

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 77-36-540
ASARCO, INCORPORATED
TACOMA PLANT
RUSTON, WASHINGTON

NOVEMBER, 1978

I. TOXICITY DETERMINATION

Employees in the converter department, reverberatory furnace area, roaster area, sulfur dioxide plant, and slimes house were exposed to levels of arsenic that exceeded NIOSH's recommended standard. Published epidemiologic studies have shown an increased risk, presumably due to arsenic, of peripheral neuropathies and lung cancer among employees of the smelter.

Larrymen in the roaster area; cranemen, crane chasers, gaspe punchers, skimmers and flue dust pullers in the converter area; a repairman in the sulfur dioxide plant; and a selenium operator and a laborer in the slimes house were exposed to airborne lead concentrations in excess of NIOSH's recommended standard. However, blood tests of employees in the converter area and sulfur dioxide plant revealed no evidence of lead toxicity. This may be a result of the routine use of respirators by some exposed employees and/or the limited number of employees volunteering for the tests.

Larrymen in the roaster area were exposed to sulfur dioxide concentrations that exceeded NIOSH's recommended standard. However, they all wore appropriate respirators.

Flue dust pullers in the converter area and larrymen in the roaster area were exposed to airborne copper dust concentrations that exceeded OSHA's standard. However, they all wore appropriate respirators.

Based on the environmental sampling data, there was no indication of a substantial health hazard associated with antimony, cadmium, dimethylaniline, nickel, selenium, or silver in the areas investigated.

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 the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

- 1) ASARCO, Tacoma, Washington
- 2) United Steel Workers Local 25, Tacoma, WA
- 3) Washington Industrial Safety and Health Agency, Olympia, WA
- 4) Occupational Safety and Health Administration, Region X, Seattle, WA
- 5) NIOSH, Region X, Seattle, WA
- 6) United Steel Workers International Union, Pittsburgh, PA

For the purpose of informing the affected employees, the employer should prominently post the Determination Report near their work area for a period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 USC 669 (a)(6), authorizes the Secretary of Health, Education, and Welfare, following receipt of a written request from 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.

The National Institute for Occupational Safety and Health received such a request from an employee representative of the United Steel Workers Local 25, Tacoma, Washington, to determine if lead, copper, cadmium, arsenic, trace metals, sulfur dioxide (SO₂), or dimethylaniline (DMA) are toxic as used or found in the converter department, reverberatory furnace department, roaster department, sulfur dioxide plant, and slimes house.

At the time this request was submitted, ASARCO was operating under abatement plans resulting from previous Washington Industrial Safety and Health Agency (WISHA) safety and health citations.

A "Complaint Against the State Program Administration" (CASPA) was filed with the Occupational Safety and Health Administration (OSHA) by the United Steel Workers against WISHA. As a result of these activities, WISHA, in conjunction with OSHA, conducted a thorough industrial hygiene survey in the areas that the request to NIOSH involved.

Because of the activity by WISHA and OSHA, the scope of this evaluation was limited to a review of ASARCO's medical and environmental data, limited blood sampling for evidence of lead toxicity, and a review of the WISHA environmental results.

IV. HEALTH HAZARD EVALUATION

A. Description of Process and Hazard Identification

The Tacoma Plant is a copper smelter and refinery. The processes involved in this request are the roaster, reverberatory furnace, and converter departments, sulfur dioxide plant, and slimes house.

Roaster

Copper ore is continuously fed into the roaster. Sulfur is partially eliminated by heating the metal sulfide in the presence of air. There are 9 to 11 workers per shift for 3 shifts in the roaster department who are potentially exposed to lead, copper, cadmium, arsenic, and sulfur dioxide.

Reverberatory Furnace

The calcined ore is transferred from the roaster to the reverberatory furnace where it is heated to about 2800°F. A "matte" consisting of molten copper sulfide and iron sulfide is formed and settles to the bottom. The remaining materials form a liquid slag with silica that has been added. There are 8 to 9 employees in this area for each of three shifts who are potentially exposed to lead, arsenic, copper, cadmium, and sulfur dioxide.

Converter

The matte is transferred from the bottom of the reverberatory furnace to the converter. Silica is added, and air is blown through the molten bath, burning off the sulfur and oxidizing the iron which, with the silica, forms a slag. After the sulfur is burned off, the melt or blister is 98 to 99% copper. There are 18 employees in this department for each of 3 shifts who are potentially exposed to lead, copper, cadmium, arsenic, and sulfur dioxide.

Sulfur Dioxide Plant

The gases from the converters are piped to the sulfur dioxide plant. Here, the dusts are removed through dust collectors and electrostatic precipitators. The sulfur dioxide is purified with dimethylaniline and compressed to form liquid sulfur dioxide. There are 6 employees in this plant on the day shift and 2 employees on the other 2 shifts who are potentially exposed to lead, copper, cadmium, arsenic, sulfur dioxide, and dimethylaniline.

Slimes House

The blister copper is further refined. The impurities in the blister copper collect in the electrostatic solution of the copper refining process and settle to the bottom of the tank. This material, called slimes, contains antimony, gold, silver, selenium, tellurium, and nickel sulfate. The slimes are leached with acid to remove the impurities present. There are seven employees working in this area on the day shift and two on each of the other shifts. These employees are potentially exposed to lead, arsenic, selenium, tellurium, silver, and gold.

