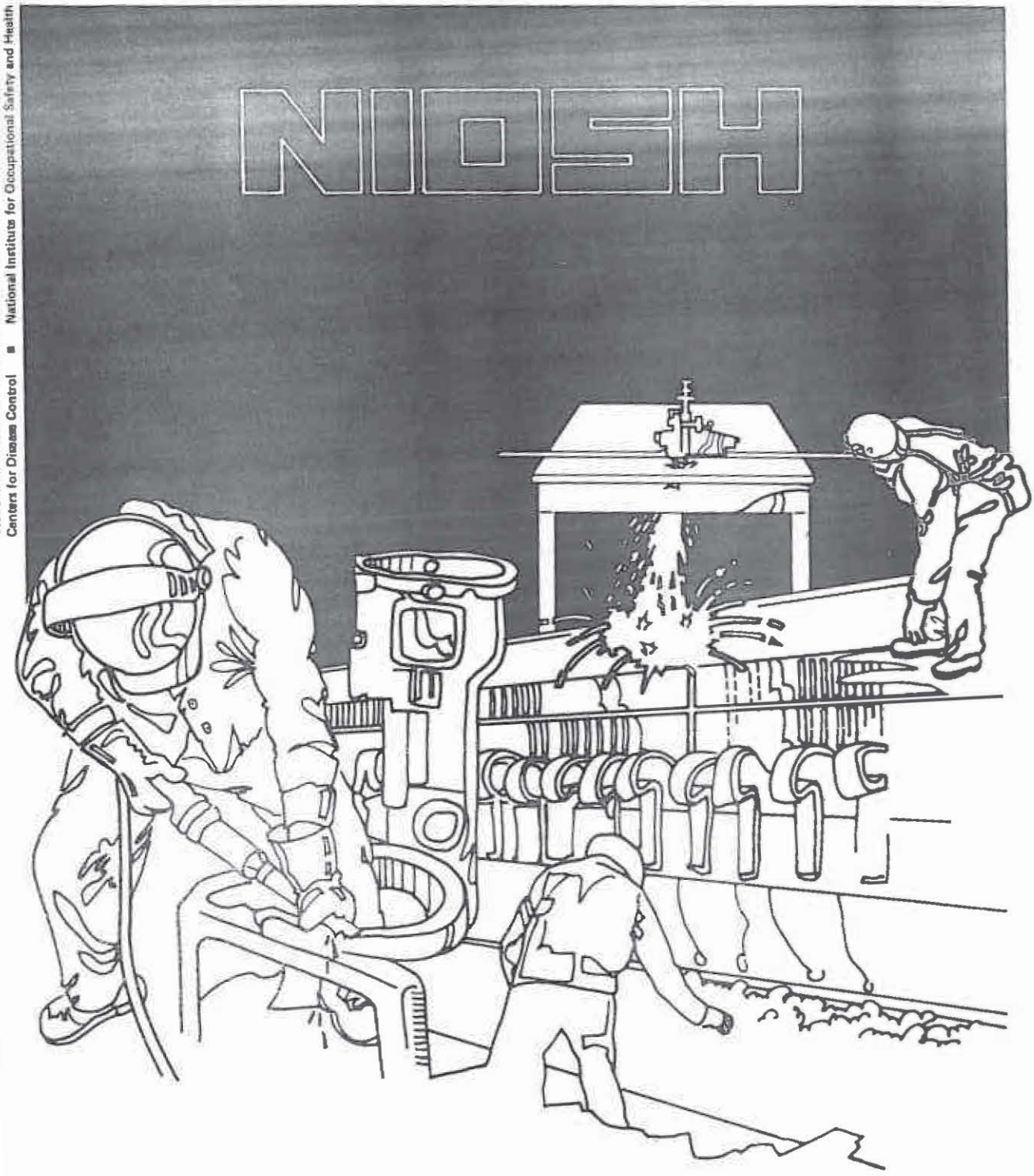
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 81-338-1070
PUBLIC SERVICE COMPANY OF COLORADO
PUEBLO, COLORADO

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following 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 Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 81-338-1070
MARCH 1982
PUBLIC SERVICE COMPANY OF COLORADO
PUEBLO, COLORADO

NIOSH INVESTIGATORS:
Bobby J. Gunter, Ph.D.,IH
Paul Pryor, M.S., IH
Theodore W. Thoburn, M.D.

