HEALTH HAZARD EVALUATION DETERMINATION REPORT

MHETA 81-108-9006

Consolidation Coal Company
Central Machine Shop 20
Cadiz, Ohio

PREFACE

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 and the Federal Mine Safety and Health Act of 1977, Public Law 91-173 as amended by PL95-164 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.

NIOSH 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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
MORGANTOWN, WEST VIRGINIA

HEALTH HAZARD EVALUATION DETERMINATION REPORT
MHETA 81-108-9006
Consolidation Coal Company
Central Machine Shop 20
Cadiz, Ohio

I. SUMMARY

In April 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Mine Safety and Health Administration (MSHA) to provide technical assistance in evaluating employee exposure to welding fumes and solvents at the Consolidation Coal Company Central Machine Shop 20, Cadiz, Ohio. The request was submitted due to employee concerns regarding excessive morbidity and mortality allegedly occurring among employees in the welding department.

An initial survey was performed at the facility in July 1981. Based on the observations made during this visit the decision was made to conduct an environmental survey concentrating on employee exposure to welding fumes and to conduct the survey during the winter months when doors and windows were closed. Review of work practices and the literature pertaining to the solvents used indicated that environmental sampling for solvent exposure was unwarranted.

On February 22-24, 1982, personal and area air samples for welding contaminants were taken in three areas of the machine shop--new building, old building, and blacksmith shop. Results showed that the airborne concentrations of manganese, iron, fluorides, ozone, nitrogen dioxide, and carbon monoxide, were either below; (a) applicable NIOSH recommended levels; (b) 1981 ACGIH, TLV Committee recommended levels; (c) 1972 ACGIH-TLV's enforced by MSHA: or (d) the lower detection limit of the analytical method. Analysis of ten samples specifically for chromium (VI) indicated that two samples taken in the blacksmith shop contained concentrations (.002 mg/m^3, .001 mg/m^3) equal to or in excess of the NIOSH recommended standard (.001 mg/m^3). Also three of eight samples obtained on welders in the blacksmith shop for nickel showed time weighted averages (TWA's) of airborne nickel (0.03 mg/m^3-0.04 mg/m^3) in excess of the NIOSH recommended standard (0.015 mg/m^3). Our data demonstrates that the welders in the blacksmith shop are exposed to chromium VI and nickel, both carcinogenic substances.

Based on the results of the environmental evaluation, NIOSH has determined that a health hazard did not exist from overexposure to manganese, iron, fluorides, ozone, nitrogen dioxide, or carbon monoxide on the days NIOSH sampled. However, individuals were exposed to airborne concentrations of chromium (VI) and nickel, in excess of NIOSH recommended values. Recommendations to improve welding work practices and to upgrade the maintenance of the ventilation systems are contained in Section VII of this report. A decision not to conduct a mortality study at this plant was made because it would duplicate the planned NIOSH industry-wide mortality study of welders.

Key Words: SIC 1211, Welding, Chromium VI, Nickel

II. INTRODUCTION

In April 1981, the Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health received a request from the Coal Mine Safety and Health District 8, Mine Safety and Health Administration (MSHA) to provide technical assistance in evaluating employee exposure to welding fumes and solvents in the Consolidation Coal Company Central Machine Shop #20 located in Cadiz, Ohio. MSHA submitted the request because of employee reports of excessive morbidity and mortality from heart disease, cancer, and emphysema allegedly occurring among employees in the welding department of the Central Machine Shop.

III. BACKGROUND

The Central Machine Shop #20, which has been in operation since 1943 provides support for all the Consolidation Coal Company mines located in Ohio. Approximately 75 individuals (welders, machinists, mechanics) are employed in the shop--13 of 48 day shift workers (8 am - 3:15 pm) are welders, 1 of 17 on the evening shift (3:45 pm - 11:00 pm) is a welder, and 2 of 11 on the night shift (12:00 pm - 7:15 am) are welders. The machine shop and welding shop are the largest departments of the Central Machine Shop. A majority of the welding is done on mild steel using the Metal Inert-Gas (MIG) or Manual MetalArc (MMA) processes. Other welding processes frequently used are brazing, hardfacing, oxyacetylene, and submerged arc. Occasionally, such metals as galvanized steel, aluminum, and stainless steel are welded upon.