B. Study Design

An initial survey was conducted on March 17, 1977. At that time, NIOSH obtained ASARCO's environmental and biological monitoring data from January 1974 to March 1977.

In November 1977 WISHA conducted an environmental compliance inspection. (Between March and November the plant had been shut down for a few months because of a labor dispute.) Environmental sampling was not conducted by NIOSH. The results of the WISHA compliance inspection are used for this evaluation in lieu of the collection by NIOSH of additional samples within one or two months of the WISHA sampling.

The medical investigation consisted of a review of company medical records (supplemented by discussions with employees and their union representatives), blood testing of a sample of employees for evidence of excessive lead absorption, and a review of available studies of arsenic toxicity at the Tacoma plant.

C. Evaluation Methods

1. Environmental

The sampling and analytical methods used were:

a) Metals. The samples were collected on Millipore type AA* filters (37 mm, 8um pore size) at flow rate of 1.5 to 2.0 lpm. The antimony, lead, cadmium, nickel, and silver were determined by atomic absorption and/or a graphite furnace technique. The arsenic, selenium, and tellurium were determined by a flameless hydride generation technique.

b) Sulfur Dioxide. The samples were collected in midget impingers containing 10 milliliters of hydrogen peroxide at a flow rate of 2.0 lpm. They were analyzed by direct titration of the sulfuric acid formed.

c) N,N, dimethylaniline (DMA). The samples were collected on charcoal tubes at flow rates of 50-200 cc per minute and analyzed by gas chromatography.

*Mention of a company name or product is for information only and does not constitute endorsement by the National Institute for Occupational Safety and Health.

2. Medical

Of the 5 areas evaluated, the converter, and to a lesser extent the sulfur dioxide plant, appeared - on the basis of previous air and blood lead testing - to present the greatest risk of exposure to lead. We therefore offered blood tests for lead and free erythrocyte protoporphyrin (FEP) to employees in these areas. Nine men participated: 6 from the converter area, 2 from the sulfur dioxide plant, and one not from a production area.

Blood lead was determined by a heated graphite furnace/atomic absorption technique. (Five specimens were also determined by the Delves cup atomic absorption method at another laboratory.) FEP was determined using coproporphyrin as a standard.

D. Environmental Evaluation Criteria

The environmental criteria for evaluating arsenic, cadmium, lead, nickel and sulfur dioxide are NIOSH's most recently recommended standards for those substances.¹⁻⁵ The criteria for antimony, copper, dimethylaniline, selenium, and silver are the current OSHA standards. Exposure limits are presented in Table 1.

E. Toxicity of Substances (a non-technical summary)

1. Lead^{3,6,7}

Lead accumulates in the body and is excreted slowly. The general public is exposed to small amounts of lead in food, water, and air. Occupational lead exposure is primarily by inhalation, and to a lesser degree by ingestion (contamination of hands, food, smoking material). Inorganic lead poisoning is a chronic process, although symptoms may develop suddenly after sufficient chronic exposure. Manifestations of inorganic lead poisoning in adults include decreased appetite, abdominal pain, nausea, constipation (or diarrhea), fatigue, irritability, insomnia, headache, anemia, muscle pain, sore joints, tremor, weakness of the extensor muscles of the wrists and ankles, and impaired kidney function. Lead encephalopathy (somnolence, delirium, convulsions, coma) is rare in adults with inorganic lead poisoning.

2. Arsenic^{1,6,8}

Inorganic arsenic poisoning can be acute or chronic. The general public is exposed to arsenic in some food, primarily seafood. Occupational exposure is by inhalation, direct skin and mucous membrane contact, and ingestion.

Manifestations of chronic inorganic arsenic poisoning include dermatitis, warts, hyperkeratoses ("calluses") of the palms and soles, conjunctivitis, respiratory tract irritation, ulceration and perforation of the nasal septum, headache, drowsiness, confusion, convulsions, anemia, decreased white blood cell count, and peripheral neuropathy (numbness, tingling, and burning of the hands and feet; decreased senses of touch, pain, and temperature in the hands and feet; muscle weakness, inability to walk or stand, muscle atrophy). However, the major neurologic symptoms have not been associated with arsenic poisoning of occupational origin. Arsenic has been implicated as a cause of skin cancer, and epidemiologic studies⁹⁻¹¹ have associated arsenic with lung cancer.

3. Other metals^{2,4,12,13}

Symptoms of inorganic antimony poisoning include irritability, fatigue, arm and leg pain, gastrointestinal symptoms, and upper respiratory tract irritation. Symptoms of chronic selenium poisoning are similar. Occupational exposure to nickel has been associated with cancer of the lung and nasal sinuses. Exposure to silver can result in argyria, a localized or generalized (depending on the type of exposure) gray discoloration of skin and mucous membranes. Occupational exposure to cadmium, by inhalation, can result in acute or chronic poisoning. Acute cadmium poisoning is an inflammatory reaction in the lungs that can be fatal, but more often results in a mild, permanent decrease in lung function. Manifestations of chronic cadmium poisoning include yellowing of the necks of the teeth, nasal discharge, loss of sense of smell, anemia, shortness of breath, gastrointestinal symptoms, mental disturbances, kidney dysfunction, soft tissue swelling, and bone pain.

