

HEALTH HAZARD EVALUATION DETERMINATION REPORT

MHETA 80-119-9007

Peabody Coal Company  
Ken Surface Mine Processing Plant  
Beaver Dam, Kentucky

## 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 PL 95-164 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 of 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

HEALTH HAZARD EVALUATION DETERMINATION REPORT  
MHETA 80-119-9007  
Mine I.D. No. 15-02077

Peabody Coal Company  
Ken Surface Mine Processing Plant  
Beaver Dam, Kentucky 42320

I. SUMMARY

On September 16, 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request to determine the potential for adverse health effects as a result of welding in coal washboxes at the Ken Surface Mine Processing Plant near Beaver Dam, Kentucky. A NIOSH industrial hygienist and physician conducted a walk-through survey on October 20, 1980. Work practices and ventilation controls were found to be deficient and an interim report with recommendations was issued in January, 1981.

An industrial hygiene survey was conducted on January 24, 1982. Exposures to "total welding fume", iron oxide fume, manganese fume, fluorides, ozone, carbon monoxide, nitrogen dioxide, and sulfur dioxide were monitored. All exposures were less than the applicable 1981 ACGIH TLV or NIOSH recommended health standard.

Based upon the results of the most recent survey, it appears that the work practices and ventilation control measures presently in use are effective in controlling welder exposure to welding fumes and gases. NIOSH recommends that these procedures continue as company policy when welding maintenance is required on the inside of the washboxes.

II. INTRODUCTION

Section 501(a)(11) of the Federal Mine Safety and Health Act of 1977, Public Law 91-173 as amended by PL 95-164 authorizes the Secretary of Health and Human Services to determine upon written request by any mine operator or authorized representative of miners, whether any substance normally found in a coal or other mine has potentially toxic effects or whether any physical agents or equipment found or used in a coal or other mine has potentially hazardous effects.

The United Mine Workers of America, made a written request, dated September 12, 1980, to NIOSH to conduct a health hazard evaluation at the

Peabody Coal Company's Ken Surface Mine in Beaver Dam, Kentucky. The request was prompted by the fact that an employee had suffered a stroke shortly after welding in a coal wash box in January, 1980; NIOSH was asked to determine what effects such enclosed space welding might have on welders. A NIOSH industrial hygienist and physician conducted a walk-through survey on October 20, 1980, at which time discussions were held with the company, the union, and processing plant welders. An interim report (see Appendix C) was issued in January of 1981. This report contained interim recommendations for improving existing controls and work practices.

An industrial hygiene survey was conducted on January 24, 1982. This report contains the results and recommendations of the industrial hygiene survey.

### III. BACKGROUND AND PROCESS DESCRIPTION

#### Background

The Ken Mine is a surface coal mine which employed 154 union workers before September 16, 1980, including 22 welders of whom 9 worked in the processing plant (tipple). After a September 16th layoff, the total union employment was 106, including 12 welders of whom 8 were processing plant welders.

#### Process

Coal is moved from the strip mine to the processing plant via 60 ton coal trucks. In order to meet customer specifications the coal is "washed" at the processing plant to remove pyritic sulfur and ash. This is accomplished through the use of two five-cell and one three-cell coal wash boxes.

The coal wash box, also known as a jig, utilizes a process of particle stratification. A pulsating fluid flow separates the clean coal from the undesirable materials. Raw coal is fed onto a series of screens through which water is forced from below. The raw coal particles are distended and allowed to resettle. The higher specific gravity particles settle faster and a stratification of the bed results. This cycle of suspending and resettling may be repeated 30 to 60 times per minute as the coal moves over the screens. After stratification has taken place the top layer of clean coal is physically cut from the bottom layer of refuse.

Each cell is approximately 11-12 feet long, 10 feet deep, and 4 feet in width. The screen is 4-5 feet below the top of the cell. Each cell has its own air impulse valve (which causes the cyclic pulsations through the screen suspending and resettling the coal bed), and is separated from adjacent cells by a baffle plate beginning just below the screens (see

Appendix A). Each cell may be accessed by a manhole located at the bottom side of the wash box or by removing the screen. The wash box is constructed of 1/2 and 5/8 inch mild steel plate.

For a description of the work practices and conditions present at the time of the walk-through, see Appendix C, Part VI of the Interim Report.

At the time of the industrial hygiene survey, there had been no major changes to the operation of the plant. The previous exhaust fan/barrel assembly had been replaced by two more effective units as we recommended in the interim report. The new units are similiar to the one described in the interim report except that both the barrel and propellor fan are larger.

Washbox maintenance is sporadic. Since the walk-through survey the washboxes have required welding maintenance only at intervals of several months. The company now requires that the coal screens be cleared off or removed and the exhaust fan placed over the impulse valve cylinder prior to any washbox welding maintenance.

During the January 1982 survey a 2 x 3 ft section of an interior wall was replaced. The section to be replaced was cut out during the previous shift using an oxy/acetylene torch. The washbox had been drained, the coal screen removed, the impulse valve cap removed, and the exhaust fan placed over the impulse valve cylinder. In addition, most of the slag had been removed from the metal surfaces on all sides of the section to be replaced. When we arrived at the processing plant all that remained was to size the replacement plate, tack it in, and weld the seams. Two workers did most of the work but only one did the welding and cutting. The other assisted but did not enter the cell. The replacement plate was mild steel. The welder used 1/8" E7018 welding rods.

