U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 78-136-643

KENNECOTT SMELTER
GARFIELD, UTAH

DECEMBER 1979

I. TOXICITY DETERMINATION

A health hazard evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) at the Kennecott Smelter, Garfield, Utah, on October 25-26, 1978, December 13-14, 1978, and January 8-11, 1979. At the time of these evaluations, breathing zone and general room air samples were taken on workers for arsenic, lead, copper, molybdenum, and selenium. Direct reading detector tubes were used to monitor sulfur dioxide. The medical evaluation of forty workers was conducted on December 13-14, 1978. On January 9-11, 1979, blood and urine specimens were obtained on all workers in the reactor areas.

A health hazard existed at the time of this hazard evaluation. This is based upon excessive exposure of workers to arsenic, lead, copper, and sulfur dioxide. This hazard is also based upon the following medical findings.

Of the forty workers seen privately by the NIOSH physician, the majority had complaints referable to the upper respiratory system, with or without concomitant headache and/or eye irritation. On examination these workers had nasal mucosal inflammation, varying from mild injection to ulceration. Of the four workers presenting with dermatitis, two appeared to be of occupational origin--one being allergic in nature, and the other irritant.

Of the twenty-eight blood specimens analyzed for lead, three exceeded the OSHA standard of 40 micrograms per 100 grams (ug/100 g), and two of these exceeded the NIOSH recommended standard of 60 ug/100 g.

Seventy-nine urine samples were analyzed for arsenic. Although normal values for arsenic in urine are not generally available because of different methods for expressing data, after consulting several sources, it would appear that normal urine arsenic is less

than 150 ug/liter; up to 230 ug/liter is considered to reflect light exposure; 230-700 ug/liter indicates moderate exposure, and above 700 ug/liter is unacceptable. Using these criteria, five of the workers were lightly exposed, four moderately, and one unacceptably.

Environmental medical surveillance and work practice recommendations are detailed at the end of this report.

II. DISTRIBUTION AND AVAILABILITY

Copies of this determination report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

1. Kennecott Smelter.
2. U.S. Steel Workers Local 4347.
3. U.S. Department of Labor/OSHA, Region VIII.
4. NIOSH, Region VIII.

For the purpose of informing approximately 150 affected employees a copy of this report shall be posted in a prominent place accessible to the employees for a period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(b) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

NIOSH received such a request from Local 4347 of the U.S. Steel Workers to evaluate potential exposures to arsenic, lead, copper, and molybdenum at the Kennecott Garfield smelter.

IV. HEALTH HAZARD EVALUATION

A. Process Evaluated

This evaluation was concerned with arsenic, lead, copper and molybdenum in a specific area of the Kennecott Smelter. This area consisted of the three Noranda reactors and the convertors. Concentrated ore is fed into the reactors where air, oxygen, and fuel are added. Copper matte is drawn off the reactors and immediately goes to the convertors. After the copper matte is heated in the convertors, it is about 99% pure copper. This copper is then sent to the Anode furnaces for casting.

The reactor areas were just placed into operation. This is a new facility and plant management is actively working on the ventilation system in the ore prep and reactor areas. The company is aware that overexposures are occurring and respirators are used; however, an approved respirator program that meets all of OSHA's requirements under 29 CFR 1910.134 was not implemented at the time of this evaluation.

B. Medical Facilities

This plant has a well-equipped medical unit staffed by two full-time registered nurses, one of whom is present from 7:00 a.m. to 4:30 p.m. daily, and is on return call from 11:00 p.m. to 12:00 midnight. The other nurse covers from 3:45 p.m. to midnight on three days per week. The security guards are emergency medical technicians. Approximately two thousand attendances per year are recorded at the medical facility for injuries and minor illnesses. The major complaint is that of foreign body in the eye.

Two local physicians alternate spending two hours per day in the unit.

Comprehensive pre-placement and annual medical examination of the workers takes place in the physicians' own clinic. Specific medical investigations are undertaken, dependent upon the workers' jobs.