I. SUMMARY

In June 1981 the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Brotherhood of Electrical Workers Local Union 111, Denver, Colorado, to evaluate fly ash, silica, and arsenic exposures to workers who repair electrostatic precipitators at the Public Service Company of Colorado Comanche Power Plant, Pueblo, Colorado.

On July 18-19, 1981, all eight workers were monitored for crystalline silica (quartz and cristobalite), total dust particulates (respirable and non-respirable), arsenic, lead, selenium, and cadmium.

Most respirable and total particulate breathing zone air samples exceeded both the Occupational Safety and Health Administration (OSHA) Standards and the American Conference of Governmental Industrial Hygienists (ACGIH) recommended Threshold Limit Values (TLVs). The air concentrations for total dust ranged from less than 5 to 379 mg/M^3 (evaluation criteria 10 mg/M^3). The respirable dust values ranged from 6 to 58 mg/M^3 (criteria 5 mg/M^3). The values of the five air samples taken for arsenic ranged from below detection limits to 0.01 mg/M^3 (above the evaluation criteria of 0.002 mg/M^3). Of the eleven air samples taken for silica, ten were below the laboratory detection limits and one (0.62 mg/M^3) exceeded the evaluation criteria of 0.05 mg/M^3. All other breathing zone air samples for trace metals were either below laboratory detection limits or well within the evaluation criteria.

Seven of the eight workers were seen by the NIOSH physician. Three of these seven workers indicated they had skin problems due to the exposure to fly ash. Only one worker showed any significant loss of pulmonary function. This was a forced vital capacity (FVC) 79% of predicted with FEV_1 within the normal range. It was concluded that the exposure to fly ash during cleanout of precipitators probably has not resulted in pulmonary disease. A slightly irritating particulate such as fly ash can aggravate any underlying respiratory problem such as sinusitis or bronchitis unless excessive exposure is prevented.

On the basis of the environmental data collected at the Comanche Power Plant, NIOSH concluded that a potential health hazard exists from overexposure to particulates (respirable and non-respirable), arsenic, and crystalline silica. Recommendations for control of excessive exposures are presented in this report.

KEYWORDS: SIC 4911 (Electric Power Generation), respirable free silica, quartz, cristobalite, fly-ash, arsenic, total and respirable particulates, trace metals.

II. INTRODUCTION

NIOSH received a request in June 1981 from the International Brotherhood of Electrical Workers Local Union 111 in Denver, Colorado, to evaluate fly ash, silica, and arsenic exposures at the Public Service Company of Colorado Comanche Power Plant, Pueblo, Colorado.

This union request reported lung problems in one person and skin rashes on many employees from exposure to fly ash and other unknown substances when they are required periodically to enter, clean out, and repair the precipitators and related hoppers at the Comanche Power Plant. An industrial hygiene survey was conducted July 18-19, 1981, during a cleanout. The medical testing of the identified employees was conducted on November 19, 1981, in the union offices in Denver. The environmental sampling results were sent to union and management on October 16, 1981.

III. BACKGROUND

This is a coal-fired electrical generating plant. The specific area of interest during this evaluation was the repair and maintenance of large electrostatic precipitators used for the collection of burned coal (fly ash). The electrostatic precipitators have long wires (electrodes) that become corroded with fly ash and sometimes break. At this time workers are required to enter precipitators to clean wires and repair the fallen and broken wires. During this repair process workers are grossly overexposed to fly ash. Full-face respiratory protection and disposable clothing was provided by the Company. All protective equipment was worn by the workers at the time of this evaluation.