The welding operations are conducted in two interconnecting buildings (See Figure 1, (Shop Diagram)). The two buildings are each approximately 200 feet by 60 feet with a ceiling height of approximately 40 feet. A separate blacksmith shop area measures approximately 85 feet by 40 feet with a ceiling height of approximately 40 feet.

Ventilation is provided by two 42 inch exhaust fans located in the ceilings of both the new building and the old building and one 42 inch fan in the ceiling of the blacksmith shop. Also local exhaust ventilation for welding operations is provided at a majority of the welding areas. The local exhaust ventilation which has been in use for approximately 10 years consists of flexible ducts which can be moved to within a few inches of the welding operation.

IV. EVALUATION DESIGN AND PROCEDURES

A. Environmental

An initial survey was performed at the facility in July 1981. The purpose of that visit was to gather information on the types of welding operations and the chemicals used in the shop area. Based on the observations made during the initial visit, the decision was made to conduct a comprehensive survey concentrating on employee exposure to welding fumes, and to conduct the survey during the winter months when doors and windows were closed. After observing work practices and reviewing the literature pertaining to the solvents used in the shop, it was determined that environmental sampling for solvent exposure was unwarranted.

The environmental evaluation was conducted on February 22-24, 1982. Exposures to various welding contaminants were evaluated. The contaminants were monitored using standard personal and area sampling techniques. Due to work habits, it was not feasible to attach the filter cassettes to the inside of the welders' helmets. Therefore, the personal welding fume samples were obtained by clipping the filter cassette to the worker's collar. The sampling and analytical methodologies are presented in Table 1. Air velocity measurements of the local exhaust ventilation systems were determined using a constant temperature thermal anemometer.

B. Medical

A medical approach to this technical assistance request would be to do a morbidity and mortality study at the Cadiz welding shop. Morbidity and mortality studies have been done on welders resulting in widely divergent conclusions. This topic was recently reviewed by M. Attfield for the NIOSH industry-wide welding study. He came to the conclusion that the available epidemiological studies did not resolve the question of excess morbidity and mortality in welders as compared to the rest of the population, although it is generally accepted that welders are exposed to a variety of toxic substances, including various carcinogens. NIOSH has therefore proposed an industry wide mortality study of welders. Since Cadiz is only one welding shop, self-selected for a cohort study, it would be hard to prove that documented excess mortality was not due to selection bias. A mortality study conducted at another small welding shop cannot answer these criticisms. A mortality study at Cadiz would ultimately prove to be non-definitive.

V. EVALUATION CRITERIA

A. Environmental

The primary sources of environmental evaluation criteria considered in this report are: a) NIOSH Criteria Documents with recommended standards for occupational exposure; b) 1981 American Conference of Governmental Industrial Hygienists Threshold Limit Values (ACGIH-TLV's); and c) the 1972 ACGIH-TLV's which are incorporated into the Federal Mine Safety and Health Act of 1977 by reference.

Occupational health exposure limits for individual substances are generally established at levels that can be tolerated by a worker during an 8 to 10 hour workday, 40 hour workweek without adverse effects. NIOSH maintains that the worker be protected by the standard or recommended levels that afford him the greatest degree of protection.

For the substances monitored during this survey, the environmental criteria are shown in Table 2.

B. Medical

The chronic health effects of welding fumes have been examined in numerous studies. There may be excess lung cancer and chronic respiratory disease. Welders may have a shorter life expectancy from all causes than other occupational groups.

The two substances that exceeded NIOSH recommended levels have both been implicated in causing lung cancer. Chromium (VI) can cause perforation of the nasal septum and sensitization of the respiratory tract leading to asthma. There are no data to indicate whether or not an exposure level of less than .01 mg/M^3 carries a cancer risk. [1] Nickel can cause asthma, dermatitis, and cancer of the respiratory tract. Whether there is a dose-response relationship between these substances and the development of cancer is unknown.