Oxide fumes of copper and all of the other metals discussed in the preceding paragraph can result in metal fume fever, a condition characterized by fever, chills, sweating, nausea, thirst, headache, exhaustion, and arm and leg pain. It begins a few hours after exposure (at which time cough and chest pain may have occurred) and lasts one to three hours. Complete recovery usually occurs within a day or two. Repeated exposure to the fumes results in tolerance, but this is lost after two days without exposure.

4. Sulfur dioxide¹⁴

Sulfur dioxide is a mucous membrane irritant. Exposure to high levels is intolerable and causes chemical bronchopneumonia or death by asphyxiation. Levels low enough so that working is tolerable may still result in eye discomfort, sneezing, coughing, alteration of taste and smell, difficulty breathing, and fatigue. About 80% of exposed persons become acclimatized to such levels. Chronic exposure has been associated with impaired pulmonary function and chronic respiratory disease.⁵

5. Dimethylaniline¹⁵

Dimethylaniline causes methemoglobinemia, a condition in which the ability of the blood to deliver oxygen to body tissues is impaired. Methemoglobinemia causes a blue discoloration of the skin.

E. Evaluation Results and Discussion

1. Environmental. (All samples are 6- to 8-hour time-weighted average breathing-zone samples unless otherwise noted.)

a) Roaster area. The results of the samples collected in the roaster area are shown in Tables 2 and 3. Forty-three of the 44 arsenic samples exceeded the arsenic criterion of 0.002 mg/cu m. They had a range of 0.005 to 0.82 mg/cu m. None of the cadmium samples contained detectable quantities of cadmium. Three of the 36 copper samples exceeded the copper dust criterion of 1 mg/cu m. All 3 samples were from larrymen and were 1.10, 1.33, and 1.63 mg/cu m. Six of the 44 lead samples exceeded the lead criterion of 0.1 mg/cu m. They had a range of 0.1 to 0.18 mg/cu m. All 6 of these samples were also from larrymen. Eleven 2-hour sulfur dioxide area samples were collected in the calcine larrycar area. All exceeded 0.5 ppm, and the average concentration over the 22-hour period was 1.54 ppm.

Respirators are mandatory in the roaster area and were reportedly being worn.

b) Reverberatory Furnace Area. The results of the samples collected in the reverberatory furnace area are shown in Tables 4 and 5. Twenty of the 21 arsenic samples exceeded the arsenic criterion of 0.002 mg/cu m. They had a range of 0.005 to 0.19 mg/cu m. None of the 25 cadmium samples contained detectable quantities of cadmium. None of the 28 copper samples exceeded the copper dust criterion of 1 mg/cu m. One of the 29 lead samples exceeded the lead criterion of 0.1 mg/cu m. This was on a skimmer helper, and the concentration was 0.11 mg/cu m. The highest of 3 other samples on skimmer helpers was 0.02 mg/cu m. Twelve 2-hour sulfur dioxide area samples were collected between the matte and slag launder. In 11, sulfur dioxide was not detectable, and in one it was 0.15 ppm.

c) Converter area. The results of samples collected in the converter area are shown in Tables 6 and 7. All 20 of the arsenic samples exceeded the arsenic criterion of 0.002 mg/cu m. They had a range of 0.016 to 0.88 mg/cu m. Only 2 of the 24 cadmium samples contained detectable quantities of cadmium. They were 0.01 and 0.13 mg/cu m,

which are well below the evaluation criterion of 0.04 mg/cu m. Twenty-eight samples were collected for copper fume and dust. The amount of copper contributed by either the fume or the dust was not determined. If the copper was fume, then 22 of the 28 samples exceeded the copper fume criterion of 0.1 mg/cu m. However, if the copper present was copper dust, then only 2 of the 28 samples exceed the copper dust criterion of 1.0 mg/cu m. Both of these samples were collected on the flue-dust pullers and were 3.41 and 3.46 mg/cu m. Fourteen of the 36 samples collected for lead exceeded the lead criterion of 0.10 mg/cu m. Of these, 3 of 14 samples from the cranemen and crane chasers, 5 of 8 samples from the skimmers, 2 of 10 samples from the gaspe punchers, and 4 of 4 samples from the flue-dust pullers were high. The high samples from the cranemen, crane chasers, skimmers, and gaspe punchers had a range of 0.10 to 0.29 mg/cu m. The individuals on these jobs are supposed to wear respirators. The 4 samples from the flue-dust pullers were 0.28, 0.78, 3.60, and 4.06 mg/cu m. The 24-hour average sulfur dioxide concentration in the operator shacks was 0.36 ppm.

d) Sulfur dioxide plant. The results of the samples collected in the sulfur dioxide plant are shown in Table 8. Two samples each were collected for arsenic, cadmium, copper dust, and lead. Both arsenic samples exceeded the evaluation criterion of 0.002 mg/cu m. The cadmium and the copper dust samples were less than the respective criteria of 0.04 and 1.0 mg/cu m. One lead sample exceeded 0.10 mg/cu m. The employee concerned was wearing a respirator, but it did not contain a dust filter. All 5 of the dimethylaniline samples were less than 0.5 ppm, which is well below the evaluation criterion of 5 ppm. All 3 of the sulfur dioxide samples were less than 0.5 ppm.

