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CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 77-117-444

EAZ-LIFT TOWING SYSTEMS
ELKHART, INDIANA

NOVEMBER 1977

I. TOXICITY DETERMINATION

A survey team from the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation on September 9, 1977, at EAZ-Lift Towing Systems, Inc., Elkhart, Indiana at the request of an authorized representative of the employees. The conclusions and recommendations presented in this report are based on environmental measurements, observation of the workplace and work practices, medical questionnaires and a review of current literature.

Airborne concentrations of contaminants from the welding operation, notably iron (Fe), nickel (Ni), chromium (Cr), manganese (Mn), and total particulate, were collected in the workers' breathing zone. The airborne contaminant concentrations measured were found to be within acceptable limits of exposure with the exception of two workers, who exceeded the recommended criteria for total welding particulate.

Environmental and biological measurements for worker exposure to carbon monoxide (CO) were taken. All measurements for CO were within acceptable limits.

Information obtained from medical questionnaires indicated that half of the workers interviewed have a cough and/or congestion which they feel may be due to their exposure to contaminants generated by the welding operation.

The potential for overexposure of employees to welding contaminants exists in this welding operation. Recommendations for the alleviation of this hazard are presented in this Report.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office at the Cincinnati address.

Copies of this report have been sent to:

a) EAZ-Lift Towing Systems, Elkhart, Indiana
b) United Steel Workers of America, District 30
c) National Office of the United Steel Workers of America
d) U.S. Department of Labor, Region V
e) NIOSH - Region V

For the purpose of informing the approximately ten "affected employees" the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) near where exposed employees work.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of United Steel Workers of America, District 30 employees regarding employee exposure to smoke generated from welding operations. The request stated that several employees had developed coughs and had to seek medical attention.

IV. HEALTH HAZARD EVALUATION

A. Conditions of Use

EAZ-Lift Towing Systems is engaged in the manufacture of towing hitches for trailers. Their two products are an equalizing hitch which distributes the load evenly on the trailer and vehicle axles and a sway control hitch to control the back and forth motion of the load.

The area of concern is an area approximately 50 feet by 44 feet located in the center of a building 300 feet by 80 feet (Figure I). The area is partitioned into ten smaller areas, five to a side. In one station a chipping hammer is used to smooth out as-welded parts; the other nine stations are set up for welding various parts of the hitch together. See Figure II for details.

With the exception of the spring bar parts, all steel used in this operation is mild steel, i.e., low carbon content steel. All welding operations are performed under an atmosphere of carbon dioxide, i.e., gas metal arc (MIG) welding. There are two types of welding operations - one consumable stick welding and eight consumable wire electrode weldings. Table I depicts the composition of the electrodes used at the time of this survey.

Each welding station is equipped with local exhaust ventilation. There are three separate ventilation systems, one on one side of the welding area serving four welding stations and two on the other side, serving three and two stations respectively (see Figure II). Each exhaust is a 12-inch by 6-inch (0.5 ft^2) opening with a 3-inch rectangular flange connected to a 6-inch ID duct with a 45^o taper. The design condition is 780 cubic feet per minute (cfm) for each opening. Each fan is rated at 3800 cfm at 2 1/2-inches static pressure and should provide a duct velocity of 4000 feet per minute (fpm).

B. Evaluation Design and Methods

1. Environmental Evaluation Methods

Personal breathing zone samples for total particulate, nickel, manganese, chromium, and iron were obtained. Pre- and post-shift breath tests for CO were taken. Whole air samplers were placed on selected employees to measure CO exposure over the shift and peak measurements of CO were obtained during various phases of operation. All nine welders and the one lead man (material supplier) were sampled in this survey. The following outlines the sampling procedure used for each type of measurement:

a. Total Fume, Nickel, Chromium, Manganese, and Iron Oxide - MSA model G personal sampling pumps adjusted to pull sample volume of between 1.5 and 2.0 liters per minute were used with 37mm, 0.8 micrometer pore size Gelman VM-1 filters as the collecting media. Sampling periods representing the entire shift were used. The filters were clipped to the subject in such a manner that when the welding helmet was positioned the filter would be inside the helmet. Metal analysis was accomplished by direct aspiration atomic absorption. Total weight analysis was performed on a Perkin-Elmer AD-2 balance.