VI. RESULTS

A. Environmental Sampling

A total of 55 personal samples for general welding fumes was collected in the three areas of the shop--old building, new building, and blacksmith shop. Representative samples from each of the three areas were selected and analyzed using "inductively coupled plasma-atomic emission spectroscopy[1] (ICP-AES)" to determine qualitatively and quantitatively the elements present. ICP analysis revealed the presence of 14 trace metals. However, only 4 metals - manganese, iron, chromium, and nickel - were present in significant amounts and the samples containing these metals were obtained in the blacksmith shop. Therefore, based on these results and the fact that the welding operations and welding fumes were more concentrated in the blacksmith shop than in the other two areas of the shop, only the remaining samples collected in the blacksmith shop were selected for futher analysis for these 4 metals.

Samples for which time-weighted averages (TWA) were computed were collected over the length of the normal work period. On days where the work period was less than 8 hours, a zero value was assigned to the unsampled portion of the work shift in computing the TWA. None of the samples analyzed exceeded limits imposed by Federal standards.

Results in Table 3 show that the airborne concentrations of manganese, chromium metal, and iron were well below all evaluation criteria. However, of the eight samples obtained in the blacksmith shop and analyzed for nickel, three exceeded the NIOSH recommended standard of .015 mg/m^3 and two other samples indicated a TWA of .010 mg/m^3. Two of the samples which exceeded the recommended standard were obtained on mechanics engaged in grinding operations.

Tables 4 thru 7 contain results of the additional personal and area samples for chromium (VI), NO_2, fluoride, and manganese which were collected in all areas of the shop. Two samples obtained on welders in the blacksmith shop for chromium (VI) showed concentrations of airborne chromium (VI) (.002 mg/m^3, .001 mg/m^3) equal to or in excess of the NIOSH recommended standard (0.001 mg/m^3). (3) This shows that the welders may be at increased risk of overexposure to chromium (VI).

Several measurements using direct reading equipment were made at all the welding positions for ozone and carbon monoxide. Ozone was not detected at any of the positions and the highest level of carbon monoxide detected was 4 ppm (TWA) which is approximately 11 percent of the NIOSH recommended criteria of 35 ppm TWA.

Capture velocities, measured in the zone of welding, approximately 5-6 inches from the opening of the local exhaust ducts, provided to welding stations 2,7,11,12,14, and 16 (See Figure 1, Shop Diagram) ranged from 35-100 linear feet per minute (fpm). These measurements were obtained with all the ducts on each system open and operational. Position 16 was the only position for which the minimum recommended air flow of 100 fpm (4) was recorded. It was noted that some of the exhaust ducts were in poor mechanical condition, i.e. bent and/or holes in the ducts, which would allow for the inefficient operation.

B. General Observations

Several observations of working conditions and worker habits were made during the survey and are discussed below:

1. Several of the workers informed the NIOSH investigator that they did not always use the local exhaust ducts provided because the ventilation disturbed the quality of weld. Tests have indicated that a velocity of 100 linear fpm across the weld will not disturb the shielding gases in metal inert-gas welding (MIG) operations, where normal gas flow rates are used. (4)

2. At times, the overhead crane operator's vision may be impaired due to the sudden flashes from the welding operations in the floor area thereby increasing the potential for accidents.

3. In one of the welding areas, it was noted that the welding screens were painted a bright orange. This will reflect the untraviolet radiation thus increasing the potential for burns and eye damage.

4. Discussions with welders who had performed repairs inside the "pads" and "doors" (semi-enclosed areas) indicated that general ventilation was many times the only means of exhausting the contaminated air. Gases and/or vapors will accumulate from welding operations when there is inadequate ventilation and increase the potential for hazardous conditions.