#### IV. Health Effects and Evaluation Criteria

Welding (and cutting) is a process in which the degree of risk varies greatly with the type of welding equipment used, the type of base metal, presence of surface coatings (lead based paints, galvinizing), the type of welding rod, and type of flux. The amount of exposure is determined by the welder's work practices, the location of the welder relative to the arc, and the type and effectiveness of any control measures.

Many toxic substances can be generated including ozone, carbon monoxide, nitrogen oxides, and various metal fumes (which vary according to type of welding rod and base metal used). Reported toxic effects include simple irritation, metal fume fever, and lung diseases. There are reports in the literature of excessive exposure to nitrogen dioxide or ozone generated during confined space welding that resulted in acute pulmonary edema or pneumonitis.

Interviews during the walk-through survey indicated that when welding inside the washbox, welders would experience acute eye and nose irritation, throat irritation, breathlessness, headaches, and faintness. These symptoms were associated with instances where welding was done without appropriate controls. Since these symptoms were consistent with the acute effects of welding fume exposure we decided that it would be appropriate to concentrate on the potential acute effects. These acute effects can result from overexposure to welding gases - nitrogen dioxide and ozone - and to welding fumes. Carbon monoxide will also be present although it is unlikely to be present in sufficient quantities to produce acute effects. Of added concern is the use of the oxy/acetylene torch or welding in a confined space which can result in oxygen deprivation.

In our opinion, based upon worker interviews and our own initial assessment of the washboxes, there existed a possibility of acute exposures to welding fumes and gases if proper precautions were not taken. Therefore, we felt an important part of the industrial hygiene survey should be to determine 1) if elevated exposures occur during normal welding repair where proper work practices and ventilation are used, and 2) what set of circumstances might lead to elevated exposures.

The occupational health standards used in this report were obtained from various sources: NIOSH recommended occupational health standards, current ACGIH TLVs, federal standards, and current research. NIOSH is not restricted to applying only federal (MSHA) standards when conducting a Health Hazard Evaluation. Since the time the MSHA standards were promulgated more current research and epidemiological studies have prompted the ACGIH TLV committee to lower a number of their TLVs and NIOSH to recommend revising a number of existing federal standards. For the purposes of a Health Hazard Evaluation NIOSH may select as evaluation criteria those exposure standards that best reflect current research. The evaluation criteria for this study were selected on this basis.

We chose to use as criteria for assessing the potential for acute effects the published "Immediately Dangerous to Life and Health" (IDLH) levels:

<u>Substance</u>	<u>IDLH Level</u>
nitrogen dioxide	50 ppm
ozone	10 ppm
<u>carbon monoxide</u>	<u>1500 ppm</u>

Source: NIOSH/OSHA Pocket Guide to Chemical Hazards.

IDLH refers to those conditions that pose an immediate threat to life or health, or conditions that pose an immediate threat of severe exposure to contaminants which are likely to have adverse cumulative or delayed effects on health (30 CFR Part 11, Subpart A, 11.3(t)). The above IDLH

levels represent a maximum exposure from which one could escape within 30 minutes without any escape-impairing symptoms - severe eye or respiratory irritation - or any irreversible health effects (pocket guide).

The evaluation of exposure which may potentially cause chronic effects was difficult to do considering the infrequent nature of washbox welding. All exposure standards, except ceiling standards, are based upon an exposure averaged over 8 hours. The repair job done during our survey required only a few hours which would necessarily result in a lower 8-hour TWA exposure than the actual exposure during the repair job. Future repair jobs might require more or less time. We decided to consider the welder's exposure during our survey as characteristic of washbox welding, regardless of the length of time required. A worst case would be a full eight hours of welding. Therefore, to be on the safe side, the welding exposures for the few hours required for this particular job were compared to the following 8-hour TWA evaluation criteria:

<u>Substance</u>	<u>ACGIH TLV</u>	<u>NIOSH</u>	<u>MSHA</u>
iron oxide fume	5 mg/m <sup>3</sup>	-----	10 mg/m <sup>3</sup>
manganese fume	1 mg/m <sup>3</sup>	-----	C 5 mg/m <sup>3</sup>
total welding fume	5 mg/m <sup>3</sup>	-----	-----
fluorides	2.5 mg/m <sup>3</sup>	2.5 mg/m <sup>3</sup>	2.5 mg/m <sup>3</sup>
nitrogen dioxide	3 ppm	C 1 ppm	C 5 ppm
ozone	0.1 ppm	-----	0.1 ppm
carbon monoxide	50 ppm	35 ppm	50 ppm
		C 200 ppm	

Note: A few of the above standards are ceiling standards as noted by the prefix C, and not TWAs, but are included here rather than in a separate section.

#### V. SURVEY DESIGN

Samples were collected for welding fumes using a Millipore HA 0.45um pore size filter mounted in a two-piece cassette connected to a personal sampling pump calibrated at 2.0 Lpm. Samples were collected for fluorides using an identical sample train.

Exposures to nitrogen dioxide were monitored by taping a Palmes NO<sub>2</sub> dosimeter to the inside of the welding helmet or, if the welder was using the torch, by clipping it to the collar.

Carbon monoxide exposure was determined using an Ecolyzer CO monitor. A length of flexible tubing was connected to the monitor inlet and used to draw an air sample from inside of the welder's helmet or from the welder's breathing zone when cutting.

We had planned to monitor peak exposures to nitrogen dioxide and sulfur dioxide, but unfortunately the instruments failed to perform properly. Instead, detector tubes were used to determine peak exposures to nitrogen dioxide and sulfur dioxide. Detector tubes were also used to determine peak exposures to ozone.