e) Slimes house. The following samples were collected in the slimes house (Table 9): antimony - 6, arsenic - 7, copper dust - 8, lead - 8, nickel - 6, selenium - 2, and silver - 2. All of the antimony, copper dust, nickel, selenium, and silver samples were less than their respective evaluation criteria. Six of the 7 arsenic samples exceeded the evaluation criterion of 0.002 mg/cu m, and 2 of the 8 lead samples exceeded the evaluation criterion of 0.10 mg/cu m. The selenium operator's exposure to lead was 0.49 mg/cu m. On the day the sample was taken he was wearing a full-face canister respirator. One of the 2 lead samples from the laborer was 0.13 mg/cu m, which exceeded the evaluation criterion of 0.10 mg/cu m.

The ASARCO environmental sampling results for arsenic and lead from January 1974 to May 1977 were reviewed. The concentrations measured were comparable to those reported in this study.

2. Medical

a) Review of Company records:

The Summary of Occupational Injuries and Illnesses (WISHA Form 102) for 1976 listed 146 incidents, 9 of which were of occupational skin diseases or disorders," 8 of which involved days away from work (for a total of 67 days), and 4 of which resulted in termination or permanent transfer. There were 4 cases of "respiratory conditions due to toxic agents," 2 of which resulted in days away from work (for a total of 10 days); none resulted in termination or permanent transfer.

As of November 25, 1977 the yearly Log of Occupational Injuries and Illnesses (OSHA Form 100) had 136 entries, 125 of which were injuries. Of the other 11, one was a case of hemoglobinuria in a refinery worker, one was a case of conjunctivitis in an acid plant worker, and 9 were dermatitis cases. The dermatitis involved the face in 7 of the 9 dermatitis cases (3 electricians, 1 worker each in the reverberatory furnace, arsenic plant, slimes plant, and steel); 2 had involvement of the nasal mucosa (an electrician and the slimes plant worker). The 2 cases of dermatitis not involving the face were both in roaster workers.

Since the beginning of 1967, 28 workers left the Tacoma Plant because of permanent medical disability. They ranged in age from 50 to 64; the median age was 60. Three left in 1967, 1 in 1970, 3 in 1971, 3 in 1972, 5 in 1973, 8 in 1974, 3 in 1975, 1 in 1976, and 1 in 1977. There does not appear to be an unusual concentration of disabled workers in any particular area or work category. Diagnoses were: cardiovascular disorders (including stroke) - 14; emphysema and/or chronic bronchitis - 4; orthopedic disorders - 5; neurologic disorders (excluding stroke) - 2; diabetes - 3; cancer - 1; tuberculosis - 1; metabolic disorders - 2; gastrointestinal disorders - 1. (The total is greater than 28 because some persons had more than one diagnosis.) This distribution of disease categories, as well as the distribution of specific diagnoses, does not appear to be unusual for a population of older workers.

b) Lead Exposure

Historical Data

The company's blood lead monitoring program currently includes annual screening of about 110 workers in the converter, roaster, boiler room, sulfur dioxide plant, and acid plant. In addition, about 6 workers in the converter area are tested quarterly, as is anyone else with a blood lead over 50 ug/dl. The current policy is to transfer anyone with a blood lead greater than 80 to another job until his blood lead falls below 50,

but this has never been done since there has reportedly never been a blood lead as high as 80 at the plant. None of the disability diagnoses are particularly suggestive of lead poisoning, and we heard of only one case - undocumented - of lead poisoning in the past few years.

NIOSH Blood Tests

Hematocrits ranged from 42 to 51%, all within the usual range for men.¹⁶ Blood leads ranged from 16 to 41 ug/dl; except for the highest and lowest, the range was 22-31. Seven of the FEP's were below 60, the upper limit of "normal" in unexposed persons;¹⁷ one was 73 (blood lead 41) and another 197 (blood lead 31 at the primary laboratory, 43 at the other). With the possible exception of the last worker, in which there is the suggestion of minimally excessive lead exposure, these results indicate that biologically significant lead exposure is not occurring among the workers we tested.

c) Arsenic exposure

The company's biologic monitoring program for arsenic includes annual urine screening of all employees, plus quarterly screening of workers (about 95) in the roaster, boiler room, and cottrell areas, and of workers (7 or 8 at the time of our visit) with prior urine arsenic levels greater than 250 ug/l. "Action levels" are (1) 200 ug/l, at which time the worker is re-tested, and if still above 200 ug/l, counseled on appropriate industrial hygiene practices, and (2) 500 ug/l, at which time the worker is transferred to a job involving lower arsenic exposure. At the time of our visit 3 persons - all from the cottrell - were reassigned because of urine arsenic levels above 500 (all reportedly below 1,000).

This arsenic monitoring protocol was apparently designed to comply with the airborne exposure limit of 0.5 mg/cu m, a standard intended to prevent substantial dermatitis and overt systemic toxicity.¹⁸ Since a urine arsenic level of 1,000 ug/l roughly corresponds to a time-weighted average air level of 0.25 mg/cu m,¹⁹ the protocol appears to be adequate for that purpose. However, it is not adequate to monitor compliance with NIOSH's recommended arsenic standard of 0.002 mg/cu m, and it presumably does not offer adequate protection against arsenic's carcinogenic effects and perhaps not against its neurologic effects (see below).

