U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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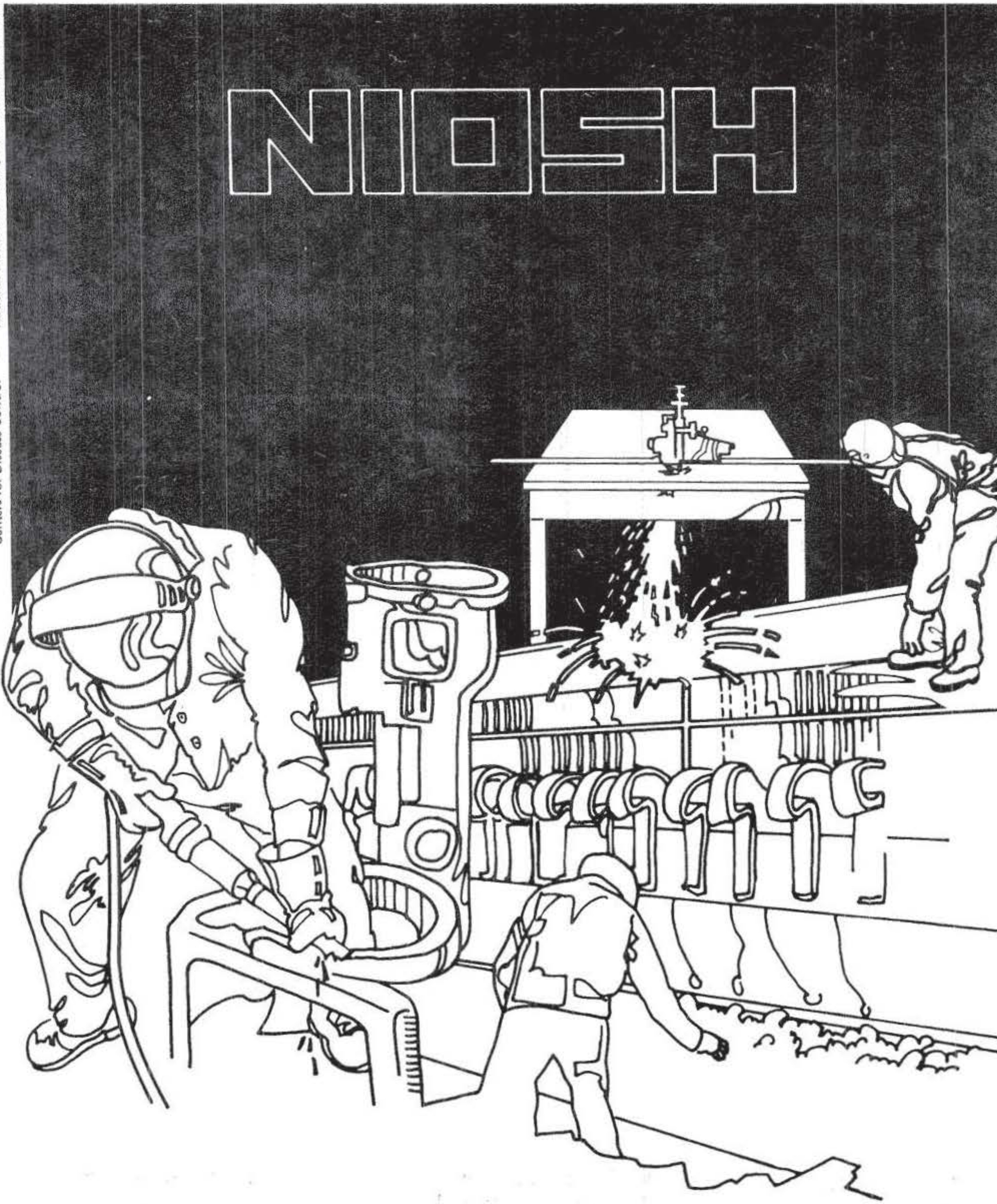

Health Hazard Evaluation Report

HHE 80-062-863
HENDRICKSON MANUFACTURING COMPANY
LYONS, ILLINOIS

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.