b. Carbon Monoxide - Worker exposure to CO was evaluated by use of a portable, direct reading CO meter calibrated against a known concentration of CO. CO measurements with NIOSH certified detector tubes (certification No. TC-84-012) were taken initially to pinpoint potential sources of high CO generation. In addition, pre- and post-shift measurements of expired CO were taken on selected personnel to document any changes in the carboxyhemoglobin (CoHb) level in the blood. CoHb levels were determined in the following manner -

$$\% \text{ CoHb} = 0.5 + \frac{\text{biological level of CO (ppm)}}{5}$$

(See Section C(f) and D).

c. Measurements of the local ventilation system were taken with a Sierra Air Velocity meter and compared to the design data of the system.

2. Medical Evaluation Methods

A confidential non-directed medical questionnaire was administered to all ten employees who participated in the survey. The non-directed questionnaire is designed to review employee work history, medical history and smoking habits.

C. Evaluation Criteria

There are three criteria used to evaluate the toxic air contaminants in an industrial setting: (1) NIOSH criteria documents for Recommended Occupational Health Standard, (2) Proposed and Recommended Threshold Limit Values (TLV's) of the American Conference of Governmental Industrial Hygienists (ACGIH), and (3) OSHA standards. These values are based on the current state of knowledge concerning the toxicity of the specific substances. These levels are values to which it is believed that nearly all workers may be exposed for an 8-hour day, 40-hour workweek, over a working lifetime with no ill effect. However, because of a wide variation in individual susceptibility, a small percentage of workers may experience discomfort from some substances at concentrations at or below the recommended level; a smaller percentage may be affected more seriously by aggravation of a pre-existing condition or by development of an occupational illness.

The following table lists the levels recommended by this author for the specific substances studied in this evaluation. The most current criteria is presented with a brief reference to source and other pertinent information. Also presented is the current Occupational Safety and Health Act Standard, which is enforceable. All levels presented in this determination report are achievable with existing control technology.

Substance	Most Current Recommended Level	OSHA Standard
Iron (as oxide)[a]	5 mg/M^3	10 mg/M^3
Manganese[b]	5 mg/M^3	5 mg/M^3
Nickel[c]	0.015 mg/M^3	1 mg/M^3
Chromic Acid [d]	1 mg/M^3	1 mg/M^3
Total Welding Fume[e]	5 mg/M^3	none
Carbon Monoxide[f]	35 ppm	50 ppm

[a]The American Conference of Governmental Industrial Hygienists (ACGIH) in their 1976 publication of "Threshold Limit Values (TLV's) for Chemical Substances in the Workroom Environment" (1) indicates a TLV of 5 milligrams per cubic meter (mg/M^3). The current OSHA standard is 10 mg/M^3. Long term occupational exposure (on the order of 6-10 years) to iron oxide fume may cause a condition known as siderosis, a non-progressive non-disabling lung disease. There is a lack of information in the literature on the relationship between iron dust deposits in the lungs and other industrial dusts and their combined effect on the worker. Although benign, it cannot be stated that iron dust deposits in the lungs are totally harmless. A chronic bronchial cough may develop after long term exposure with poor ventilation. Variations in individual susceptibility may make this apparent in some workers and not others.

[b]The ACGIH recommends a TLV of 5 mg/M^3, as does OSHA. This value of 5 mg/M^3 is also a ceiling value which means that during no time period in a worker's shift should his exposure to manganese be more than 5 mg/M^3. This limit is based on data that indicates manganese affects the central nervous system, inducing symptoms of sleepiness, weakness in the legs, languor, uncontrollable laughter, and a spastic gait with a tendency to fall when walking. Most of the literature dealing with these symptoms relate to exposures well in excess of the TLV; however, there is enough exposure data at or below the TLV to suggest that there is a relatively small margin of safety with manganese. This is the basis for the ceiling value of 5 mg/M^3. The main effect of low level manganese exposure is respiratory irritation.

[c]The National Institute for Occupational Safety and Health "Criteria for a recommended standard for occupational exposure to nickel" (2) suggests a level of 0.015 mg/M^3 based on evidence that exposure may cause lung and nasal cancer, dermatitis (nickel itch), perforation of the nasal septum, pulmonary irritation and an asthma-like lung disease, and a decrease in lung function. The most common symptom is nickel itch which is characterized by a red, swelling and papular rash in the web of the fingers and on the fingers, wrists and forearms. There is a wide variation in individual susceptibility to this compound.