Anecdotal reports - undocumented - and entries in the Log of Occupational Injuries and Illness indicate that arsenic dermatitis, including nasal mucosal inflammation, occurs occasionally at the plant. Studies of the neurologic and carcinogenic effects of arsenic exposure among employees of the Tacoma Plant have been done recently by others. An EPA-sponsored study conducted in June 1976 found an association between arsenic exposure and peripheral neuropathies.²⁰ A mortality study conducted

by the Washington State Department of Social and Health Services has found increased mortality from lung cancer among the smelter's employees,^{21,22} a finding consistent with other epidemiologic reports associating arsenic exposure with excess lung cancer deaths among smelter workers^{9,10} and residents of communities near copper, lead, or zinc smelters.¹¹ Although the carcinogenicity of arsenic, especially at the levels currently found at the Tacoma plant, has been questioned,²³ the various studies cited appear to have adequately demonstrated the potential hazards of arsenic exposure at the Tacoma Plant. Therefore, we do not think that another medical study of the effects of arsenic is necessary for this health hazard evaluation.

V. SUMMARY AND CONCLUSIONS

- A. Company records suggest the occasional occurrence of arsenic dermatitis and mucosal inflammation but do not reveal any unusual distribution of disabling medical disorders. Such records would not ordinarily be expected, however, to reveal the presence of non-disabling, chronic occupational health problems.
- B. Employees in the roaster, reverberatory furnace, and converter areas, sulfur dioxide plant, and slimes house were exposed to arsenic concentrations in excess of NIOSH's recommended standard. (Four samples in the roaster area and 2 in the converter area exceeded the ACGIH standard, which was intended only to protect against the non-carcinogenic, overt toxic effects.¹⁸)

On the basis of previous studies, smelter workers appear to be at increased risk of developing peripheral neuropathies and lung cancer as a result of exposure to inorganic arsenic.

- C. Two of 4 samples from flue-dust pullers in the converter area, and 3 of 12 samples from larrymen in the roaster area, exceeded the criterion for exposure to copper dust. However, all of these employees wore respirators.
- D. All area samples for sulfur dioxide in the calcine-larry car area of the roaster area exceeded 0.5 ppm. Roaster area employees wear respirators with acid-gas cartridges.
- E. Five of 14 samples from roaster area larrymen, 1 of 29 samples from reverberatory furnace area employees, 13 of 36 samples from converter area employees, 1 of 2 samples from sulfur dioxide plant employees, and 2 of 7 samples from slimes house employees exceeded the criterion for lead exposure. However, the blood test results showed no evidence of excessive lead absorption. This may be because employees in jobs involving high lead exposure use respirators and/or because several jobs involving high lead exposure, such as the flue-dust pullers in the converter area, were not represented among the employees who volunteered for the blood tests.

- F. Most samples for cadmium showed no detectable amounts. Only one sample exceeded NIOSH's recommended standard; this was from an employee who wore a full-face respirator with a fume filter. No samples showed excessive levels of dimethylaniline, nickel, selenium, or silver.

VI. RECOMMENDATIONS

- A. In general, NIOSH recommends that all toxic substances discussed in this report be controlled so that employee exposures do not exceed the criteria cited above (part IV D 1). Where this has not yet been achieved, the use of NIOSH-approved respirators appropriate for the substance(s) involved is recommended. The use of respirators should be part of a comprehensive respiratory protection program with provisions for training, fitting, maintenance, and supervision (29 CFR, Chapter XVII, Part 1910I, paragraph 1910.134).
- B. The technical difficulties involved in meeting NIOSH's proposed standard for arsenic in workroom air are recognized. Also recognized are the scientific and practical difficulties of establishing a "safe" or "acceptable" level of a known or suspected carcinogen, particularly when the substance is ordinarily present in the general environment. Such standards are inherently somewhat arbitrary, but the concept of attempting to approach a level not substantially above "natural" background is appropriate. It is therefore recommended that air arsenic levels be reduced by the best available technology and that all reasonable efforts be made to improve current technology for controlling airborne arsenic until the proposed NIOSH standard is achieved.

As air arsenic levels are reduced, "action levels" for urine arsenic should also be reduced. Eventually, urine arsenic levels should be within the "normal" range, generally under 100 ug/l.^{1,6}

- C. NIOSH has recommended that the blood lead level at which action should be taken to reduce exposure be lowered from the traditional 80 ug Pb/100 g blood (84 ug/dl) to 60 ug/dl.³ However, there is evidence that even this level may not prevent all of the adverse biological effects of lead.³ Since individual lead absorption appears to be well-controlled, it is suggested that ASARCO consider adopting 40 ug/dl as the highest acceptable blood lead at the Tacoma plant.