On retirement all workers should report to the company physicians for treatment.

There are ten lead workers who are statutorally examined on a quarterly basis for blood-lead. Specimens are drawn in the medical unit and the lead levels are determined at the company laboratory, but the results are not made available to the plant physicians and therefore not included in the workers' medical records.

A mobile medical unit had recently been present at the plant to carry out the medical examination of workers potentially exposed to arsenic, as mandated under the arsenic standard recently promulgated by OSHA. (Reference 1) Some four hundred workers had chest x-rays, skin and nasal examinations, and sputum was obtained for exfoliative cytological screening. Approximately another one hundred men were to have these investigations undertaken in the near future.

For men over 45 years of age, these examinations will be carried out biannually, and for the others, annually.

C. Environmental Evaluation Design

All workers in the reactor/convertor area were monitored for arsenic, lead, and copper. Workers in a separate building were monitored for molybdenum and selenium exposures. Sulfur dioxide was monitored frequently in the reactor/convertor area.

D. Environmental Evaluation Methods

Arsenic, lead, copper, molybdenum, and selenium samples were collected on AA filters using vacuum pumps operated at 1.5 liters per minute and analyzed by atomic absorption spectroscopy. One group of arsenic samples was analyzed by arsine generation. Samples were collected for the entire work shift. Sulfur dioxide was measured by direct reading detector tubes. All environmental sample results may be reviewed in the Tables.

E. Medical Evaluation Design and Methods

Over a period of three shifts, all workers who believed that their health had been adversely affected in any way by the work-environment were privately interviewed by the NIOSH physician and, where indicated, brief medical examinations were performed. Employee interview forms were completed by the NIOSH industrial hygienist at initial visit on 20 workers and were evaluated by the NIOSH physician prior to the visit in December. During the opening conference, the NIOSH physician requested that the union representatives inform all workers that a government doctor was available in the plant for private consultation on work-related illnesses.

The standard forms for release of relevant medical information to NIOSH from the workers' personal physicians were supplied to the Chairman, USWA Local 4347, for distribution to and completion by any worker who believed that working conditions were detrimental to his health. Postage-free, addressed envelopes were also supplied. None were returned to the NIOSH doctor. At a later date, specimens of blood and urine were obtained by a NIOSH physician's assistant for analysis of lead and arsenic levels respectively.

Over the next two days, covering three shifts, forty workers presented themselves. Of these, seven had no current complaints of ill health. Two reported because they had been informed by a technician from the mobile health unit recently present at the plant to carry out the medical examinations statutorally required by OSHA for all workers exposed to arsenic that they were suffering from arsenic poisoning. The remaining five had no evidence or suggestion of work-related disease.

F. Criteria for Assessing Workroom Concentrations of Air Contaminants

Three sources of criteria are generally used to assess workroom concentrations of air contaminants: (1) NIOSH criteria for recommended standards; (2) recommended threshold limit values (TLVs) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH), 1978; (3) Occupational Safety and Health Administration (OSHA) standards (29 CFR 1910), January 1978.

Substance	Permissible Exposures 8-Hour Time-Weighted Exposure Basis (mg/M^3) NIOSH Criteria For Recommended Standard	TLV	Current OSHA Standard
Arsenic.....	0.002	0.5	0.01
Lead.....	0.10	0.15	0.05
Copper.....	--	1.0*	1.0*
Molybdenum.....	--	5.0	5.0
Selenium.....	--	0.2	0.2
Sulfur Dioxide.....	5.0	13.0	13.0

* = 1.0 copper dust; 0.2 copper fume.

mg/M^3 = milligrams of substance per cubic meter of air.

Occupational health standards are established at levels designed to protect individuals occupationally exposed to toxic substances on an 8-hour per day, 40-hour per week basis over a normal working lifetime.

G. Toxicology

Arsenic -- The toxic properties of arsenic are well established, and arsenic is known on heavy exposure to cause skin cancer. It has also long been suspected, although not substantiated by animal experiments, of causing cancer of the lung. There have been a number of positive epidemiological studies, however, linking arsenic exposure with the development of this cancer and there appears to be a dose-response relationship. There is an increased mortality from lung cancer in smelter workers.