VII. RECOMMENDATIONS

1. It is recommended that the local exhaust ventilation systems be upgraded to provide a rate of air flow sufficient to maintain a velocity in the direction of the hood of 100 linear feet per minute in the zone of welding. (5)

2. As an interim protective measure, NIOSH/MSHA approved metal fume respirators should be provided the welders/mechanics in the blacksmith shop engaged in shielded metal arc welding and grinding that are exposed to chromium (VI) and nickel until such time as the local exhaust ventilation system is operating according to the guidelines in 1 above. Sampling should be performed in order to assess the effectiveness of the upgraded ventilation in reducing nickel and chromium exposures.

3. Metal fume respirators and local exhaust ventilation should be provided the individuals assigned to weld in the semi-enclosed areas, i.e. "doors" and "pads".

4. Those welders required to wear the metal fume respirators should be instructed in the proper use, fitting, cleaning, and maintenance of the respirators as outlined in ANSI standard Z88.2.

5. It is recommended that tinted spectacles be provided the overhead crane operator to provide protection from the blinding flashes of the welding operations.

6. The on-going education program should emphasize the health hazards associated with welding and cutting operations, and the proper use and maintenance of the local exhaust ventilation system.

7. Shielding set up around the welding activities should be painted with a finish formulated with a pigment such as zinc oxide which has low reflectivity to ultraviolet radiation.

VIII. REFERENCES

1. Norseth, T., Chromium and its compounds, Zenz C. Occupational Medicine, 1975, 644-649.

2. NIOSH, Summary of NIOSH Recommendations for Occupational Health Standards, DHEW (NIOSH), October, 1978.

3. NIOSH Criteria for a Recommended Standard: Occupational Exposure to Chromium (VI), National Institute for Occupational Safety and Health, D.H.E.W. Publication No. (NIOSH) 76-129, 1975.

4. Jefferson, T.B., The Welding Enclyclopedia, 17 ed., Monticello Books, 1967.

5. American Welding Society. "Safety in Welding and Cutting," ANSI 2491, 1973.

6. NIOSH Manual of Analytical Methods, Volumes 1-7, D.H.E.W., National Institute for Occupational Safety and Health.

7. NIOSH Criteria for a Recommended Standard: Occupational Exposure to Inorganic Fluoride, National Institute for Occupational Safety and Health, D.H.E.W. Publication No. (NIOSH) 76-103, 1975.

8. Attfield, M., Welders project proposal, literature review, NIOSH.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared By:

Ronnie J. Cornwell
Industrial Hygienist
Environmental Investigations Branch
Division of Respiratory Disease Studies
Morgantown, West Virginia 26505

Michael Hodgson, M.D.
Medical Officer
Clinical Investigations Branch
Division of Respiratory Disease Studies
Morgantown, West Virginia 26505

Originating Office:

Mining Health Hazard Evaluation and
Technical Assistance Program
Division of Respiratory Disease Studies
Morgantown, West Virginia 26505

Environmental Evaluation
Conducted By:

Ronnie J. Cornwell, Rick Ferguson, and
Paul Hewett
Industrial Hygienists
Environmental Investigations Branch
Morgantown, West Virginia 26505

Paul Johnson
Industrial Hygienist
Hazard Evaluation and Technical
Assistance Branch
Cincinnati, Ohio

Report Typed By:

Deanna Cress
Mining Health Hazard Evaluation and
Technical Assistance Program
Division of Respiratory Disease Studies
Morgantown, West Virginia 26505

TABLE 1

Consolidation Coal Company
Central Machine Shop 20
Cadiz, Ohio

Report No. MTA 81-108

Sampling and Analytical Methodologies

Substance Sampled	Sampling Media	Flow Rate (LPM)(1)	Analytical Method	Analytical Method Reference
Chromium (VI)	FWS Filter	1.5	Visible Spectrophotometry	P&CAM 319 (2)
Chromium Metal	AA Filter	1.5	Atomic Absorption Spectrophotometry	P&CAM 173 (2)
Nitrogen Dioxide	Triethanolamine (Passive Dosimeter)	--	Visible Spectrophotometry	Palmes, E.D. (3)
Carbon Monoxide	Long term Detector Tube	0.01	Direct Reading	--
Ozone	Detector Tubes	--	Direct Reading	--
Fluoride	AA Filter	2.0	Selective Ion Electrode	P&CAM 212 (2)
Manganese	AA Filter	1.5	Atomic Absorption Spectrophotometry	P&CAM 173 (2)
Nickel	AA Filter	1.5	Atomic Absorption Spectrophotometry	P&CAM 173 (2)
Iron	AA Filter	1.5	Atomic Absorption Spectrophotometry	P&CAM 173 (2)