VII. REFERENCES

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Table 1

Environmental Evaluation Criteria

ASARCO, Incorporated
Ruston, Washington
HHE 77-36

Exposure limits, air concentration¹

<u>Substance</u>	<u>NIOSH²</u>	<u>OSHA³</u>	<u>ACGIH⁴</u>
Antimony	5	0.5 mg/cu m	0.5 mg/cu m ⁶
Arsenic (inorganic)	0.002 mg/cu m ⁷	0.01 mg/cu m	0.5 mg/cu m ⁸
Cadmium	0.04 mg/cu m 0.2 mg/cu m ⁷	fume 0.1 mg/cu m 0.3 mg/cu m ⁷ dust 0.2 mg/cu m ⁷ 0.6 mg/cu m ⁷	fume 0.05 mg/cu m dust 0.05 mg/cu m ⁷ 0.15 mg/cu m ⁷
Copper	- -	fume 0.1 mg/cu m dust 1 mg/cu m	fume 0.2 mg/cu m dust 1 mg/cu m ⁷ 2 mg/cu m ⁷
Dimethylaniline	-	5 ppm or 25 mg/cu m	5 ppm or 25 mg/cu m 10 ppm ⁷ or 50 mg/cu m ⁷
Lead (inorganic)	0.1 mg/cu m	0.2 mg/cu m ⁹	0.15 mg/cu m 0.45 mg/cu m ⁷
Nickel (inorganic)	0.015 mg/cu m	1 mg/cu m	1 mg/cu m
Selenium	-	0.2 mg/cu m	0.2 mg/cu m
Silver	-	0.01 mg/cu m	0.01 mg/cu m ⁷ 0.03 mg/cu m ⁷
Sulfur dioxide	0.5ppm or 1.3 mg/cu m	5ppm or 13 mg/cu m ¹⁰	5 ppm or 13 mg/cu m

1. 8- or 10- hour time-weighted average unless otherwise specified; mg/cu m = milligrams per cubic meter, ppm = parts per million by volume
2. See references 1-5
3. 29 CFR, Chapter XVII, Part 1910Z
4. American Conference of Governmental Industrial Hygienists: Threshold Limit Value for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1977
5. No official recommendation
6. Proposed change: 2 mg/cu m for soluble antimony salts, 0.05 mg/cu m for antimony trioxide production, 0.5 mg/cu m for antimony trioxide handling and use
7. 15-minute ceiling concentration
8. Proposed change: 0.05 mg/cu m for arsenic trioxide production
9. Proposed change: 0.1 mg/cu m
10. Proposed change: 2 ppm or 5.23 mg/cu m (8-hour time-weighted average)
10 ppm or 26.12 mg/cu m (15-minute ceiling concentration)

T A B L E 2

RESULTS OF BREATHING ZONE SAMPLES
COLLECTED IN THE ROASTER AREAASARCO, INCORPORATED
RUSTON, WASHINGTON

HHE 77-36

TIME-WEIGHTED AVERAGE*
CONCENTRATIONS mg/cu m

JOB	DATE	ARSENIC	CADMIUM	COPPER	LEAD
FIREMAN	11-16-77	0.04	ND	0.04	ND
"	11-16-77	0.08	ND	0.04	ND
"	11-17-77	0.14	ND	0.02	0.02
"	11-17-77	0.06	ND	0.07	ND
"	11-17-77	0.09	-	-	0.01
"	11-17-77	0.07	-	-	0.01
"	11-18-77	0.07	-	0.09	0.01
"	11-18-77	0.03	-	0.04	ND
LARRYMAN	11-16-77	0.34	ND	0.41	0.06
"	11-16-77	0.27	ND	0.41	0.04
"	11-17-77	0.69	ND	1.63	0.15
"	11-17-77	0.24	ND	0.73	0.05
"	11-17-77	0.18	-	-	0.03
"	11-17-77	0.39	-	-	0.09
"	11-18-77	0.15	ND	0.55	0.04
"	11-18-77	0.41	ND	0.99	0.12
"	4-3-78	0.54	-	1.33	0.18
"	4-3-78	0.29	-	0.83	0.12
"	4-12-78	0.37	-	1.10	0.11
"	4-12-78	0.13	-	0.79	0.03
"	4-26-78	0.54	-	0.40	0.06
"	4-26-78	0.82	-	0.69	0.10
FEEDERMAN	11-16-77	0.014	ND	0.08	0.01
"	11-17-77	0.18	ND	0.70	0.05
"	11-17-77	0.13	ND	0.09	0.01
"	11-17-77	0.20	-	0.56	0.05
BELTMAN	11-16-77	0.11	ND	0.13	0.02
"	11-16-77	0.02	ND	0.10	0.02
"	11-16-77	0.02	ND	0.14	0.07
"	11-17-77	0.07	ND	0.06	0.04
"	11-17-77	0.09	ND	0.16	0.03
"	11-17-77	0.05	ND	0.13	0.03
"	11-17-77	0.041	ND	0.11	0.02
"	11-17-77	0.026	ND	0.08	0.02
"	11-17-77	0.056	ND	0.09	0.07
"	11-18-77	0.05	-	-	0.02
"	11-18-77	0.06	-	0.14	0.02
"	11-18-77	0.04	-	0.11	0.02
CRANEMAN	11-16-77	0.004	ND	0.06	0.01
"	11-17-77	0.0001	ND	0.03	ND
"	11-17-77	0.012	-	-	0.02
"	11-18-77	0.005	-	-	ND
ROASTER					
LUNCH ROOM	11-17-77	0.04	ND	0.03	ND
"	11-17-77	0.015	-	-	ND

* Sample times are 6-8 hours each.