Arsenic can be absorbed into the body by the lungs and skin, and small amounts by ingestion. Locally, arsenic compounds are irritants of the skin, respiratory tract and eyes. Arsenical dermatitis has been reported, but occurs very rarely in industry.

Overexposure to arsenic tri-oxide commonly results in ulceration of the nasal septum, as well as conjunctivitis and pharyngitis. (References 2,3,4)

Copper Mist, Dust, and Fume -- Inhalation of dusts and mists of copper and copper salts results in irritation of the upper respiratory tract and, occassionally, ulceration and perforation of the nasal septum. Metal fume fever, a 24-28 hour illness characterized by chills, fever, aching muscles, dryness in the mouth and throat, and headache, may occur due to exposure to metaloxide fume rather than copper dust.

Copper particles embedded in the eye result in a pronounced foreign body reaction, with characteristic discoloration of ocular tissue.

Allergic contact dermatitis due to copper, although rare, has been reported. (Reference 3)

Lead -- Although capable of causing acute toxicity when absorbed in large amounts, lead exposure is usually associated with chronic toxicity due to absorption of lesser amounts over prolonged periods of time. The major route of entry of lead into the body is the lung, although slight amounts may be ingested.

The early effects of lead toxicity are non-specific, and except for laboratory determination of lead in the blood, are difficult to distinquish from the symptoms of minor seasonal illness. The symptoms are decreased physical fitness, fatigue, sleep disturbance, headache, aching bones and muscles, digestive system symptoms (particularly constipation), abdominal pains and decreased appetite. These symptoms are reversible, and complete recovery is possible on removal from exposure.

The three systems most commonly affected are the bone marrow (producer of red blood cells), the nervous system, and the kidneys.

Because of more efficient material handling methods and biological monitoring, serious cases of lead poisoning are rare in industry today.

Inorganic lead has been shown to be mutagenic and teratogenic. It can cross the placental barrier and can affect embryological and fetal development. Lead is eliminated from the body via urine and feces. NIOSH recommends that a blood lead value of 60 micrograms per 100 grams whole blood (60 ug Pb/100 g blood) be the maximum occupational blood lead level. When this value is exceeded, the employee should be removed from the lead exposure to allow his body to reduce its lead burden.

Kennecott Copper had initiated a respirator program. Several items, which included inadequate fitting, the wearing of beards, and improper filters, indicated that an adequate respirator program was not being enforced. The ventilation system throughout the reactor area (a new facility) was under construction and installation. Therefore, an adequate evaluation could not be performed. It was evident that there was not adequate ventilation due to the excessive airborne levels of arsenic, lead, copper, and sulfur dioxide.

Lead is a highly toxic metal, but long experience in industry has shown that good engineering controls in the workplace and good personal hygiene among employees can make lead a safe material with which to work.

The OSHA lead standard (29 CFR 1910.1025) states: The employer shall make available medical examinations for all workers that are exposed to inorganic lead at levels exceeding 30 ug/M^3 over an 8-hour work period. This level (30 mg/M^3) is called the action level. Each worker at or above 40 ug/100 grams shall also have an annual physical according to OSHA 1910.1025.

Molybdenum -- Molybdenum is a relatively safe element. Only a couple of industrial toxicology reports have appeared. These both agree that molybdenum and its compounds exhibit a low order of toxicity compared to other heavy metals such as arsenic and lead. Levels found during this evaluation were far below the evaluation criteria. (Reference 5)

Selenium -- Selenium is an irritant and a sensitizer. Overexposures may produce headache, dizziness, weight loss, and anemia. It may cause red staining of the teeth and nails. It is a strong respiratory irritant affecting the upper respiratory tract. It may produce pulmonary edema which is often a delayed effect. Selenium urine concentration of 0.1 mg/L warrants removal from exposure. (Reference 6)

Sulfur Dioxide -- Sulfur dioxide, a colorless gas, is a severe irritant of the eyes, upper respiratory tract, and skin.