A rotating vane anemometer was used to determine the quantity and velocity of air being pulled through the washbox by the exhaust fan.

The time required for a typical welding repair job in a washbox is usually no more than a couple of hours once the washbox has been drained, the screens removed, and the exhaust fan installed. On this day more time than usual was required; approximately 2.5 hours were needed to cut and fit the replacement plate and approximately 1 hour to weld it in place. During the cutting and fitting the oxy/acetylene torch was used at intervals and exposure to nitrogen dioxide, carbon monoxide, and sulfur dioxide were evaluated. Once the welder started to tack weld the plate into place, we placed metal fume and fluoride samplers on him, while continuing to sample for welding gases as before.

Because we felt that there existed a danger of excessive exposures if no ventilation controls were used, we requested that the exhaust fan be cut off and that the welder weld another pass. New sampling media were used to monitor the welder's exposure during this exercise. Detector tubes were used to check exposure to ozone, carbon monoxide, and nitrogen dioxide. The Ecolyzer CO monitor was also used to monitor carbon monoxide.

## VI. SAMPLE RESULTS

### Personal Samples

The following represents the results of the samples taken during the actual welding repair operation with the exhaust fan in operation.

The result of gravimetric analysis of the personal filter samples indicate that the welder's exposure to "total welding fume" was 1.89 mg/M<sup>3</sup> which is below the 1981 ACGIH TLV of 5 mg/m<sup>3</sup> (See Appendix A, Table I).

Exposures to nitrogen dioxide, as determined by either Palmes dosimeters or detector tubes, during both welding and cutting, ranged between "less than detectable" to 0.32 ppm, and were all below both the 1981 ACGIH TLV of 3 ppm and the NIOSH recommended ceiling level of 1 ppm, respectively (See Appendix A, Table II).

Exposures to carbon monoxide, as determined using a detector tube and the Ecolyzer CO monitor, ranged between "less than detectable" to 4 ppm with



occasional peaks in the range of 16-23 ppm. All readings were less than the NIOSH recommended standard of 35 ppm (See Appendix A, Table V).

Exposure to ozone, determined using a detector tube, yielded a reading of "less than detectable". Exposures to sulfur dioxide, determined using detector tubes while the welder was cutting metal surfaces contaminated with slag, yielded readings of "less than detectable" (See Appendix A, Table IV).

Exposures to iron oxide fume and manganese fume were  $0.33 \text{ mg/M}^3$  and  $0.06 \text{ mg/m}^3$ , respectively, which were less than the 1981 ACGIH TLVs of  $5 \text{ mg/m}^3$  and  $1 \text{ mg/m}^3$ , respectively (See Appendix A, Table III).

Exposure to fluorides was not determined due to a personal sampling pump failure early in the sampling period which invalidated the sample.

Following the shutting off of ventilation, the welder ran a second bead around the seams. During this period detector tube samples for carbon monoxide, nitrogen dioxide, and ozone all gave "less than detectable" readings. The Ecoloyzer CO monitor gave readings ranging from 1 to 4 ppm when the sample was drawn from inside the welder's helmet. Exposures to iron oxide fume and manganese during this 34 minute exercise were  $0.88 \text{ mg/m}^3$  and  $0.19 \text{ mg/m}^3$ , respectively; both were below their respective 1981 ACGIH TLVs but greater than when the fan was in operation. Exposure to fluorides for this period was  $0.87 \text{ mg/m}^3$ , which is less than the 1981 ACGIH TLV of  $2.5 \text{ mg/m}^3$  for an 8-hour exposure. Exposure to total welding fume was  $5.07 \text{ mg/m}^3$  which is equal to 1981 ACGIH TLV and more than twice the welder's earlier exposure. Across the board exposures without the fan running did not exceed the respective TWAs or ceiling criteria and were nowhere near the respective IDLH levels, but they were elevated over the earlier exposures (See Appendix A).

#### Area Samples

An area sample for metals and total fume and a Palmes dosimeter were placed in the impulse chamber where they would be exposed to the welding fumes being exhausted by the exhaust fan. The total fume concentration was measured at  $8.56 \text{ mg/m}^3$  which is 171% of the 1981 ACGIH TLV of  $5 \text{ mg/m}^3$ . The iron oxide fume and manganese fume concentrations were  $2.07 \text{ mg/m}^3$  and  $0.44 \text{ mg/m}^3$ , which are 41% and 44% of their respective TLVs. The nitrogen dioxide concentration was 0.09 ppm or 9% of the NIOSH recommended standard (ceiling) (See Appendix A).

### VII. DISCUSSION AND CONCLUSIONS

We were requested to evaluate the potential for adverse health effects resulting from welding inside a washbox. Based upon our walk-through evaluation we determined that the washbox should be considered a confined

space. Welding fumes in a confined space usually cannot be sufficiently diluted or removed by natural ventilation. Some form of mechanical ventilation is usually required. It was doubtful that the exhaust fan available to the welders at the time of the walk-through would be very effective in removing fumes; therefore, it was recommended that it be replaced with a more effective unit. Interviews with several welders indicated that it was not uncommon to weld inside the washbox without clearing the overhead coal screen of coal and without installing the exhaust fan. Because of these factors coupled with the symptoms noted by the welders, we felt washbox welding probably represented more of an acute health problem than a chronic health problem. Recommendations were made in the interim report to improve the exhaust fan and make mandatory the use of the exhaust fan and the removal of coal from the washbox screen.