[d]The current OSHA standard for exposure to insoluble, trivalent$^{(+3)}$ forms of chromium is 1.0 mg/M^3 (3). There are two NIOSH criteria documents published on hexavalent$^{(+6)}$ chromium compounds - Chromium VI (pub. 1975)(4) and chromic acid (pub. 1973)(5) which recommend lower limits for exposure (.001 mg/M^3 - carcinogenic Cr, 0.025 mg/M^3 - noncarcinogenic Cr and 0.05 mg/M^3 - chromic acid). However, if one can accept the following statement from Patty (6) - "Chromium ... in an Atmosphere of CO_2 oxidizes to Cr_2O_3," a trivalent compound - then the OSHA limit of 1.0 mg/M^3 can be considered instead. There is scant literature on the effects of exposure to Cr_2O_3 alone. Most studies indicate exposures to a mixture of trivalent and hexavalent compounds. However, some authors - Morris (7), Mancuso (8) - have reported Chromium (III) causing skin sensitization, nasal septum perforation, chemical pharyngitis, and inflammation of the mucus membrane of the nose (rhinitis).

[e]The ACGIH TLV for total welding fume is 5 mg/M^3. 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 (in the absence of contrary information), total fume concentration is also measured. Conclusions based on total fume concentration are generally adequate in the absence of toxic elements.

[f]The current NIOSH criteria for carbon monoxide (9) is 35 ppm, with a ceiling value of 200 ppm. Thirty five ppm corresponds to a 5% CoHb level. In welding operations utilizing an atmosphere of carbon dioxide, carbon monoxide is produced. The effects of acute CO poisoning are well documented - headache, nausea, vomiting, dizziness, drowsiness and collapse. However, low level exposure (less that 100 ppm) effects are less well defined. The main effect is to the cardiovascular system. CO binds tenaciously with the hemoglobin molecule in the blood, forms 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 tissues, however, in doing so, requires more oxygen itself. The heart is then stressed when it cannot meet its oxygen demand. The literature also reports behavioral effects resulting from CO exposure such as reduction in vigilance, visual and audio threshold reduction, etc., however, attempts at duplication of these results have not been routinely successful. The effects of occupational exposure to CO is augmented by smoking. There is a well established relationship between smoking and increased risk of coronary heart disease. Goldsmith (10) has estimated that a smoker is exposed to 475 ppm of CO for six minutes per cigarette.

D. Results and Discussion

The results of personal samples for metals, welding fume and CO are presented in Tables II and III. All environmental measurements (average and peak) were well below the recommended criteria for CO. Detector tube measurements for CO taken in the selected welding plumes showed levels 100-200 ppm. The tip of the detector was approximately 3-6 inches from the welding point. The peak measurements, taken with the tip of the sampling tube inside the welding helmet, showed levels of 3-7 ppm. The welder generally keeps his face (helmet) one foot to 18 inches away from the welding point. This indicates that the levels of CO are rapidly reduced to levels hardly over ambient in a short distance from the welding point.

The biological measurements (pre- and post-shift breath analysis) indicated no significant exposure to CO during the shift. Converting the exhaled CO to corresponding CoHb levels indicated a range of 1.5-2.9% for baseline or pre-shift measurement and a range of 1.5-2.1% for post-shift measurement. The CoHb levels for the control group were 1.5-1.9% and 1.7%, respectively. There is no significant difference between the measurements for the welders and the control group, providing evidence that there was no significant exposure to CO.

All personal samples for Fe, Cr, Ni, and Mn were below the recommended criteria. Two of ten samples for total fume concentration exceeded, and one sample was just under, the recommended criteria.

There are five factors which may influence the amount of exposure a welder has: 1) type of steel being welded; 2) type of electrode being used; 3) size of the piece being welded, i.e., in relation to the distance the job is from the exhaust ventilation; 4) the amount of welding required per piece; and 5) the welder's technique, i.e., how close he gets to the welding point, whether or not he moves the welding point as close to the exhaust ventilation as possible. The fact that two samples exceed the total fume criteria and one approached the level indicates that there is a problem with worker exposure to welding fume. It is conceivable that variation in any of the above factors could cause all exposures to exceed recommended criteria.