IV. DESIGN AND METHODS

A. Environmental

All respirable and total particulate samples were collected on preweighed 37 mm filters. The filters were then reweighed on an electrobalance. Lead, selenium, arsenic, and cadmium samples were collected on 37 mm filters and analyzed by atomic absorption. Respirable crystalline silica samples were collected on 37 mm filters and analyzed according to NIOSH Method P&CAM No. 259.

B. Medical

Each worker was administered a questionnaire covering work history with specific questions on the cleanout operation and medical history with an emphasis on respiratory problems. Pulmonary function tests--forced vital capacity (FVC), one-second forced and expiratory volume (FEV_1)--were obtained using an Ohio Medical Products Model 822 Spirometer.

V. EVALUATION CRITERIA

A. Environmental

Three sources of criteria used to assess the workroom concentrations of the chemicals were (1) recommended Threshold Limit Values (TLVs) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH), 1981, (2) the NIOSH criteria for a recommended standards, and (3) the Occupational Safety and Health Administration (OSHA) standards (29 CFR 1910.1000), July 1980.

	Permissible Exposure Limits 8-Hour Time-Weighted Exposure Basis	
Arsenic	0.002 mg/M^3	(NIOSH)
	0.5 mg/M^3	(OSHA)
Cadmium	0.04 mg/M^3	(NIOSH)
	0.2 mg/M^3	(OSHA)
Lead	0.05 mg/M^3	(NIOSH)
	0.05 mg/M^3	(OSHA)
Selenium	0.2 mg/M^3	(NIOSH, OSHA)
Crystalline Silica (Respirable)	0.05 mg/M^3	(NIOSH)
	10 mg/M^3 / % SiO_2 + 2	(OSHA)
Respirable Particulate	5.0 mg/M^3	(ACGIH, OSHA)
Total Particulate	10.0 mg/M^3	(ACGIH)
	15.0 mg/M^3	(OSHA)

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.

B. Medical

The pulmonary function tests included measurements of forced vital capacity (FVC), one-second forced expiratory volume (FEV_1), and calculation of the ratio of FEV_1/FVC. FVC measures the total amount of air one can force out of his lungs after breathing in as deeply as possible. FEV_1 measures the amount of air one can breathe out in the first second. The FVC can be impaired by restrictive lung disease, such as pulmonary fibrosis. FEV_1 can be impaired by cigarette-related lung damage or some other conditions causing obstruction to air flow. Any condition that impairs FVC usually impairs FEV_1, but the reverse is not true. Conditions that impair FEV_1 do not necessarily impair FVC. The FEV_1/FVC ratio is also used to help evaluate obstructive lung disease.

damage to the kidneys is the excretion of a low molecular weight protein in the urine called beta-2 microglobulin. Blood levels of cadmium indicate increased exposure but do not correlate well with organ damage or symptoms.

Lead[2,3] -- Inhalation of lead dust and fumes is the major route of lead exposure in industry. A secondary source of exposure may be from lead dust contamination on food, cigarettes, or other objects. Once absorbed lead is excreted from the body very slowly. The absorbed lead can damage the kidneys, peripheral and central nervous systems, and the blood forming organs (bone marrow). These effects may be felt as weakness, tiredness, irritability, digestive disturbances, high blood pressure, kidney damage, mental deficiency, or slowed reaction times. Chronic lead exposure is associated with infertility and with fetal damage in pregnant women.

Blood lead levels below 40 ug/100ml whole blood are considered to be normal levels which may result from daily environmental exposure. However, fetal damage in pregnant women may occur at blood lead levels as low as 30 ug/100ml. Lead levels between 40-60 ug/100ml in lead exposed workers indicate excessive absorption of lead and may result in some adverse health effects. Levels of 60 to 100 ug/100ml represent unacceptable elevations which may cause serious adverse health effects. Levels over 100 ug/100ml are considered dangerous and often require hospitalization and medical treatment.