(1) LPM - Liters per minute
(2) NIOSH Manual of Analytical Methods, Vol. 1-7.
(3) Palmes, E.D., Am. Ind. Hyg. Assoc. J. 37, 1976.

TABLE 2

Consolidation Coal Company
Central Machine Shop 20
Cadiz, Ohio

Report No. MTA 81-108

Exposure Criteria

Substance	NIOSH(1)	1981 ACGIH(2)	1972 ACGIH(3)
Carbon Monoxide (CO)	35 ppm*	50 ppm	50 ppm
Chromium (VI) (insol)	.001 mg/m^3**	.05 mg/m^3	1.0 mg/m^3
Chromium Metal	--	.5 mg/m^3	1.0 mg/m^3
Fluorides (F)	2.5 mg/m^3	2.5 mg/m^3	2.5 mg/m^3
Iron Oxide (Fe)	--	5 mg/m^3	10 mg/m^3
Manganese Fume (Mn)	--	1 mg/m^3	5 mg/m^3 (Ceiling)
Nickel (Ni)	.015 mg/m^3	1 mg/m^3	1 mg/m^3
Nitrogen Dioxide (NO_2)	1 ppm (Ceiling)	3 ppm	5 ppm (Ceiling)
Ozone	.1 ppm	.1 ppm	.1 ppm

*ppm - Parts Per Million
**mg/m^3 - Milligrams of substance per cubic meter of air
(1) NIOSH - National Institute for Occupational Safety and Health..."Criteria for a Recommended Standard."
(2) 1981 ACGIH-TLV's - American Conference of Governmental Industrial Hygienists-Threshold Limit Values.
(3) 1972 ACGIH-TLV's - American Conference of Governmental Industrial Hygienists - Threshold Limit Values - Criteria enforced by the Mine Safety and Health Administration (MSHA) for coal mine surface work areas.

TABLE 3

Consolidation Coal Company
Central Machine Shop 20
Cadiz, Ohio

Report No. MTA 81-108

Personal Exposure Data

TWA (mg/m^3)

Work Area[1] Job Title	Date	Nickel	Manganese	Iron	Chromium	Process Description (Welding Method/Rod/Base Metal)
7/Welder	2/23	.007	.07	.67	.03	SMAW[2]/E10018M & 258 TIC/High Tensile Steel
7/Welder	2/24	.01	.14	1.36	.11	SMAW/E10018M/High Tensile Steel
8/Welder	2/23	.01	.03	.54	.01	SMAW/E10018M & Carbon Arc/High Tensile Steel
8/Welder	2/24	.04	.08	2.23	.03	SMAW/E10018M/High Tensile Steel
9/Welder	2/23	.007	.08	.66	.02	SAW[3]/L60/High Tensile Steel
9/Welder	2/24	.004	.04	.31	.008	SAW/L60/High Tensile Steel
10/Mechanic	2/23	.03	.05	1.34	.02	Grinding High Tensile Steel
10/Mechanic	2/24	.04	.04	2.89	.01	Grinding High Tensile Steel
Evaluation Criteria		.015mg/m^3 (NIOSH)	1 mg/m^3 (81 ACGIH)	5 mg/m^3 (81 ACGIH)	.5 mg/m^3 (81 ACGIH)	

(1) See Figure 1, Shop Diagram
(2) SMAW - Shielded Metal Arc Welding
(3) SAW - Submerged Arc Welding

TABLE 4

Consolidation Coal Company
Central Machine Shop 20
Cadiz, Ohio

Report No. MTA 81-108

Results of Personal Exposure
Measurements for Chromium (VI)