The irritant effects of sulfur dioxide are caused by the rapidity with which it forms sulfurous acid on contact with moist membranes. Approximately 90% of all sulfur dioxide inhaled is absorbed in the upper respiratory passages, where most effects occur; however, it may cause pulmonary edema on severe exposure.

Workers repeatedly exposed to 10 parts per million (ppm) experienced upper respiratory tract irritation, and some nose-bleeds, but the symptoms did not occur at 5 ppm. (Reference 3)

There does not appear to be any long-term effects upon pulmonary function. (Reference 7)

H. Environmental Results and Discussion

Environmental results showed that approximately 20% of the workers were overexposed to arsenic, lead, and copper. No time-weighted average (TWA) exposures were monitored for sulfur dioxide. However, detector tube levels ranged from 25 to 50 mg/M^3. Some detector tube samples for sulfur dioxide were below detection limits. No overexposures were found for either molybdenum and selenium. For review of all environmental results, refer to Tables I, II, and III.

I. Medical Results and Discussion

On review of the twenty confidential employee interview forms completed by the NIOSH industrial hygienist on October 25-26 and forwarded to the medical investigator, nine workers had no occupationally induced health complaints. The main complaints of the

remaining eleven men referred to the respiratory system and included nasal and lung irritation with or without difficulty in breathing.

These findings were confirmed among the forty workers who sought private consultation with the NIOSH physician. Of the 24 men complaining of nasal irritation, all had signs varying from mild injection to ulceration, and one man had had a recent nosebleed. These effects are probably due to exposure to copper dust and/or mist, arsenic tri-oxide and sulfur dioxide, either singly or in combination.

Of the seven workers complaining of difficulty in breathing, only one had symptoms and signs of auscultation of pulmonary pathology. This man was advised to report to the plant medical officers or his private physician. He agreed to seek further medical evaluation from his personal doctor. Three other workers with symptoms referable to the gastro-intestinal system, ears, and joints, respectively, were given the same advice, and only the man with increasing stiffness and pain in his joints refused. He stated that he was quitting his job at this plant.

Four workers reported suffering from dermatitis, of which two had no current signs, but stated that this problem occurred only on flue dust exposure. They were advised to inform the plant physicians of this. The third worker had severe contact dermatitis in the groin and on the upper thighs, which he said only occurred when he worked in the feeder operation. He was advised to request a transfer until his skin lesions had subsided, and permanent transfer if these recurred. The fourth man had an irritant-dermatitis around his mask area. All these workers were instructed in good hygiene practices.

Two crane operators complained of severe eye and upper respiratory tract irritation, to the extent that their vision is impaired by tearing, and although they wear respirators, they experience bronchial constriction and nasal discharge. The medical investigator was informed that all crane operators have the same complaints, and that the filtering system on the cranes is not functional. These men have very little relief during the shift, and even eat their meals on the job.

The remaining ten men had a variety of non-work-related diseases.

All but twelve of the workers interviewed were smokers.

The NIOSH physician asked to be supplied with the blood-lead results obtained over the past year, and with the medical findings on the arsenic-exposed workers when available. The plant Industrial Hygiene Supervisor agreed to this request.

As this information had not been received by the medical investigator some two months later, February 20th, the Industrial Hygiene Supervisor was contacted by telephone. It was learned that for the ten workers statutorally examined on a quarterly basis, lead levels in excess of 60 ug/100 grams were considered

to be unacceptably high. Workers are notified of their blood-lead levels if they exceed this cut-off point. These men are not transferred or suspended, but instead are given instruction in good work practices and hygiene precautions, and the amount of time spent in lead-burning is arbitrarily limited by the plant hygienist(s). When questioned as to why workers showing excessive lead absorption were not referred to the plant medical officers for repeat blood-lead estimations and/or examination for lead toxicity, the Hygiene Supervisor replied that it was Company policy to regard this as purely a hygiene problem, which was also the reason given for the storage of all information on blood-lead levels in the plant safety office rather than in the medical facility. The NIOSH physician stated that it is universally accepted that excessive lead absorption is both a hygiene and a health problem and any information in this regard must be incorporated in the workers' medical records. The Hygiene Supervisor then said that once the new computer system has been set up all environmental and biological data will be incorporated with medical records.

