochemical employs local exhaust ventilation and partial enclosures in the sample prep and litharge mixing areas. In the fire assay operation, local exhaust ventilation is employed and HEPA half-mask respirators are worn during special operations. Ventilation measurements taken during this survey were consistent with well operating local exhaust ventilation systems. Because of the apparent effectiveness of the controls, this assay laboratory operation would be a suitable site for an in-depth evaluation.

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