The non-directed medical questionnaires provide further evidence that there is a problem. Five of the ten workers interviewed indicated symptoms of industrial bronchitis (11) - coughing, phlegm, congestion, sinus drainage, and chest pain. All five workers felt that the above symptoms were occupationally related. These symptoms are not uncommon to workers in dusty trades; their cause generally cannot be attributed to one compound but to the combination of many compounds. The treatment of industrial bronchitis is nonspecific and consists largely of prevention.

Measurements of the local exhaust system were taken with a Sierra air velocity meter at each hood and compared to the design criteria of the system. As stated previously, each system was designed for five hoods and to pull 780 cfm at each hood. See Figure II for ventilation system layout. Table IV details the air velocity measurements taken at each hood and the resultant calculation of air volume. Figure III depicts how the measurements were taken.

Inspection of the Q values (quantity of air pulled, in cfm) reveals that all values are below design criteria. This is due to four factors:

1. Increased resistance due to duct length, i.e., the farther the air has to be moved the harder it is to move. At constant fan speed, increased distance decreases volume exhausted.

2. Increased resistance due to unnecessary bends and turns in ductwork.

3. Increased resistance due to filter loading and dust collecting in ductwork.

4. Decreased suction from hoods due to unnecessary holes in system (from wear, burning, etc.).

Further note that the values decrease as the distance from the fans increases, with the exception of Booths 1, 2 and 3. This is also due to one or more of the above factors. The fact that the value for Booth 3 is not larger than either Booth 1 and 2 is probably caused by more kinks, holes or dust in the ductwork for that booth. If the system was designed correctly, then factor one above can be considered negligible; that is, each hood should be 780 cfm regardless of the distance from the fan. Therefore, the reduced Q values are probably due to the remaining three factors.

E. Recommendations

In light of the potential overexposure of all workers to welding particulates and worker complaints regarding welding fume, it is this author's opinion that appropriate modification and maintenance of the local ventilation system will reduce the environmental exposure and the symptomatology of the workers.

1. Periodic cleaning of the exhaust system is necessary in order to preserve proper function of the system. As dirt accumulates in the system, the resulting increased resistance reduces the capture velocity of the hood. Therefore more particles escape the exhaust system and contaminate the workers' breathing zone. How often the system should be cleaned depends on the amount of use the system gets; i.e., the amount of particulate loading. It may be necessary to experiment with different periods of loading in order to establish the optimum time period. The filters in the system should be changed or cleaned as often as necessary.

2. The exhaust system should be routinely inspected for tears and holes which reduce the efficiency of the system. Ordinary duct tape is sufficient for most repair jobs, however, if the ductwork becomes worn or torn beyond suitable repair it should be replaced. Also, efficiency may be reduced by exhaust fan belt slippage, or wear on the motor or casing which consequently reduces fan speed. Periodic inspection would prevent this problem if it was to occur.

3. The hoods should be moved as close to the welding point as possible in order to capture the maximum of welding particles. It was observed that the system was designed to be moveable to a degree but each hood had been welded in position. The welder should be able to move the hood to any position that is as close to the weld as possible without interfering with his operation. In cases where the welder must work at one spot on the piece and then move to another spot on the piece, it may be necessary to have an additional hood(s) installed for each work site if the original hood will not reach. If this addition is considered, then keep in mind that this might require a larger fan for the system in order to maintain the same cfm. The engineering firm that installed the original system can advise on any alterations to the system.

4. It was noted that the system as used contained many unnecessary twists and turns in the ductwork connecting the main duct to the hood. The extra length of ductwork was put there so that the hood in the non-stationary mode could reach all necessary work points. However, if the hoods are going to remain in their present fixed location, then the excess ductwork just represents increased resistance to the system. It is suggested that the excess ductwork be eliminated and the ductwork between the hood and main duct be as straight as possible.

5. The pedestal fans used by each welder to cool his welding booth interfered with the exhaust ventilation. The force of the fan destroyed the air patterns of the hood. Therefore, it is recommended that the fans not be used. In a related matter, the welders mentioned removing the top half of the booths to improve air circulation. This is not recommended since this would cause interbooth contamination and cause the air flow characteristics to be influenced by other air motion (notably, the air movement caused by the building doors being open).