Work area/[1] Job Title	Sampling Time	Date	TWA (mg/m^3)	Process Description (Welding Method/Rod/Base Metal)
7/Welder	0804-1449	2/24	.0020	SMAW[(2)]/E10018M/High Tensile Steel
8/Welder	0815-1500	2/23	.0010	SMAW/E10018M & Carbon Arc Rod/High Tensile Steel
8/Welder	0805-1448	2/24	ND[(3)]	SMAW/E10018M/High Tensile Steel
9/Welder	0819-1453	2/23	ND	SAW[(4)]/L60/High Tensile Steel
9/Welder	0808-1448	2/24	ND	SAW/L60/High Tensile steel
10/Mechanic	1012-1357	2/23	ND	Grinding/High Tensile Steel
10/Mechanic	0900-1458	2/24	.0002	Grinding/High Tensile Steel
15/Welder	0813-1504	2/24	ND	MIG[(5)]/AS18/Mild Steel
16/Welder	0810-1510	2/23	ND	SMAW/Alloy 32, Hardface/Mild Steel
16/Welder	0814-1510	2/23	ND	SMAW/Alloy 32, Hardface/Mild Steel

Evaluation Criteria — .001 mg/m^3 (NIOSH)
.05 mg/m^3 (1981 ACGIH)

Limit of Detection - .0002 mg

(1) See Figure 1, Shop Diagram
(2) SMAW - Shielded Metal-Arc Welding
(3) ND - None Detected
(4) SAW - Submerged Arc Welding
(5) MIG - Metal Inert-Gas Welding

TABLE 5

Consolidation Coal Company
Central Machine Shop 20
Cadiz, Ohio

Report No. MTA 81-108

Results of Personal Sampling for NO_2
Using Passive Dosimetry (Palmes Method)

Work area/[1] Job Title	Sampling Time	Date	TWA (ppm)	Process Description (Welding Method/Rod/Base Metal)
2/Welder	0804-1516	2/23	0.05	SMAW[2]/E10018M/Mild Steel
2/Welder	0830-1510	2/23	0.02	MIG,[3] SAW[4]/AS25/Mild Steel
2/Welder	0822-1510	2/24	0.04	MIG/AS25/Mild Steel
2/Welder	0830-1505	2/24	0.05	SMAW/E10018M/Mild Steel
2/Welder	0829-1505	2/24	0.04	SMAW/E10018M/Mild Steel
3/Welder	0824-1510	2/23	0.15	MIG/AS25/Mild Steel
4/Welder	0803-1502	2/23	0.01	MIG/AS25/Mild Steel
4/Welder	0803-1450	2/24	0.07	MIG/AS25/Mild Steel
Old Building/ Mechanic	0803-1500	2/24	0.03	-----
7/Welder	0827-1500	2/23	0.03	SMAW/258TIC & E10018M/High Tensile Steel
7/Welder	0804-1449	2/24	0.04	SMAW/E10018M/High Tensile Steel
8/Welder	0827-1500	2/23	0.04	SMAW/E10018M & Carbon Arc Rod/ High Tensile Steel
8/Welder	0805-1448	2/24	0.01	SMAW/E10018M/High Tensile Steel
9/Welder	0827-1453	2/23	0.03	SAW/L60/High Tensile Steel
9/Welder	0808-1448	2/23	0.05	SAW/L60/High Tensile Steel
10/Mechanic	1012-1357	2/23	0	Grinding
10/Mechanic	0900-1458	2/24	0.06	Grinding
15/Welder	0820-1505	2/23	0.08	MIG/AS18/Mild Steel
15/Welder	0813-1504	2/24	0.07	MIG/AS18/Mild Steel
16/Welder	0810-1510	2/23	0.21	SMAW/Alloy 32, Hardface/Mild Steel

TABLE 5 Cont'd.