During this survey a new fan/barrel assemble was in place over the impulse valve cylinder. It appeared very effective in removing fumes when welding in the impulse valve side or near the 3'x2' opening to the impulse chamber. At the opening the air velocity was 147 fpm with a calculated exhaust volume of 870 cfm. As the welder moved farther away from the opening the less effective the exhaust fan became and the welding fumes started to rise rather than be sucked into the impulse chamber and out through the fan. With the coal screen cleared of coal and removed, as it was during the survey, the rising fumes were unrestricted and, according to the sample results, did not present a health hazard. Welding or cutting near the opening of the impulse valve side did not appear to present a health hazard.

At our request, the exhaust system was shut off and the welder welded another pass over the seam. His exposure to total particulate during this exercise was  $5.07 \text{ mg/m}^3$  which equals the 1981 ACGIH TLV of  $5 \text{ mgM}^3$ , and was more than twice his earlier exposure during normal welding. His exposure to iron oxide fume and manganese fume were also increased, but not in excess of their respective TLVs. Exposures to carbon monoxide ranged from "less than detectable" to 4 ppm or 11% of the NIOSH recommended standard. During this exercise, which lasted 34 minutes, the welder welded mostly outside of the impulse valve chamber, which allowed the fumes to rise and dissipate. These levels were not excessive but did indicate that it was necessary for the coal screens to be cleared and removed, and an exhaust fan used, or else, in our opinion, exposure levels would most likely have exceed the exposure standards.

After we issued the interim report, the company built two new exhaust fans for use during washbox welding. We evaluated the other exhaust fan in another cell of the same washbox. It was somewhat less effective than the first exhaust fan, but this may have been due to a more restricted impulse valve cylinder. At the opening to the impulse valve side, the

exhaust fan pulled air through at 107 feet per minute with a calculated exhaust volume of 720 cfm. The capture velocity and exhaust volume of this fan should be effective in maintaining weldings fumes to below their respective TLVs.

In conclusion, the work practices and ventilation control measures in use during this survey appear effective in controlling welder exposure to welding fumes and gases. These procedures should continue to be company policy for washbox welding.

#### VIII. RECOMMENDATIONS

- i) Since the interim report was issued the company has stated that is now company policy to clean and remove the coal screens and to use the exhaust fan anytime welding maintainance is performed inside the washbox, that is, inside the pulsation chamber or below the coal screens. It is our recommendation that this policy continue.

It should be noted that the exhaust fan will be less effective the more distant the welder is from the impulse chamber opening. In these cases, it is important to assure that the welding fumes can rise unhindered. The fan should remain on to prevent any stagnant, oxygen deprived air pockets from occurring.

- ii) Each exhaust fan should be maintained, installed and operated so as to provide an air velocity of at least 100 fpm across the opening to the impulse chamber.
- iii) Each welder should be instructed in the hazards of confined space welding.
- iv) In those instances where it is not possible to provide any exhaust ventilation when welding in a space where the fumes may be confined, the use a NIOSH/MSHA approved air supplied respirator or hose mask is recommended.
- v) In those instances where it is not possible to provide adequate exhaust ventilation, the use of a NIOSH/MSHA approved belt-mounted high-efficiency metal fume respirator is recommended. Measurements for oxygen deficiency, using an MSHA approved device, should be taken inside the washbox by the welder. Measurements should be taken immediately after any extensive welding or cutting. The welder should remove himself from the washbox upon a reading of 19.5% oxygen or less.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS:

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APPENDIX A  
Table I

Total Welding Fume  
Ken Surface Mine, Beaver Dam, KY  
January 24, 1982

<u>Sample Number</u>	<u>Type</u>	<u>Duration</u>	<u>mg/m<sup>3</sup></u>	<u>Comments</u>
7588	Personal	---	(Invalid)	(Pump Failed)
7584	Personal	1307-1504	1.89 mg/m <sup>3</sup>	Sampled as welder tacked and welded in replacement plate
7571,7576 (averaged)	Personal	1517-1551	5.07 mg/m <sup>3</sup>	Sampled with Exhaust fan off.
7586	Aera	1305-1504	8.56 mg/m <sup>3</sup>	Placed in impulse chamber
7582	Area	1517-1551	7.65 mg/m <sup>3</sup>	Placed in impulse chamber with the exhaust fan off

TABLE II  
 Nitrogen Dioxide  
 Ken Surface Mine, Beaver Dam, KY  
 January 24, 1982

<u>Sample Number</u>	<u>Type</u>	<u>Duration</u>	<u>PPM</u>	<u>Comments</u>
P1	Personal	1034-1137	0.32 ppm	Sampled during oxy/acetylene cutting
343	Personal	1306-1504	0.02 ppm	Sampled during welding
A25	Personal	1428-1443	.16 ppm	15-minute ceiling sample
A32	Personal	1446-1504	.13 ppm	15-minute ceiling sample
C46	Personal	1517-1551	0.09 ppm	Sampled with exhaust fan off
Detector Tube	Personal	1315	LTD/ <u>1</u>	Sampled during welding
Detector Tube	Personal	1410	LTD	Sampled during welding
Detector Tube	Personal	1525	LTD	Sampled with exhaust fan off
642	Area	1305-1504	0.04ppm	Placed in impulse chamber
A46	Area	1517-1551	.07ppm	Placed in impulse chamber with the exhaust fan off

1: Less than detectable.