6. It was reported that no pre-employment examination is given by the company. It is suggested that the need for pre- and post-employment examinations be given serious consideration. Periodical examinations may spot problems before they become serious and may help alleviate employee concern over working conditions.

7. As an aside, the investigator noticed that the walkway behind the manager's office (through the sliding glass doors) leading to a building exit was obstructed with boxes and supply parts. It is recommended that this area be cleared to allow safe and unhindered access to this exit in case of fire or similar situation where emergency egress is required.

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VI. REFERENCES

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Other References

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b. Hobart Pocket Welding Guide, Hobart Brothers Company (1977).

c. "NIOSH Manual of Sampling Data Sheets" (March 1977) NIOSH Publication No. 77-159.

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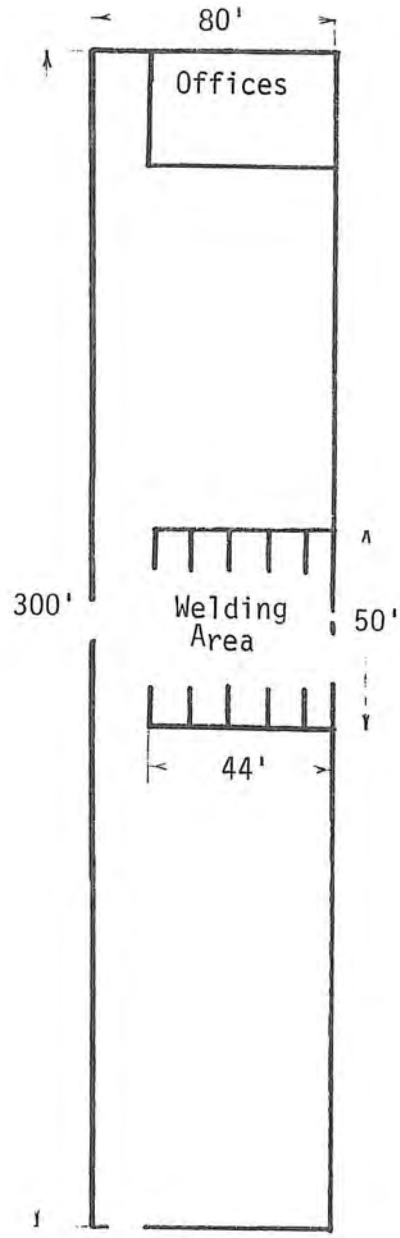
e. Industrial Ventilation, A Manual of Recommended Practice, American Conference of Governmental Industrial Hygienists, 14th Ed. (1976).