On inquiry, the medical officer learned that the results of chest x-rays, skin and nasal examination, and exfoliative cytological screening of sputum were back. They had not been sent to the plant physicians.

The Hygiene Supervisor was then reminded that he had promised to send these findings, along with the blood-lead results obtained over the past year, to the NIOSH physician. This reminder was included in a covering letter for postage-free, addressed envelopes mailed to the Supervisor that afternoon.

The information requested was not received, but in a telephone conversation on April 3, 1979, the blood-lead results on ten workers examined in March 1978, and six of the same men in August, 1978, were obtained. None exceeded the NIOSH recommended standard of 60 ug/100 grams, but seven were equal to or exceeded the promulgated OSHA standard of 40 ug/100 grams.

To date, no information has been received with respect to the findings in the medical examination performed by the mobile unit of workers potentially exposed to arsenic, nor has NIOSH received the results of the Company's analyses of the split blood and urine samples obtained by the physician's assistant in January.

The workers participating in this NIOSH investigation have been informed by letter of the level of lead in their blood and/or arsenic in their urine.

J. Conclusions

Based on medical and environmental data, a health hazard existed to workers at the Kennecott Smelter in Garfield, Utah, in the reactor areas. This is based on environmental levels exceeding evaluation criteria in approximately 20% of the breathing zone air samples taken for arsenic, lead, and copper. This conclusion is also based on the results of biological monitoring for blood lead and urine arsenic. The most serious health hazard was an inadequate respirator program.

V. RECOMMENDATIONS

A. Informing Employees of Health Hazards from Arsenic Exposures

All employees exposed to arsenic and its compounds shall be informed of all hazards, relevant symptoms of overexposure, appropriate emergency procedures, and proper conditions and precautions for safe use or exposure. This should include as a minimum the toxic level for arsenic and its compounds, skin and eye irritation properties, principal routes of absorption, and the effects of chronic (long-term) exposure. Employees must also be informed of the requirements for personal protective equipment, such as respirators, eye protection, and protective clothing. The information shall be posted in all work areas where there is potential exposure to arsenic and its compounds and kept on file and readily accessible to the worker.

A continuing educational program shall be instituted to insure that all workers have current knowledge of job hazards, proper maintenance procedures and cleanup methods, and that they know how to correctly use respiratory protective equipment and protective clothing.

B. Environmental and Engineering Controls

1. A comprehensive respirator program should be instituted that complies with the OSHA regulations outlined in 29 CFR 1910.134.

2. All employee eating areas were dirty and should be cleaned before each shift.

3. All eating, drinking, and smoking should be prohibited in the work place that was monitored during this evaluation.

4. An in-depth evaluation of the ventilation system in the reactor area (including all crane cabs) should be undertaken and improvements made that would lower the levels of arsenic, lead, copper, and sulfur dioxide. A filtered air conditioning system that would eliminate harmful effects should be installed in the cranes.

5. Employee use of respirators must be enforced. Many of the workers did not take the wearing of respirators very seriously.

6. Housekeeping was very poor and efforts must be made to keep the work place cleaner.

7. Where the possibility of skin or eye irritation from inorganic arsenic exists, the employer shall provide the employee and assure that employees use appropriate and clean protective work clothing and equipment such as, but not limited to, coveralls, gloves, shoes or overshoes, face shields or vented goggles.

(a) Protective clothing shall be changed at least daily at the end of the shift.

(b) Work clothing shall not be taken home by employees. The employer shall provide for maintenance and laundering of protective clothing.

(c) The employer shall ensure that precautions necessary to protect laundry personnel are observed when soiled protective clothing is laundered.