Work area/[1] Job Title	Sampling Time	Date	TWA (ppm)	Process Description (Welding Method/Rod/Base Metal)
16/Welder	0814-1510	2/23	0.08	SMAW/Alloy 32, Hardface/Mild Steel
16/Welder	0805-1504	2/24	0.11	MIG/AS18/Mild Steel
16/Welder	0802-1506	2/24	0.05	MIG/AS18/Mild Steel
New Bldg./ Crane Op.	0825-1510	2/23	0.07	---
New Bldg./ Crane Op.	0818-1509	2/24	0.08	---
Evaluation Criteria			3 ppm-TWA (1981 ACGIH)	

(1) See Figure 1, Shop Diagram
(2) SMAW - Shielded Metal-Arc Welding
(3) MIG - Metal Inert-Gas Welding
(4) SAW - Submerged Arc Welding

TABLE 6

Consolidation Coal Company
Central Machine Shop 20
Cadiz, Ohio

Report No. MTA 81-108

Results of Area Sampling for
Inorganic Fluoride

Work area/[1] Job Title	Sampling Time	Date	Concentration (mg/m^3)	Process Description (Welding Method/Rod/Base Metal)
7	0850-1500	2/23	0.05	SMAW[2]/258 TIC & E10018M/High Tensile Steel
7	0820-1445	2/24	0.15	SMAW/E10018M/High Tensile Steel
8	0822-1445	2/24	0.05	SMAW/E10018M/High Tensile Steel
8	0905-1500	2/23	0.12	SMAW/E10018M & Carbon Arc/ High Tensile Steel
9	0857-1500	2/23	0.15	SAW[3]/L60/High Tensile Steel
9	0824-1445	2/24	0.02	SAW/L60/High Tensile Steel
13	0840-1500	2/23	0.03	SAW/L60/Mild Steel
14	0842-1520	2/23	LOD	MIG[4]/AS18/Mild Steel
16	0847-1515	2/23	0.02	SMAW/Alloy 32, Hardface/Mild Steel

Evaluation criteria 2.5 (NIOSH)
Limit of Detection (LOD) .005 mg

(1) See Figure 1, Shop Diagram
(2) SMAW - Shielded Metal-Arc Welding
(3) SAW - Submerged Arc Welding
(4) MIG - Metal Inert Gas-Welding

TABLE 7

Consolidation Coal Company
Central Machine Shop 20
Cadiz, Ohio

Report No. MTA 81-108

Results of Ceiling Exposure
Measurements for Manganese

Work area/Job Title[1]	Sampling Time	Date	Concentration (mg/m^3)	Process Description (Welding Method/Rod/Base Metal)
2	1000-1015	2/24	3.46	SMAW[3]/E10018M/Mild Steel
4	0932-0948	2/24	1.0	MIG[4]/AS18/Mild Steel
4	1035-1050	2/24	.71	MIG/AS18/Mild Steel
7	0953-1008	2/24	.25	SMAW/E10018M/High Tensile Steel
7	1247-1300	2/24	ND[2]	SMAW/E10018M/High Tensile Steel
7	1430-1445	2/23	ND	SMAW/E10018 & 258 TIC/High Tensile Steel
9	1221-1233	2/24	ND	SAW[5]/L60/High Tensile Steel
15	0905-0920	2/24	.49	MIG/AS18/Mild Steel
15	1410-1425	2/24	1.69	MIG/AS18/Mild Steel
15	1430-1445	2/24	2.13	MIG/AS18/Mild Steel
16	0809-0830	2/24	ND	MIG/AS18/Mild Steel
16	0835-0900	2/24	.03	MIG/AS18/Mild Steel
16	1325-1340	2/24	.58	MIG/AS18/Mild Steel
16	1430-1450	2/24	ND	MIG/AS18/Mild Steel