TABLE III  
 Metal Fumes  
 Ken Surface Mine, Beaver Dam, KY  
 January 24, 1982

<u>Sample Number</u>	<u>Type</u>	<u>Duration</u>	<u>Iron Oxide Fume</u>	<u>Manganese Fume</u>	<u>Comments</u>
7588	Personal	---	(Invalid)	(Invalid)	(Pump Failed)
7584	Personal	1307-1504	0.33 mg/m <sup>3</sup>	0.06 mg/m <sup>3</sup>	Sampled during welding
7571	Personal	1517-1551	0.88 mg/m <sup>3</sup>	0.19 mg/m <sup>3</sup>	Sampled with exhaust fan off
7586	Area	1305-1504	2.07 mg/m <sup>3</sup>	0.44 mg/m <sup>3</sup>	Placed in impulse chamber
7582	Area	1517-1551	1.81 mg/m <sup>3</sup>	0.42 mg/m <sup>3</sup>	Placed in impulse chamber with fan off

TABLE IV

Sulfur Dioxide, Ozone, Fluorides  
 Ken Surface Mine, Beaver Dam, KY  
 January 24, 1982

<u>Sample Number</u>	<u>Type</u>	<u>Duration</u>	<u>Sulfur Dioxide</u>	<u>Ozone</u>	<u>Fluorides</u>	<u>Comments</u>
Detector Tube	Breathing Zone	1112	LTD*	---	---	While oxy/acetylene cutting
Detector Tube	Breathing Zone	1120	LTD	---	---	While oxy/acetylene cutting
Detector Tube	Breathing Zone	1320	---	LTD	---	While Welding
Detector Tube	Breathing Zone	1527	---	LTD	---	While Welding
7588					(Invalid)	(Pump Failed)
7576	Personal	1517-1551	---	---	0.87 mg/m <sup>3</sup>	Sampled while fan was off

\*LTD - "less than detectable"



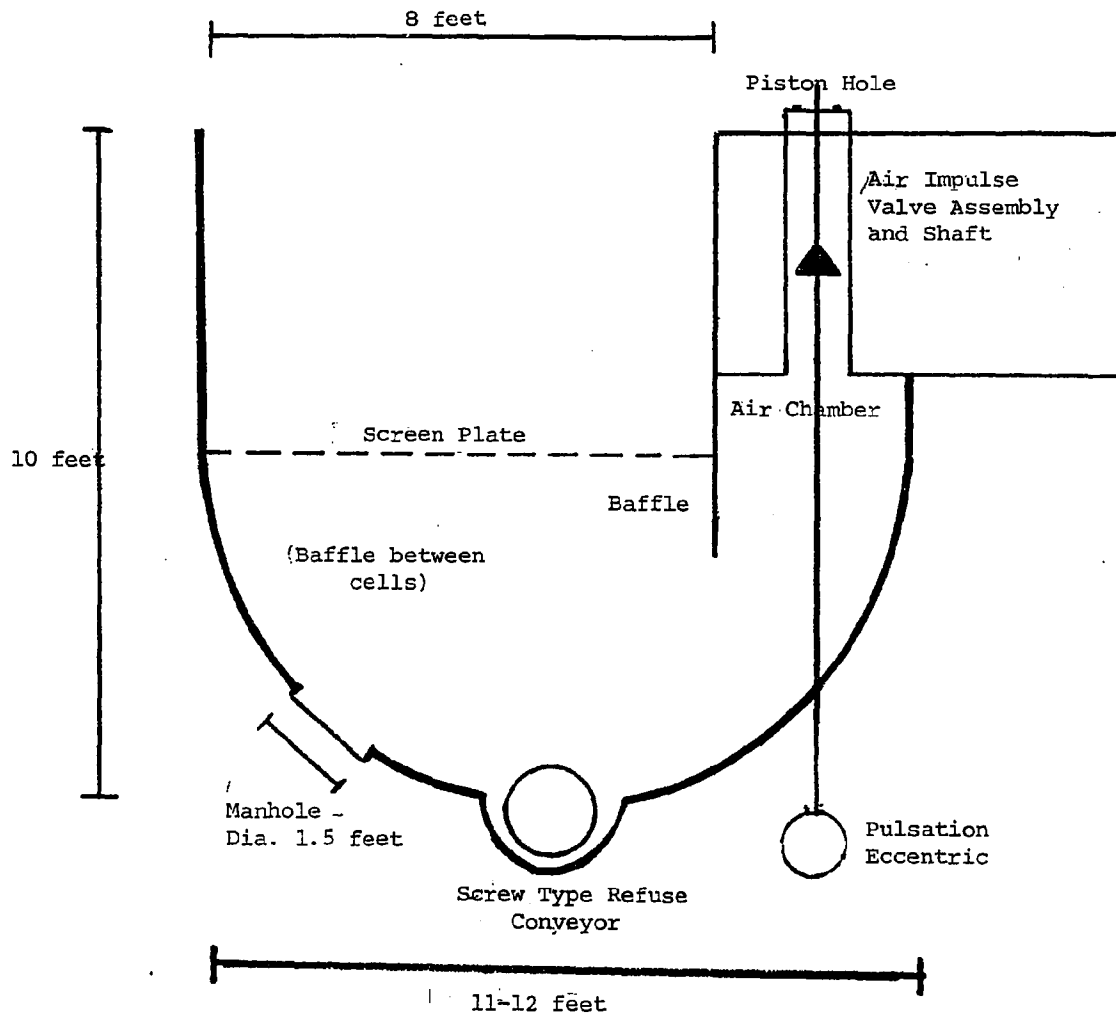
TABLE V  
Carbon Monoxide  
Ken Surface Mine, Beaver Dam, KY  
January 24, 1982