C. Medical Surveillance

Medical surveillance shall be made available as specified below for all workers occupationally exposed above the action level for arsenic, without regard to the use of respirators, at least 30 days per year.

Pre-placement and annual medical examinations shall include:

1. Comprehensive work history and medical history which shall include a smoking history and the presence and degree of respiratory symptoms such as breathlessness, cough, sputum production and wheezing. An evaluation of the advisability of the worker using negative or positive pressure respirators.

2. A 14 inch by 17 inch posterior-anterior chest x-ray, and ILO/UICC/Cincinnati rating.

3. Careful examination of the skin for the presence of hyperpigmentation, keratoses, or other chronic skin lesions. Care shall be taken to observe and record the location, condition, appearance, size, and any changes in all such lesions. Any worker demonstrating arsenical dermatitis should be carefully monitored, and should there be any progression of this disease he should be removed from exposure to arsenic and its compounds.

4. Examination of the sputum for the presence of atypical cells. Any worker demonstrating this abnormality shall be kept under strict surveillance and any appropriate medical examinations should be instituted.

5. If the employee for any reason develops signs and/or symptoms commonly associated with exposure to inorganic arsenic, the employer shall provide an appropriate examination and emergency medical treatment.

6. The worker shall be informed of the results of all medical and environmental monitoring and this information must be kept in his medical file at work, as should any employee health complaints related to exposure to inorganic arsenic.

7. These records must be retained for at least 40 years or for the duration of employment plus 20 years, whichever is longer.

8. The blood-lead levels of those employees statutorally examined on a quarterly basis shall be incorporated in the workers' plant medical records. It shall be a medical decision as to the disposition of any worker(s) showing unacceptably high lead absorption. Any employee with abnormal findings shall be notified of the fact and he must seek medical counsel.

9. Borofax or similar ointment must be supplied to all workers complaining of nasal irritation.

VI. REFERENCES

1. OSHA Safety and Health Standards (29 CFR 1910.1018) - Inorganic Arsenic.

2. Proctor, N.H., Hughes, J.P., Chemical Hazards in the Workplace, J.P. Lippincott Co., Philadelphia, 1978.

3. NIOSH Recommended Standard for Occupational Exposure to Inorganic Arsenic, U.S. Government Printing Office: 1974 657-061/2015.

4. Hine, C.H., Pinto, S.S., Nelson, M.S., Medical Problems Associated with Arsenic Exposure, J. Occ. Med., Vol. 19, No. 6, 1977.

5. Documentation of the Threshold Limit Values for Substances in Workroom Air, American Conference of Governmental Industrial Hygienists, Third Edition, 1971, pp. 173-174.

6. Plunkett, E.R., Handbook of Industrial Toxicology, Chemical Publishing Company, New York, 1976, pp. 364-365.

7. Lebowitz, M.D., et al, Pulmonary Function in Smelter Workers, J. Occ. Med., Vol. 21, No. 4, 1979.

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TABLE III

Breathing Zone Air Concentrations of
Molybdenum (Mo) and Selenium (Se)

Kennecott Smelter
Garfield, Utah

December 12, 1978

Sample Number	Location	Job Classification	Time of Sampling	mg/m^3 Mo	mg/m^3 Se
39	Mo Plant	Foreman	8:40 AM - 11:45 AM	0.93	*
44	Mo Plant	Material Handler	8:42 AM - 2:45 PM	0.39	0.04
38	Mo Plant	Material Handler	8:45 AM - 2:45 PM	0.46	*
34	Mo Plant	Material Handler	8:45 AM - 2:50 PM	0.37	*
		EVALUATION CRITERIA		5.0	0.2
		LABORATORY LIMIT OF DETECTION mg/sample		0.006	0.0002

* below laboratory limit of detection

TABLE II

Breathing Zone Air Concentrations of Arsenic (As)