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I. SUMMARY

In February 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request from the United Steel Workers, Local 4336, for a health hazard evaluation at the Hendrickson Manufacturing Company, Lyons, Illinois. The requestor was concerned with possible adverse health effects from vehicle exhaust and welding fumes in the assembly area.

NIOSH investigators conducted an initial survey in March 1980. Environmental surveys were performed in May 1980, and February 1981. Personal and area samples were collected to determine exposure to total welding particulate, iron, zinc, copper, chromium, and carbon monoxide. Confidential interviews were conducted with 19 employees.

Analysis of environmental data indicated no overexposure to the substances evaluated. Eight-hour time weighted average (TWA) personal exposures to total welding fume particulate ranged from 1.0 to 3.5 mg/m^3 with a mean of 2.5 mg/m^3 (recommended limit is 5 mg/m^3). Eight-hour TWA personal exposures to iron oxide fume ranged from 0.26 to 1.24 mg/m^3 with a mean value of 0.67 mg/m^3 (recommended limit is 5 mg/m^3). Personal exposures to zinc oxide and copper were well below the environmental criteria. Chromium was not detected in the samples. Instantaneous levels of carbon monoxide during vehicle operation did not exceed 80 ppm, with an approximate average of 25 ppm (recommended 15 minute ceiling limit is 200 ppm).

During the interviews, two employees noted health problems aggravated by the exhaust and welding fumes, including sinus problems, shortness of breath, and dizziness.

Prior to the follow-up environmental survey, the company repaired and replaced ventilation hoses to remove vehicle exhaust from the plant. The company is presently constructing welding booths with local exhaust ventilation for isolation of major welding operations.

On the basis of data obtained in this investigation, NIOSH determined that a hazard from exposure to carbon monoxide, iron oxide, zinc oxide, copper, and chromium did not exist at the time of the survey. However, in order to alleviate the possibility of future exposures, recommendations on engineering controls, personal protection, and work practices are incorporated in Section VIII of this report.

KEY WORDS: SIC 3711 (Motor Vehicles and Passenger Car Bodies), welding, MIG welding, welding fumes

II. INTRODUCTION

On January 22, 1980 an authorized representative of the United Steel Workers of America Local 4336, requested a NIOSH health hazard evaluation to determine if a health hazard existed due to vehicle exhaust and welding fumes in the assembly area of the Hendrickson Manufacturing Company, Lyons, Illinois. On March 4-5, 1980, NIOSH investigators conducted an initial survey visit, which consisted of an opening conference with management and union officials, a walk-thru inspection of the assembly areas, and confidential interviews with the employees. On May 13, 1980 a preliminary environmental survey was conducted during which time production had been slowed due to decreased product demand. Following the resumption of normal plant activities, a second environmental survey was conducted on February 2, 1981.

III. BACKGROUND

The plant is engaged in the assembly of truck, bus, crane, and other heavy vehicle chasis. Shielded metal arc welding (stick welding) occurs primarily in the craneline, truckline, and frame department of the plant. A majority of the 35 employees working in these areas are required to do varying amounts of welding. The approximate time spent on an individual operation may range from 10 minutes when securing small brackets, to 8 hours when welding cross-members for the chasis. The frequency of these operations is dependent on the type of vehicles being manufactured, which in turn is dictated by the current consumer demand. The overall time spent on welding operations was estimated to be 45 man-hours per month.

Stick welding utilizes almost equal amounts of two electrodes, the E 6013 (titanium dioxide and iron powder) and the E 7018 (low hydrogen and 30% iron powder). Additionally, a copper-coated gas rod is used on an infrequent basis. The base metal being welded is usually a mild steel.