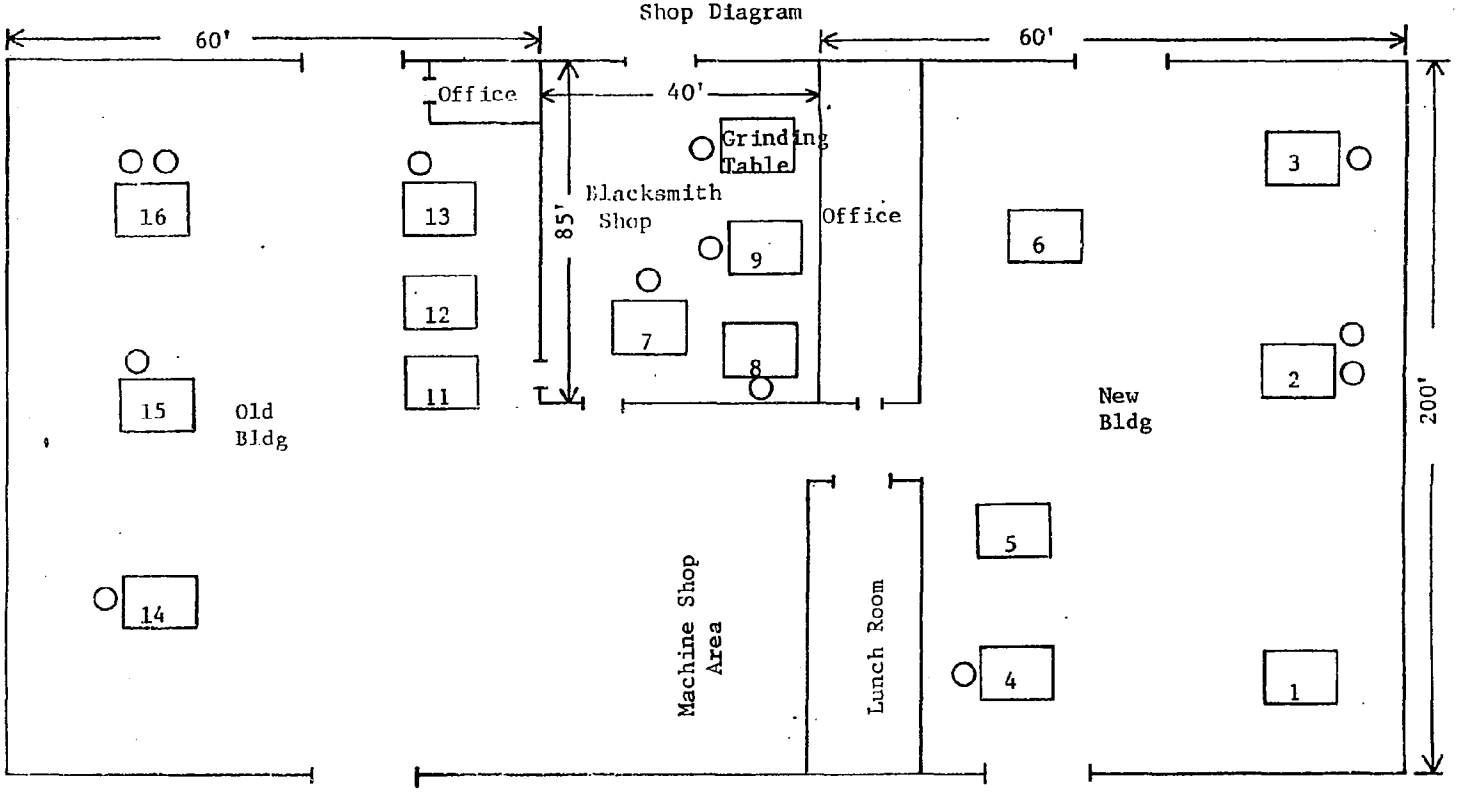
Evaluation Criteria: 5 mg/m^3 (ceiling)(81 ACGIH)
Limit of Detection: .001 mg

(1) See Figure 1, Shop Diagram
(2) ND - None Detected
(3) SMAW - Shielded Metal-Arc Welding
(4) MIG - Metal Inert-Gas Welding
(5) SAW - Submerged Arc Welding

FIGURE 1

Consolidation Coal Company
Central Machine Shop 20
Cadiz, Ohio

Report No. MTA 81-108
Shop Diagram



Ceiling height approx 40 feet

8/