The new OSHA standard for lead in air in most workplaces is 50 ug/M^3 on an eight-hour time-weighted average for daily exposure.[4] For this particular industry the current standard is 50 ug/M^3. The new standard also dictates that workers with blood lead levels greater than 60 ug/100g must be removed from further lead exposure if confirmed by a follow-up test and starting from March 1, 1983, workers with average lead levels of 50 ug/100g or greater must also be removed. Removal is also possible on medical grounds. Removed workers have protection for wage, benefits, and seniority until they can return to lead exposure areas.

Selenium -- Elemental selenium is almost harmless. Selenium salts are highly toxic either by inhalation or ingestion. The mode of action is that of a pulmonary irritation and a sensitizer. They combine with sulfhydryl groups and interfere with enzyme systems. Signs and symptoms of selenium exposure include dizziness, headache, weight loss and anemia. When a worker's urine concentration of selenium exceeds 0.1 mg/M^3 per liter, he should be moved from exposure.[5]

Silica -- Crystalline silica, usually referred to as free silica, is defined as silicon dioxide (SiO_2) molecules arranged in a fixed pattern as opposed to a nonperiodic, random molecular arrangement defined as amorphous silica. The three most common crystalline forms of free silica encountered in industry are quartz, tridymite, and cristobalite, with quartz being by far the most common of these. NIOSH, in its recommendations for a free silica standard, has proposed that exposures to all forms of free

silica be controlled so that no worker is exposed to respirable airborne concentrations greater than 0.05 mg/M^3, as averaged over a 10 hour working day, 40 hour work week. This recommendation was designed to protect workers from silicosis, a pneumoconiosis due to the inhalation of silicon dioxide-containing dust. Exposures to free silica greater than one-half the recommended standard or "action level" should initiate adherence to the environmental, medical, labeling, recordkeeping, and worker protection guidelines as contained in Chapter I of the NIOSH criteria document, "Occupational Exposure to Crystalline Silica." The current federal or OSHA standard for respirable free silica exposure is an 8 hour time-weighted average based upon the 1968 ACGIH TLV formulas of 10 mg/M^3 divided by the percent SiO_2 plus 2 (10mg/M^3/%SiO_2+2) for respirable quartz. One-half this amount was established as the limit for cristobalite and tridymite. As can be seen from the calculation, the OSHA regulation is based on the percentage of free silica contained in the respirable particulate exposure, whereas the NIOSH recommended standard applies directly to the airborne concentrations of respirable free silica.

Total and Respirable Particulate -- Overexposures to any particulate may produce irritation and possibly damage to the total respiratory system especially if the particulate contains disease producing substances.

VI. RESULTS AND DISCUSSION

A. Environmental

Eleven breathing zone air samples were collected for respirable crystalline silica (quartz and cristobalite) and respirable particulate (Table 1). All respirable particulate samples exceeded the evaluation criteria. Only one of the eleven samples collected for crystalline silica exceeded the evaluation criteria. Five samples were analyzed for arsenic and total particulate (Table 2). One of the arsenic samples exceeded the evaluation criteria. One other arsenic sample was equal to the evaluation criteria. Three out of five of the total particulate samples exceeded the evaluation criteria. Four breathing zone air samples were analyzed for lead, selenium, cadmium, and total particulate (Table 3). All samples for lead, selenium, and cadmium were either below laboratory detection limits or below evaluation criteria. All total particulate samples exceeded the evaluation criteria.

It should be noted that all workers were requested to wear full-face respirators and disposable clothing. These procedures were followed during the time of this survey. All workers were not clean shaven which prevents proper sealing of respirators. This was evidenced by fly ash concentrating around the nostrils of several of the workers even though they were wearing full-face respirators.