On occasion (approximately once every 2 to 3 months) an improperly placed weld must be removed. This is achieved by a process known as carbon arcing, where the weld is torch heated and the filler metal is removed resulting in the generation of large amounts of dust and fume. When required, this operation is carried out in an isolated area and partitions are used to separate it from any nearby operations.

Metal inert gas (MIG) welding is also utilized in the frame department. This process uses carbon steel as the filler metal with a shielding gas composed of 75% argon and 25% carbon dioxide.

With the exception of the drive line area, local ventilation is not provided for welding operations. Dilution ventilation is achieved by ceiling exhaust fans, air moving fans located on the side walls, and openings in the building structure. Welding helmets and gloves are worn by the employees during welding operations. Barrier curtains are available, but not utilized in all instances.

Vehicle exhaust is generated within the plant when an engine is operated to inspect hydraulic systems or move a truck chasis. This occurs primarily in the crane and truck lines, and to a lesser extent on the International Harvestor Conversion and bus line. The duration of engine operation may range from a few minutes to 15 minutes at a time. Local ventilation is provided at the truck and bus lines by hoses which attach to the vehicles and exhaust the contaminants to the outside of the building.

IV. METHODS AND MATERIALS

Based on the infrequent nature and variable duration of welding operations, environmental survey dates were scheduled to correspond with significant amounts of welding activity. During these surveys all welding jobs lasting for longer than one-hour were selected for monitoring. Personal breathing zone samples (at the workers lapel) and area samples were collected using battery powered sampling pumps operating between 1.5 and 1.75 liters per minute (lpm) attached via tygon tubing to three-piece cassettes. The collecting media were 37 mm diameter 0.8 um pore size mixed cellulose membrane filters (type AA), and M5 and FWSB pre-weighted filters. The samples were analyzed for total particulate weight, and for the presence of iron, zinc, copper, and chromium according to NIOSH Method P&CAM 173 and S-366[1,2].

Carbon monoxide from vehicle exhaust was measured (using a direct reading, portable carbon monoxide indicator) during the two instances that vehicle engines were operated within the assembly area during the preliminary environmental survey.

Confidential employee interviews were conducted with 19 employees working in the frame department and the crane line; areas identified as having the greatest potential for exposure. During the course of these interviews information was collected related to the employees work and medical history, and the presence of any work related health problems.

V. EVALUATION CRITERIA

The following table lists the current environmental limits and the primary health effects for the various contaminants.

SUMMARY OF ENVIRONMENTAL STANDARDS AND MAJOR HEALTH EFFECTS[3,4]
[8-10 hour Time weighted average (TWA) values]

Substance	Primary Health Effect Considered	NIOSH[2] mg/M3	OSHA[2] mg/M3	ACGIH[3] mg/M3	Ceiling Limit (15 Minute)
Total Welding Particulate	Pneumoconiosis			5	
Iron Oxide Fume	Bronchitis		10	5	
Copper Fume	Metal fume fever		0.1	0.2	
Zinc Oxide Fume	Metal fume fever	5	5	5	15mg/M^3(NIOSH)
Carbon Monoxide (CO)	Respiratory and Heart Disease	38.5 (35ppm)*	55 (50ppm)	55 (50ppm)	220mg/M^3(NIOSH) (200ppm)

Values given in mg/M^3 - milligrams of contaminant per cubic meter of air.
CO values also given in ppm - parts of contaminant per million parts of air.

A number of sources recommend airborne levels of substances under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. Due to variations in individual susceptability, a small percentage of workers may experience effects at levels at or below the recommended criteria; a smaller percentage may be more seriously affected by aggravation of a pre-existing condition or by a hypersensitivity reaction[4].

A. Total Welding Particulate

A consideration of the constituents of welding fume is of primary importance in assessing worker exposure to toxic agents. The more toxic compounds will have a greater effect in smaller quantities than will the less noxious compounds. However, since the effects of exposure to many different compounds at the same time is considered cumulative, total fume concentration is also measured. Conclusions based on total fume concentration are generally adequate in the absence of the identification of the specific toxic constituents[4].