Kennecott Smelter
Garfield, Utah

January 11, 1979

Sample Number	Location	Job Classification	Time of Sampling	mg/m^3 Arsenic**
34	Crane	Electrician	8:13 AM - 2:18 PM	.03
33	#2 Converter	Welder Boilermaker	8:18 AM - 2:22 PM	.02
35	#2 Reactor	Welder Boilermaker	8:14 AM - 2:20 PM	.05
28	Reactor 1-2-3	Welder Boilermaker	8:20 AM - 2:20 PM	.04
29	Reactor 1-2-3	Welder Boilermaker	8:21 AM - 2:20 PM	.03
32	Reactor #2	Welder Boilermaker	8:24 AM - 2:20 PM	.06
		EVALUATION CRITERIA		0.01
		LABORATORY LIMIT OF DETECTION mg/sample		0.003

** These filters were analyzed by arsine generation.

TABLE 1

Breathing Zone Air Concentrations of
Lead (Pb), Arsenic (As), and Copper (Cu)

Kennecott Smelter
Garfield, Utah

Sample Number	Date	Location	Job Classification	Sampling Time	mg/m^3 Pb	As	Cu
45	1-10-79	Reactor (3)	Foreman	7:28 PM - 2:30 PM	0.05	*	0.39
39	1-10-79	Reactor (3)	Laborer	7:30 AM - 2:35 PM	0.07	*	0.63
40	1-10-79	Reactor (3)	Tapper	7:32 AM - 2:35 PM	0.08	*	0.27
46	1-10-79	Reactor (3)	Lunch Room	7:35 AM - 2:32 PM	*	*	0.04
44	1-10-79	Reactor (3)	Feeder	7:38 AM - 2:35 PM	0.03	*	0.49
50	1-10-79	Reactor (3)	Skimmer Helper	7:35 AM - 2:35 PM	0.12	*	1.50
48	1-10-79	Reactor (1 & 3)	Matt Tapper	8:00 AM - 2:45 PM	0.07	*	1.00
38	1-10-79	Reactor (1)	Skim Bay Helper	8:00 AM - 2:45 PM	0.04	*	0.67
49	1-10-79	Reactor (1)	Matt Tapper	8:02 PM - 2:45 PM	0.16	0.09	3.6
36	1-10-79	Reactor (1)	Puncher	8:06 AM - 2:45 PM	0.06	*	2.5
47	1-10-79	Reactor (1)	Slag Tapper	8:08 AM - 2:45 PM	0.03	*	0.76
41	1-10-79	Reactor (1)	Lunch Room	8:09 AM - 2:45 PM	*	*	0.06
43	1-10-79	Reactor (1)	Water Tender	8:12 AM - 2:43 PM	*	*	0.05
42	1-10-79	Reactor (1)	Feeder	8:16 AM - 2:45 PM	0.04	*	0.94
37	1-10-79	Reactor (3)	Operator	8:25 AM - 2:31 PM	0.03	*	0.11
31	1-11-79	Convertor	Flues	7:35 AM - 2:00 PM	0.02	*	0.14
7	1-11-79	Convertor	Repair	7:36 AM - 2:07 PM	0.01	*	0.04
11	1-11-79	Convertor	General	7:40 AM - 2:05 PM	0.03	*	0.21
2	1-11-79	Reactor	Crane Repair	7:53 AM - 2:02 PM	0.13	*	0.88
30	1-11-79	Reactor	Crane Repair	7:55 AM - 2:00 PM	0.29	0.29	7.1
1	1-11-79	Convertor	Welder	7:57 AM - 2:04 PM	0.01	*	0.17
26	1-11-79	Convertor	Welder	8:07 AM - 2:21 PM	0.09	*	1.1
6	1-11-79	Convertor	Pipe Fitter	8:10 AM - 2:06 PM	0.10	*	0.96
27	1-11-79	Reactor Crane	Electrician	8:11 AM - 2:18 PM	0.07	*	0.38
				EVALUATION CRITERIA	0.05	0.01	1.0**
				LIMIT OF DETECTION mg/sample	0.005	0.003	0.06

* = below laboratory limit of detection
** = 1.0 Cu dust; 0.2 Cu fume.