B. Medical

Seven of the eight workers involved in the cleanout were seen. The workers examined were all white men, ages 21 to 35. Three were smokers. Two were regularly assigned to the Comanche Power Plant (the more senior workers), the remainder having been brought in for this particular cleanout. Length of time with Public Service varied from one and one-half to twelve and three-fourths years with time in job (not necessarily grade) varying from four months to seven and one-half years. The Working Foreman, although only recently assigned to the job had a number of years of service in the various grades of electrician before being promoted. The usual progression for the electrician grades is Electrician Helper (2 seen), Electrician Apprentice (2 seen), Electrician (1 seen), and Electrician Specialist (1 seen). There are no sharp demarcations between duties for adjacent grades. All workers worked either in power plant or substation servicing. The senior men were involved in eight to twelve cleanouts a year for four or five hours each. The rest were involved in two to six cleanouts a year working for one to three days on each.

Only one worker showed any significant loss of pulmonary function. That was a Forced Vital Capacity (FVC) of 79% of predicted. The history did not suggest that this was a pulmonary problem and the Forced Expiratory Volume at one second (FEV_1) and FEV_1/FVC Ratio were both good. Clinically, excess body weight interfering with deep inspiration appears to be the most likely cause. Although their pulmonary functions were normal, all the smokers (but not the non-smokers) gave histories of colds going into the chest or several episodes of cough and phelgm production indicative of bronchitis.

Three of the seven workers indicated they had skin problems due to the exposure to fly ash. This was described as a drying effect going on to a red, non-blistering, non-pealing rash which was more likely if the exposed skin was sweaty and lasted one to three days. One said it itched. Showering immediately after the job has helped. The Comanche Plant has shower facilities available, although this is not true of all plants where cleanouts are performed.

Less specific health complaints which may have a relationship to the job included one peptic ulcer, more frequent colds (in a worker who has had sinus problems much of his life), hay fever aggravated by exposure to weeds during substation work, and possibly some skin lumps, some of which appear to be sebaceous cycts.

VII. CONCLUSIONS

Based on environmental data obtained during this evaluation, workers are overexposed to arsenic, free silica, and particulate dust. The workers are partially protected by an inadequate respiratory program. A respiratory program should be instituted that meets requirements set forth in OSHA General Industry Standards 1910.134.

The exposure to fly ash during cleanout does not appear to have resulted in pulmonary disease. However, it can prove irritating to moist body surfaces, so protection including respiratory protection is desirable and showering immediately after stopping work is to be encouraged.

A slight irritating particulate, such as fly ash, can aggravate any underlying respiratory problem, such as sinusitis or bronchitis, unless excessive exposure is prevented.

VIII. RECOMMENDATIONS

1. Shower facilities be provided at power plants still lacking them.
2. A respiratory program should be instituted that meets OSHA General Industry Standard 1910.134.
3. Any worker who routinely repairs precipitators should be clean shaven (so respirator will fit).
4. Once a year physical examinations with emphasis on pulmonary function should be performed on these workers.

IX. REFERENCES

1. Knudson, R.J., Slatin, R.C., Lebowitz, M.D., Burrows, B. "The Maximal Expiratory Flow-Volume Curve", American Review of Respiratory Disease, Volume 113, pp. 587-600 (1976).
2. Delves, H.T. Analyst, 95:431, 1970.
3. Barthel, W.F. J.A.O.A.C., 56, No. 5, 1973.
4. Occupational Safety and Health Administration General Industry Standard 29 CFR 1910.1025.
5. Plunkett, E.R., Handbook of Industrial Toxicology, Chemical Publishing Company, New York, 1976, pp. 364-365.