NOTE - Respirators are available and mandatory in Roaster Area.
Most wear half-face respirators with acid gas, dust, mist cartridges.
Full-face respirators are available for use.

T A B L E 3

SULFUR DIOXIDE SAMPLE RESULTS
ROASTER AREA

ASARCO, INCORPORATED
RUSTON, WASHINGTON
HHE 77-36

<u>LOCATION</u>	<u>DATE</u>	<u>SAMPLE TIME</u>	<u>SULFUR DIOXIDE PPM</u>	
Calcine - Larry Cars (area samples)	11-30-77	1025-1225	0.68	
		1225-1425	0.89	
		1425-1625	1.08	
		1625-1825	2.49	
		1825-2025	2.49	
		2025-2225	1.76	
	2225-0025	1.21		
	"	12-01-77	0025-0225	0.68
			0225-0425	2.05
			0425-0625	1.89
0625-0825			0.68	
"	"	22 hour TWA	1.54	

T A B L E 4

RESULTS OF BREATHING ZONE SAMPLES
COLLECTED IN THE REVERBERATORY FURNACE AREAASARCO, INCORPORATED
RUSTON, WASHINGTON

HHE 77-36

TIME WEIGHTED AVERAGE*
CONCENTRATIONS mg/cu m

<u>JOB OR LOCATION</u>	<u>DATE</u>	<u>ARSENIC</u>	<u>CADMIUM</u>	<u>COPPER</u>	<u>LEAD</u>
Dump Motorman	11-15-77	---	ND	0.01	ND
"	11-16-77	0.06	ND	0.04	ND
"	11-16-77	0.04	ND	0.04	ND
Dump Motorman Helper	11-15-77	---	ND	0.02	0.01
Dump Mtrmn Hlpr	11-16-77	0.02	ND	0.03	ND
Dump Mtrmn Hlpr	11-17-77	0.04	ND	0.13	0.01
Tapper	11-15-77	--	ND	0.05	0.03
"	11-15-77	--	ND	0.04	0.01
"	11-16-77	0.02	ND	0.02	ND
"	11-16-77	0.05	ND	0.02	0.01
"	11-16-77	0.03	ND	0.02	ND
"	11-17-77	0.05	ND	0.04	0.03
Tapper Helper	11-15-77	--	ND	0.07	0.02
"	11-16-77	0.02	ND	0.02	ND
"	11-16-77	0.01	ND	0.01	ND
"	11-17-77	ND	ND	ND	ND
Skimmer	11-16-77	0.19	ND	0.07	0.04
Skimmer Hlpr	11-15-77	--	ND	0.10	0.01
"	11-16-77	0.06	ND	0.02	0.02
"	11-16-77	0.03	ND	0.02	ND
"	11-17-77	0.11	ND	0.23	0.11
Mud Mixer	11-15-77	--	ND	0.03	ND
"	11-16-77	0.06	ND	0.02	ND
Furnace Man	11-15-77	--	ND	0.02	0.01
"	11-16-77	0.04	ND	0.03	ND
"	11-16-77	0.02	ND	0.02	0.01
"	11-17-77	0.01	ND	0.03	0.01
Laborer	11-17-77	0.012	-	-	0.02
Lunch Room	11-16-77	0.0005	ND	0.01	ND

NOTE: Half-face dust, mist, acid gas respirator available, however, not normally worn.

* Sample times were 6-8 hours each.

T A B L E 5

SULFUR DIOXIDE SAMPLE RESULTS
 REVERBERATORY FURNACE AREA

ASARCO, INCORPORATED
 RUSTON, WASHINGTON

HHE 77-36

<u>LOCATION</u>	<u>DATE</u>	<u>SAMPLE TIME</u>	<u>SULFUR DIOXIDE PPM</u>
Between Matte and Slag Launder (area samples)	11-30-77	0915-1115	0.15
"	"	1115-1315	ND
"	"	1315-1515	ND
"	"	1515-1715	ND
"	"	1715-1915	ND
"	"	1915-2115	ND
"	"	2115-2315	ND
"	"	2315-0115	ND
"	12-01-77	0115-0315	ND
"	"	0315-0515	ND
"	"	0515-0715	ND
"	"	0715-0850	ND

T A B L E 6

RESULTS OF BREATHING ZONE SAMPLES
COLLECTED IN THE CONVERTER AREAASARCO, INCORPORATED
RUSTON, WASHINGTON
HHE 77-36TIME WEIGHTED AVERAGE***
CONCENTRATIONS mg/cu m