<u>Sample</u>	<u>Type</u>	<u>Time</u>	<u>PPM</u>	<u>Comments</u>
Detector Tube	Breathing Zone	1355	LTD	While Welding
Detector Tube	Breathing Zone	1520	LTD	Welding with fan off
Detector Tube	Breathing Zone	1532	LTD	Welding with fan off

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ECOLYZER CO MONITOR

<u>Number of Readings</u>	<u>Time</u>	<u>Range</u>	<u>Comments</u>
3	1104-1130	2-4 ppm (peaks of 16-23 ppm)	Readings taken while oxy/acetylene cutting
6	1315-1503	LTD-4 ppm	While Welding
4	1535-1551	1-4 ppm	While Welding with fan off

Appendix B  
Ken Surface Mine Processing Plant  
Jig (Washbox)



APPENDIX C

U. S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Center for Disease Control  
National Institute for Occupational Safety and Health

HEALTH HAZARD EVALUATION DETERMINATION  
INTERIM REPORT NO. M-HHE-80-119  
Mine I.D. No. 15-02077

Peabody Coal Company  
Ken Surface Mine Processing Plant  
Beaver Dam, Kentucky 42320

November 1980

I. SUMMARY

On September 16, 1980, the National Institute for Occupational Safety and Health (NIOSH) received a valid request to determine the adverse health effects which might be associated with confined space welding in the coal wash boxes of the Ken Surface Mine Processing Plant in Beaver Dam, Kentucky. A NIOSH industrial hygienist and physician conducted a walk-through survey on October 20, 1980, at which time discussions were held with the Company and the Union, including mine welders. The coal processing plant was examined, but no welding in the wash boxes was observed and no industrial hygiene sampling was done. The individual wash box cells were found to be confined spaces with a volume of less than 300 cubic feet. An exhaust fan was operable, but had a dented casing which would not make a good airtight seal, and by gross observation seemed to have a low CFM\* rating. Work practices are such that the screened top opening of the cell is not always cleaned nor is the fan always used during welding. Most workers reported symptoms including eye and nose irritation, trouble breathing, and headache during or after wash box welding. One welder had a cerebral vascular accident shortly after wash box welding, although he evidently had an underlying vascular disease.

Based upon the walk-through survey observations and interviews there is reason to believe that there is frequently inadequate ventilation during confined space (wash box) welding at the Ken Surface Mine Processing Plant which can lead to acute eye and nose, lung, and systemic effects, and could potentially produce chronic pulmonary impairment. Recommendations toward improving existing work practices and ventilation are contained in the body of the report. In order to ascertain personnel exposure levels and the adequacy of existing work practices and ventilation a comprehensive industrial hygiene survey of wash box welding should be conducted in the near future.

\*cubic feet per minute

## II. INTRODUCTION

Section 501(a)(11) of the Federal Mine Safety and Health Act of 1977, Public Law 91-173 as amended by PL 95-164 authorizes the Secretary of Health and Human Services to determine upon written request by any mine operator or authorized representative of miners, whether any substance normally found in a coal or other mine has potentially toxic effects or whether any physical agents or equipment found or used in a coal or other mine has potentially hazardous effects.

Mr. James L. Rowe, Safety Inspector of the United Mine Workers of America, made a written request dated September 12, 1980, to NIOSH to conduct a health hazard evaluation at the Peabody Coal Company's Ken Surface Mine in Beaver Dam, Kentucky. The request was prompted by the fact that an employee had suffered a cerebral vascular accident (stroke) shortly after welding in a coal wash box in January, 1980; and NIOSH was asked to determine what effects such enclosed space welding might have on welders.

## III. BACKGROUND

The Ken Mine is a surface coal mine which employed 154 union workers before September 16, 1980, including 22 welders of whom 9 worked in the processing plant (tipple). After a September 16th layoff, the total union employment was 106, including 12 welders of whom 8 processing plant welders.

## IV. PROCESS

Coal is moved from the strip mine to the processing plant via 60 ton coal trucks. In order to meet customer specifications the coal is "washed" at the processing plant to remove pyritic sulfur and ash. This is accomplished through the use of two five-cell and one three-cell coal wash boxes.

The coal wash box, also known as a jig, utilizes a process of particle stratification using a pulsating fluid flow to effect the separation of clean coal from the undersirable materials. Raw coal is fed onto a series of screens through which water is forced. The raw coal particles are distended and allowed to resettle. The higher specific gravity particles will settle faster and a stratification of the bed results. This cycle of distending the resettling may be repeated 30 to 60 times per minute as the coal moves over the screens. After stratification has taken place the top layer of clean coal is physically cut from the bottom layer of refuse. (1) (2)

Each cell is approximately 11-12 feet long, 10 feet deep, and 4 feet in width. The screen is 4-5 feet below the top of the cell. Each cell has its own air impulse valve - which causes the cyclic pulsations through the screen distending and resettling the coal bed

- and is separated from adjacent cells by a baffle plate beginning just below the screens (see Appendix A). Each cell may be accessed by a manhole located at the bottom side of the wash box or by removing the screen. The wash box is constructed of 1/2 and 5/8 inch mild steel plate.

V. EVALUATION CRITERIA

(A) Confined Space Welding:

1. Safety In Welding and Cutting: American Welding Society, 1973. (American National Standards Institute ANSI Z49.1-1973).
2. Working in Confined Spaces: U.S. Department of Health, Education, and Welfare, DHEW (NIOSH) Publication No. 80-106.