X. AUTHORSHIP AND ACKNOWLEDGMENTS

Report Prepared By:

Bobby J. Gunter, Ph.D.
Regional Industrial Hygienist
NIOSH, Region VIII
Denver, Colorado

Theodore W. Thoburn, M.D.
Medical Officer
NIOSH, Region VIII
Denver, Colorado

Evaluation Assistance:

Paul Pryor, M.S.
Industrial Hygienist
NIOSH, Region VIII
Denver, Colorado

Originating Office: Hazard Evaluation and Technical Assistance Branch (HETAB)
Division of Surveillance, Hazard Evaluations, and Field Studies (DSHEFS)
NIOSH, Cincinnati, Ohio

Report Typed By: Marilyn K. Schulenberg
Occupational Health Technician
NIOSH, Region VIII
Denver, Colorado

XI. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 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. Public Service Company of Colorado.
2. International Brotherhood of Electrical Workers Local Union 111.
3. International Brotherhood of Electrical Workers.
4. U.S. Department of Labor/OSHA - Region VIII.
5. NIOSH - Region VIII.
6. Colorado Department of Health.
7. State Designated Agency.

For the purpose of informing 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.

TABLE 1

Breathing Zone Air Concentrations of
Respirable Crystalline Silica (Quartz and Cristobalite) and Respirable Particulate

Public Service Company of Colorado
Commanche Power Plant
Pueblo, Colorado

July 18-19, 1981

Sample Number	Location	Job Classification	mg/M^3 Quartz	Cristobalite	Respirable Particulate
5721	Hopper	Electrician Helper	*	*	28
5679	Hopper	Electrician Helper	*	*	17
5722	B-Precipitator	Electrician	*	*	46
5739	A-Precipitator	Apprentice Electrician	*	*	28
5710	B-Precipitator	Electrician Helper	*	*	53
5736	A-Precipitator	Electrician	*	*	16
3791	B-Precipitator	Electrician	*	*	58
3754	Hopper	Construction Mechanic	0.62	*	55
5738	B-Precipitator	Electrician Helper	*	*	6
5769	B-Precipitator	Electrician Helper	*	*	9
5720	B-Precipitator	Electrician	*	*	45
EVALUATION CRITERIA			0.05	0.05	5
LABORATORY LIMIT OF DETECTION mg/sample			0.03	0.03	0.03

* = below laboratory limit of detection

TABLE 2

Breathing Zone Air Concentrations of
Arsenic and Total Particulate

Public Service Company of Colorado
Commanche Power Plant
Pueblo, Colorado

July 18, 1981

Sample Number	Location	Job Classification	mg/M^3 Arsenic	mg/M^3 Total Particulate
AA1	B-Side/Precipitator	Electrician	*	*(1)
5708	A-Side/Precipitator	Electrician	*	12.3
5711	B-Side/Precipitator	Electrician Helper	0.01	379.0
5766	A-Side/Precipitator	Hygienist	0.002	90.3
5716	A-Side/Precipitator	Mechanic	*	0.8
EVALUATION CRITERIA			0.002	10
LABORATORY LIMIT OF DETECTION mg/sample			0.00005	0.00005

* = below laboratory limit of detection

(1) respirable sample

TABLE 3

Breathing Zone Air Concentrations of
Lead (Pb), Selenium (Sel), Cadmiun (Cd), and Total Particulate

Public Service Company of Colorado
Commanche Power Plant
Pueblo, Colorado

July 18-19, 1981

Sample Number	Location	Job Classification	mg/M^3 Pb	Sel	Cd	Total Particulate
5714	B-Side/Precipitator	Electrician	*	0.008	*	130
5764	A-Side/Precipitator	Electrician	*	*	*	10
5755	B-Side/Precipitator	Hygienist	*	0.02	*	230
5712	B-Side/Precipitator	Apprentice	*	0.02	*	282
EVALUATION CRITERIA			0.05	0.2	0.04	10
LABORATORY LIMIT OF DETECTION mg/sample			0.0001	0.0001	0.0001	0.0001

* = below laboratory limit of detection

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

Third Class Mail

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HHS
HHS 396