B. Iron Oxide

Long term occupational exposure to iron oxide fume may cause a condition known as siderosis, noted by the literature to be a non-progressive non-disabling lung disease. There is no information in the literature on the combined effects of iron and other industrial dusts on the lungs. Although benign, it cannot be stated that iron dust deposits in the lungs are totally harmless. Bronchitis, a disease resulting in a chronic bronchial cough, may develop after long term exposure to welding fumes. Variations in individual susceptibility and exposures may make this apparent in some workers and not others.

C. Zinc Oxide and Copper

Exposure to fumes of zinc oxide and copper may result in a condition known as metal fume fever. Typically the syndrome begins four to twelve hours after sufficient exposure to freshly formed fumes has occurred. The worker first notices the presence of a sweet or metallic taste in the mouth, accompanied by dryness and irritation of the throat. Cough and shortness of breath may occur, along with general malaise, a feeling of weakness, fatigue, and pains in the muscles and joints. Fever and shaking chills may then develop. Profuse sweating develops and the fever subsides. The entire episode runs its course in 24 - 48 hours. Metal fume fever produces rapid development of tolerance or short-lived relative immunity. This may be lost, however, over a weekend or holiday, and the worker may again develop the complete syndrome when he returns to work if fume levels are sufficiently high.[3]

D. Carbon Monoxide

The typical signs and symptoms of poisoning due to increasing levels of carbon monoxide (CO) gas are headache, dizziness, drowsiness, nausea, vomiting, collapse, coma, and death. However, low level exposure (less than 100 ppm) effects are not as clearly defined. The main effect is to the cardiovascular system. CO binds with the hemoglobin molecule (Hb) in the blood, forms carboxyhemoglobin (COHb) and prevents oxygen from reaching the tissues resulting in a state of oxygen starvation or tissue hypoxia. The cardiac muscle must work harder to supply more oxygen to the heart tissues, however in doing so, requires more oxygen itself, but is supplied less. The heart is then stressed when the blood cannot meet its oxygen demand and myocardial infarctions may develope in already diseased hearts. The literature also reports behavioral effects resulting from low level CO exposure such as reduction in vigilance, visual and audio threshold reduction.[5] The effects of occupational exposure to CO can also be increased by smoking, since smokers usually have higher levels of COHb than nonsmokers.[3]

E. Ultraviolet Radiation

Eye exposure to ultraviolet radiation from an arc can cause an acute condition known as "welders flash" - an irritation with a sensation of sand in the eyes. These flash burns are very painful and repeated exposure may result in permanant eye injury.[6]

VI. RESULTS

A. Environmental

The results of the environmental samples are listed in the following table as eight-hour time weighted average concentrations..

Results of Samples Collected for Welding Fume Concentrations

Date	Welding Task	Sample Type	Sample Time (min.)	Welding Particulate mg/M3	Iron mg/M3	Zinc Oxide mg/M3	Copper mg/M3
8/13/80	Fire truck rails	Personal	200	1.0	0.26	ND	0.005
8/13/80	Fire truck rails	Area*	198	NA	0.35	0.02	0.007
8/13/80	Rail extensions	Personal	94	3.5	0.50	0.02	0.006
2/02/81	Cross members	Personal	372	3.1	1.24	NA	NA
2/02/81	Cross members	Area**	395	0.8	0.17	NA	NA

Abbreviations: (ND) Sample below lower limit of detection of 0.002 mg
(NA) Analysis was not performed on the sample

* Sample taken adjacent to welder.

**Sample taken opposite the welding screen from the welder.

All samples analyzed for chromium were below the level of analytical detection of .003 mg.