<u>JOB</u>	<u>DATE</u>	<u>ARSENIC</u>	<u>CADMIUM</u>	<u>COPPER</u>	<u>LEAD</u>
* Craneman	11-15-77	-	ND	0.08	0.04
"	11-15-77	-	ND	0.12	0.02
"	11-15-77	-	ND	0.09	0.02
"	11-16-77	0.08	ND	0.13	0.08
"	11-16-77	0.09	ND	0.24	0.09
"	11-16-77	0.09	ND	0.09	0.09
"	11-16-77	-	ND	0.09	0.03
* Crane Chaser	11-15-77	-	ND	0.06	0.03
"	11-16-77	0.03	ND	0.12	0.07
* Craneman/Chaser	11-16-77	-	ND	0.23	0.12
"	11-16-77	-	ND	0.04	0.03
"	11-17-77	0.045	-	-	0.06
"	11-17-77	0.09	-	-	0.10
"	11-17-77	0.16	-	-	0.21
* Skimmer	11-15-77	-	ND	0.16	0.06
"	11-15-77	-	ND	0.31	0.17
"	11-16-77	0.14	ND	0.34	0.14
"	11-16-77	0.29	0.01	0.78	0.29
"	11-16-77	-	ND	0.21	0.12
"	11-16-77	-	ND	0.27	0.07
"	11-17-77	0.031	-	-	0.13
"	11-17-77	0.015	-	-	0.02
* Gaspe Puncher	11-15-77	-	-	0.16	0.03
"	11-15-77	-	ND	0.11	0.01
"	11-16-77	0.06	ND	0.57	0.08
"	11-16-77	0.03	ND	0.27	0.03
"	11-16-77	-	ND	0.40	0.13
"	11-16-77	-	ND	0.54	0.07
"	11-16-77	-	ND	0.13	0.04
"	11-17-77	0.016	-	-	0.06
"	11-17-77	0.031	-	-	0.15
"	11-17-77	0.017	-	-	0.03
** Flue Dust Puller	12-06-77	0.88	0.13	3.41	4.06
"	12-06-77	0.83	-	3.46	3.60
"	04-03-78	0.17	-	0.75	0.78
"	04-03-78	0.02	-	0.37	0.28

* Half-face cartridge acid gas/dust-mist respirators available. Worn intermittently - not normally worn.

** MSA Full-face with GMC chemical cartridge and fume filter worn by the flue dust pullers.

*** Sample times were 6-8 hours each

T A B L E 7

SULFUR DIOXIDE SAMPLE RESULTS
CONVERTER AREAASARCO, INCORPORATED
RUSTON, WASHINGTON
HHE 77-36

LOCATION	DATE	TIME	SULFUR DIOXIDE PPM
Operator Shack #2 (area samples)	11-30-77	0900-1100	0.87
"	"	1100-1300	0.60
"	"	1900-2100	0.26
"	"	2100-2300	0.42
"	"	2300-0100	0.37
"	12-01-77	0100-0300	0.26
"	"	0300-0500	0.31
"	"	0500-0700	0.05
"	"	0700-0900	0.16
Operator Shack #3 (area samples)	11-30-77	1300-1500	0.42
"	"	1500-1700	0.29
"	"	1700-1900	0.34

T A B L E 8

RESULTS OF BREATHING ZONE SAMPLES
COLLECTED IN THE SULFUR DIOXIDE PLANTASARCO, INCORPORATED
RUSTON, WASHINGTON

HHE 77-36

TIME WEIGHTED AVERAGE*
CONCENTRATIONS mg/cu mTIME WEIGHTED AVERAGE*
CONCENTRATIONS PPM

JOB	DATE	ARSENIC	CADMIUM	COPPER	LEAD	DIMETHYL- ANILINE	SULFUR DIOXIDE
Ass't Loader	11-28-77	0.10	ND	ND	0.08	-	0.22
"	12-20-77	-	-	-	-	0.11	-
Head Loader	12-20-77	-	-	-	-	0.16	-
**Repairman	11-28-77	0.28	0.04	0.14	1.33	-	-
Operator	11-28-77	-	-	-	-	-	0.13
"	12-20-77	-	-	-	-	0.17	-
Mechanic	12-20-77	-	-	-	-	0.44	-
Ass't Mechanic	11-28-77	-	-	-	-	-	0.39
Foreman	12-20-77	-	-	-	-	0.1	-

* Sample times were 6-8 hours each.

** The repairman was wearing a half-face respirator with an acid gas cartridge but no dust filter.

NOTE: Respirators are available; they are normally worn.

T A B L E 9
RESULTS OF BREATHING ZONE SAMPLES
COLLECTED IN THE SLIMES HOUSE

ASARCO, INCORPORATED
RUSTON, WASHINGTON
HHE 77-36

TIME WEIGHTED AVERAGE*
CONCENTRATIONS mg/cu m

JOB	DATE	ANTIMONY	ARSENIC	COPPER	LEAD	NICKEL	SELENIUM	SILVER
Furnace Man	11-22-77	0.01	0.005	0.01	0.02	-	-	-
"	11-22-77	0.01	0.007	0.02	0.02	-	-	-
Selenium Operator**	11-22-77	0.13	0.21	0.32	0.49	0.01	-	-
"	04-06-78	-	0.0015	0.01	0.04	-	0.01	ND
Laborer	11-22-77	0.02	0.012	0.05	0.04	ND	-	-
"	04-06-78	-	-	0.04	0.13	-	0.12	0.009
Crusher	11-22-77	0.02	0.011	0.03	0.04	ND	-	-
Lunchroom	11-22-77	0.01	0.0015	ND	ND	ND	-	-

* Sample times were 6-8 hours each.

** The selenium operator wore a full-face canister respirator on 11-22-77.

NOTE: Respirators are available, however, they are not normally worn.