(B) Major Welding Health Hazards: In welding, brazing, and thermal cutting processes, the degree of risk present varies with the method and work practices used, metals and fluxes involved, location of workpieces, location of the process, duration of exposure, and control measures implemented. Toxic chemical substances generated in welding, brazing, and thermal cutting operations include ozone, carbon monoxide, nitrogen dioxide, and various metal fumes (which varies according to the type of welding rod and base metal), which can induce toxic effects ranging from simple irritation to metal fume fever or cancer. Physical agents such as ionizing or optical radiation and noise are emitted by the processes. Other hazards can lead to burns and traumatic injury. (Note: several general hazards such as those due to noise, fire, and accidents are not discussed):

1. Metal fume fever: Mostly associated with zinc oxide, this is an acute flu-like illness of short duration caused by the inhalation of metal oxide fumes, usually freshly generated.
2. Pneumoconiosis: Particulates in iron oxide fumes may cause a usually benign pneumoconiosis. There have been reports of mixed dust fibrosis in arc welders, although the etiology in these cases has not been well documented.
3. Acute Pulmonary Edema or Pneumonitis: Excessive exposure to nitrogen dioxide or ozone generated from welding has been associated with this potentially serious pulmonary disorder.
4. Eye Injury: Both acute and permanent eye injuries may result from welding, particularly electric arc type, without proper eye protection.
5. Skin: Various acute and chronic changes may occur, such as erythema or burns.

6. Other: Welding fumes may cause cough, nose and eye and throat irritation, and systemic effects such as headaches and nausea, depending on their composition, concentration, and the duration of exposure.
7. Enclosed Spaces: Besides tending to concentrate fumes, enclosed space welding raises the possibility of carbon monoxide poisoning, and/or oxygen deprivation.
8. Chronic exposure to welding fumes may result in reduced pulmonary function, although not all studies have confirmed this point.
9. Further information can be found in standard references (3) (4) (5).

## VI. FINDINGS

### A. Work Practices

The day shift at the processing plant is a production shift, followed by two maintenance shifts. Typically welding repair constitutes a significant portion of the maintenance performed due to equipment age, metal fatigue, and corrosion. It is an established practice to drain and inspect on a weekly basis the wash boxes for areas in need of repair. According to several welders, welding repair to the inside of the wash boxes may be as frequent as once a week to once every several months. Apparently, the frequency of repair is a function of the amount of coal per shift and the number of shifts so that the amount of welding cannot be predicted or even accurately estimated. In addition, the time involved is extremely variable - ranging from cutting and repairing a localized weak section to replacement of large panels. According to management when a welder is assigned to the plant he first undergoes "task training". In regards to welding in wash boxes each welder is instructed to drain the wash box, shovel the coal off of the screens so as to provide means for welding fumes to escape, remove the cap from the piston (air impulse valve cylinder) and place an exhaust fan/barrel assembly over the piston hole so as to draw out welding fumes. The manhole is usually open at this point to provide makeup air. The welders may "come out" of the wash box anytime they feel exposures are excessive. Removal of coal from the screen and use of the exhaust fan/barrel assembly are not mandatory but are left to the discretion of the individual welder. In addition to the above procedures particulate respirators (MSA Dustfoe 77) are available to the welders upon request.

Up to the time of the walk-through survey, no steps had been taken on the part of management towards assessing actual exposures during wash box welding. Management was of the opinion that if the above precautions are taken, exposures to any toxic materials generated during welding will be minimized.

Several welders stated that in actual practice it was not uncommon to weld inside a wash box with neither the screen cleared of coal nor the exhaust fan/barrel assembly in place. It was stated that clearing the screens and removing the cap from the piston valve were time consuming (up to two hours). Whether or not the assigned welder took these precautions depended upon the extent of the welding job and the total number of jobs he has been assigned to do that shift. Several welders also stated that frequently the fan is inoperative.

Frequently an oxy-acetylene torch is used to cut out areas to be patched and to dry the metal surfaces prior to welding, and also to remove the accumulated scale or slag. This results in what was related as highly irritating fumes or gases possibly due to oxidation of residual coal and sulfur particles. Several welders were also concerned about possible oxygen deprivation during use of the oxy-acetylene torch.

#### B. Environmental Assessment

It was not possible to inspect the interior of the wash boxes as they were in use. From a company supplied drawing and outside measurements it is possible to estimate that each cell is, at the most, approximately 300 cubic feet in volume (6 x 12 x 4 cubic feet).

The method of welding employed in wash box repair was shielded metal-arc welding using 1/8 inch 7018 LH electrodes. These electrodes are low-alloy carbon steel containing some manganese and molybdenum but no materials of high toxicity.

Welder opinions as to the efficacy of exhaust fan ranged from "it helps" to "somewhat ineffective". The exhaust fan is more effective if the welding job is on the impulse valve side of the wash box cell. Several welders stated that frequently deposits on the sides of piston hole (air impulse valve cylinder) severely restrict the exhausting of fumes from the interior of the wash box. Clearly, the exhaust fan is not uniformly effective on all the wash box cells.

On the day of the walk-through the exhaust fan/barrel assembly was in an operating condition. It consisted of a 16 inch, three propeller type fan mounted within an open ended barrel. The base of the barrel, which is supposed to fit over the air

impulse valve cylinder after removal of the impulse valve cap, was damaged (beaten in) thus preventing an air tight seal; in addition, the side of the barrel was dented to the point that the revolving fan blade would hit the side.