Exposure to carbon monoxide was found to be below the evaluation criteria for ceiling and 8 - 10 hour TWA exposures. Instantaneous levels ranged from 10 to 80 ppm with an approximate average value of 25 ppm during the two instances vehicle engines were operated within the facility. The measurements were made in the area within 10 feet of the vehicle exhaust pipe. The duration of operation of either engine did not exceed ten minutes.

B. Medical

Two of nineteen employees interviewed felt that they had work related health problems. These included sinus problems, shortness of breath, and light headedness. Fourteen of nineteen employees indicated that they periodically were bothered by the accumulation of smoke from the welding and vehicle exhaust.

VII. DISCUSSION AND CONCLUSIONS

During the survey, levels of welding fume contaminants were below the evaluation criteria used in this report. However, in view of the variable nature of the welding, these results may not represent all situations. A discussion of the factors contributing to welding exposure is appropriate to aid in identifying and controlling potential hazards.

Work practice can be a primary factor in influencing the exposure during welding operations. The heat from the welding arc causes the fumes and gasses to rise vertically. Positioning the head in the fume column will increase the amount of fume entering the workers breathing zone, thus increasing the potential hazard.

The type of welding rod being used is an important factor influencing the composition of the fume. The intense heat from the arc releases components of the filler metal and shielding gas into the air. Thus, the composition of the welding rod and the toxicity of each component should be considered. Welding rod components not evaluated in the survey include copper (from the copper coated rod), and flourides (from the low hydrogen rods). Since these substances are considered toxic in smaller quantities than many of the other welding rod components, it is necessary to control the exposure accordingly.

Special consideration should be given to the type of base metal that is being welded. Higher alloy steels contain various metals which can be of a highly toxic nature, (e.g. chromium, an extremely toxic compound, is the primary alloying agent in stainless steel). Attention should also be given to any paint or coating on the base metal. The heat from the arc can liberate the components of the coating, further adding to the toxic nature of the welding emissions.

Other hazards associated with welding are sometimes amplified by the MIG welding process. Since a higher current density is used, it is not uncommon to find ultraviolet radiation levels 10 to 20 times greater than those associated with conventional stick welding. Ultraviolet radiation from the arc, itself a physical hazard, can also cause the generation of ozone. Additionally, the use of carbon dioxide in the shielding gas can result in high levels of carbon monoxide generation[7].

The dilution ventilation proved adequate in the welding operations which were evaluated. However, a change in any of the aforementioned variables could change the exposure. Additionally, the consistent use of barrier curtains during welding could decrease the air flow at the operation, which in turn could increase the exposure. Thus, the possibility exists that a welder could be exposed to concentrations of contaminants in excess of the environmental criteria.

Exposure to carbon monoxide was of an intermittent nature and did not exceed the evaluation criteria. During the first environmental survey the ventilation hoses for the engine exhaust systems were not in working order; however, by the second environmental visit, all units had been either replaced or repaired. This corrective action should help eliminate incidences of employee sickness and discomfort due to exhaust emissions.

VIII. RECOMMENDATIONS

The following recommendations are made to alleviate the possibility of future exposures to carbon monoxide and welding fumes.

1. Welding booths with local exhaust ventilation should be installed as planned. Welding operations which require substantial amounts of time, utilize high alloy or coated base metals, or are situated such that the employee is exposed to large amounts of welding contaminants, should be confined to the welding booths.

2. Welders should be instructed in proper welding techniques with emphasis on keeping the head out of the fume column. Additionally, instruction should be provided on the proper use of local ventilation in the welding booths to keep fumes and gasses from the breathing zone and adjacent areas.

3. When welding operations are conducted in the production area, barrier curtains should be provided to prevent the possibility of eye injury to nearby employees.

4. Local exhaust ventilation systems should be periodically inspected to assure the proper removal of the contaminants for which they were designed.

IX. REFERENCES

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B. Requestor

C. Steward, United Steel Workers of America, District 31, Local 4336

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