C. Medical Effects - Obtained by history alone.

As noted above, the HHE was precipitated by the occurrence of a stroke in a young welder about one hour after wash box welding. This person had an underlying blood vessel disease, and it has not been determined to what extent his work condition might have precipitated his stroke. Except for this instance, neither the company nor the workers interviewed recall documented occurrences of lost work, hospitalization, or written complaints about wash box welding. A second welder was hospitalized for a lung problem which his physician thought was due to welding exposures. However, he only rarely did washbox welding and it is unlikely that this latter exposure per se caused his problem.

Nearly all welders stated that the wash boxes were the worst place to weld. Systems noted by the welders included: (1) Acute eye and nose irritation, especially from sulfur-like fumes caused by heating the coal caked on the walls. (2) Throat irritation and a feeling that one couldn't get his breath. (3) Headaches, sometimes lasting for 3 days. (4) Faintness (rarely).

VII DISCUSSION AND CONCLUSIONS

Environmental

The inside of the wash boxes - the space beneath the screen - clearly constitutes what is referred to as a "confined space", defined as any relatively small or restricted space. (6) Recognized work practice guidelines require that confined space welding and cutting operations be adequately ventilated to prevent the accumulation of toxic materials or oxygen deficiency. (2) Adequate ventilation may consist of local exhaust ventilation or general dilution ventilation, and should reduce exposures to toxic materials to below applicable federal standards.\*

Welder statements indicate that welding fumes tend to build up to "irritating" levels even if the screens are first cleared of coal and the exhaust fan is installed over the air impulse valve cylinder to assist in drawing out the fumes. In addition, several welders have suspected instances of oxygen deficiency. Therefore, it is reasonable to question the effectiveness of the existing control measures (exhaust fan) and recommended work practices in preventing, or even mitigating, overexposure to toxic materials.

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\*for certain substances NIOSH recommends lower exposure levels.



VIII CONCLUSIONS

The respirator available to the welders upon request is not appropriate for use against welding fumes. A NIOSH/MSHA approved high efficiency metal fume respirator with the cartridges mounted behind the welder is a more appropriate respirator.

It is doubtful that the control measure present at the time of the survey - the exhaust fan - was very effective in its then present working condition. The damage to its base coupled with the fact that the propellor fan blade was hindered by contact with the side of the barrel prevented optimum performance. Management contends that use of the exhaust fan and certain work practices, which were not mandatory, were (and are) sufficient to control possible overexposures to toxic materials. It is our opinion that it is questionable that the exhaust fan, even in optimum working condition, is effective in clearing the washbox cells of welding fumes. But prior to making an unequivocal statement as to exposure/overexposure and recommending a different means of mechanical ventilation we feel it is in the interests of both the welders and management to first ascertain the levels of exposure that occur during wash box welding. Towards this end a comprehensive industrial hygiene survey should be scheduled in the near future during a time of washbox repair in order to evaluate personal (welder) exposures to welding fumes and gases.

IX. RECOMMENDATIONS

The following recommendations are made based upon: 1) well recognized guidelines for welding and cutting within confined spaces, and 2) observations made during the walk-through survey. Additional or more specific recommendations may be included in the final report based upon the results of personal exposure samples obtained during the comprehensive industrial hygiene survey.

A. Ventilation (7)

- (i) welding and cutting in confined spaces should be adequately ventilated by mechanical means to prevent the accumulation of toxic materials or possible oxygen deficiency;
- (ii) mechanical ventilation may be effected by either local exhaust ventilation or general dilution ventilation, or both; (see reference 7, p. 47 for local exhaust ventilation requirements);
- (iii) specifically, if the existing exhaust fan/barrel assembly is to continue being used as the sole means of mechanical ventilation it should be rebuilt so as to optimize performance; install a larger capacity (CFM) fan inside

an undamaged barrel and provide for an air-tight seal around the air impulse valve cylinder. (Note: effectiveness may vary from cell to cell due to material build-up on the cylinder walls).

B. Personal Respiratory Protection

- (i) in those instances where it is not possible to provide adequate ventilation use of NIOSH/MSHS approved air-supplied respirators or hose masks is recommended; (7)
- (ii) as a supplement to the mechanical ventilation already present the use of NIOSH/MSHA approved belt-mounted high-efficiency metal fume respirators is recommended.

C. Work Practices

- (i) removal of coal from the wash box screen should be made mandatory before wash box welding;
- (ii) use of mechanical ventilation should be made mandatory during wash box welding;
- (iii) periodic measurements for oxygen deficiency, using an MSHA approved device, should be taken inside the wash box by the welder. The welder should remove himself from the wash box upon a reading of 19.5 per centum oxygen or below.

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XI. REFERENCES

1. Coal Preparation. Battelle Columbus Laboratories, Columbus, Ohio, 1975.
2. Leonard, J. W. and D. R. Mitchell, editors. Coal Preparation. 1968.
3. Zeng, Cart, editor. Occupational Medicine. Year Book Medical Publishers, Inc., Chicago, 1975.
4. Huater, Donald, editor. The Diseases of the Occupations. Hodder and Stoughton, London, 1978.
5. Morgan, W. K. C. and A. Sieton. Occupational Lung Diseases. W. B. Saunders Company, Philadelphia, 1975.
6. OSHA Safety and Health Standards, 29 CFR 1910.252 (e)(4)(i).
7. Safety in Welding and Cutting. American Welding Society, 1973. (American National Standards Institute ANSI Z49.1-1973).