Figure I

Building Dimensions and Area of Evaluation

EAZ-Lift Towing Systems
Elkhart, Indiana

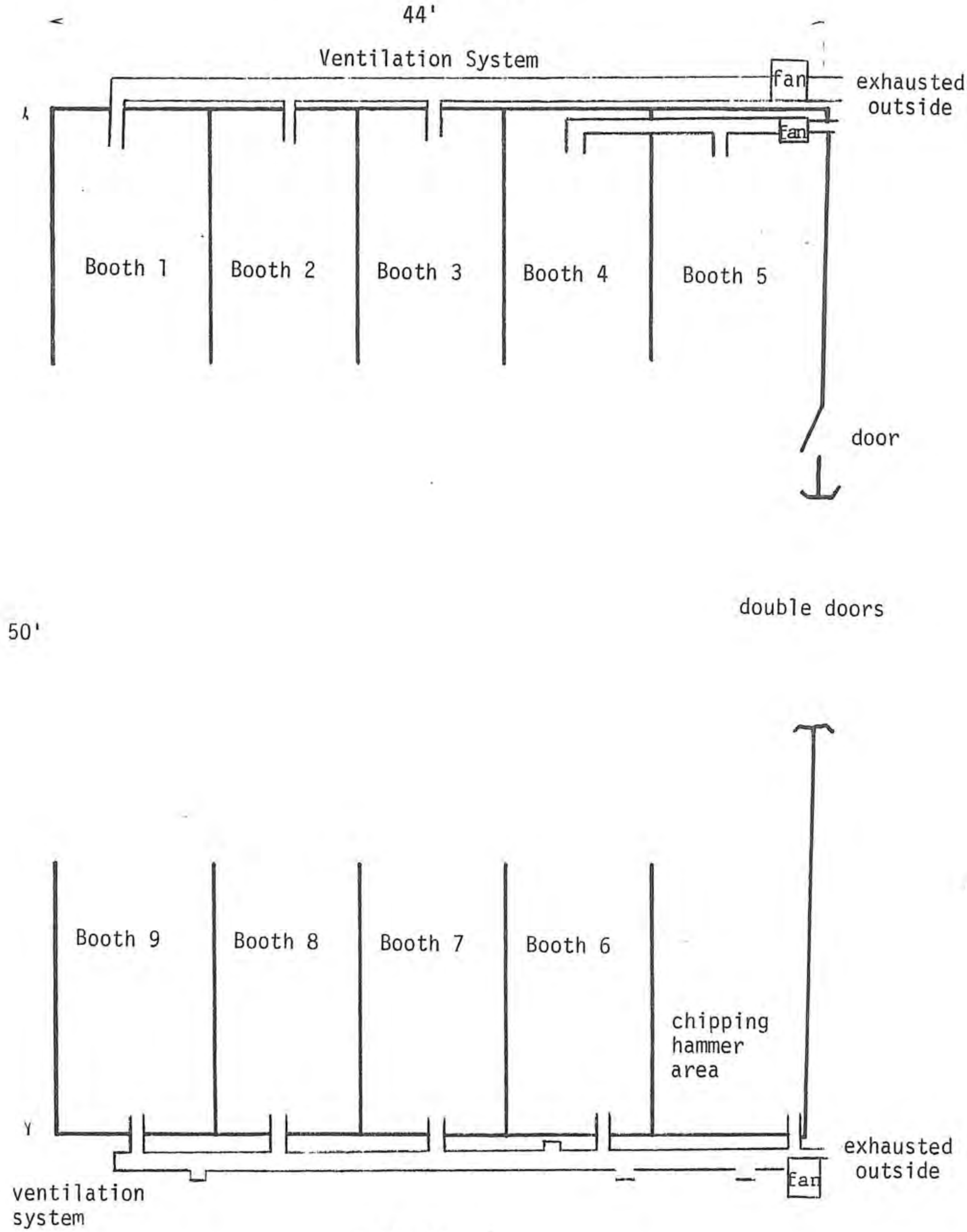


Scale 1" = 50'

Figure II

Detailed View of Welding Area

EAZ-Lift Towing Systems
Elkhart, Indiana



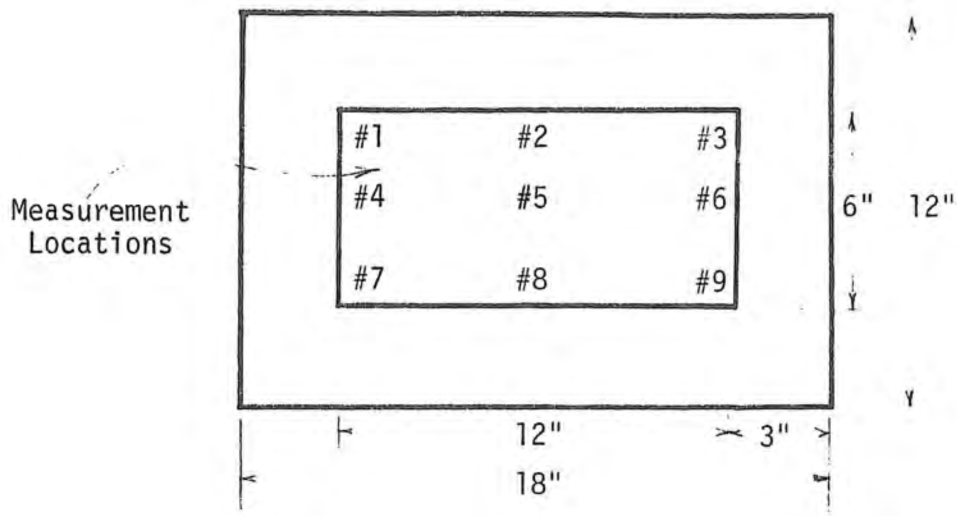
Scale 1" = 7'

Figure III

Typical Hood Dimensions and Measurements Taken

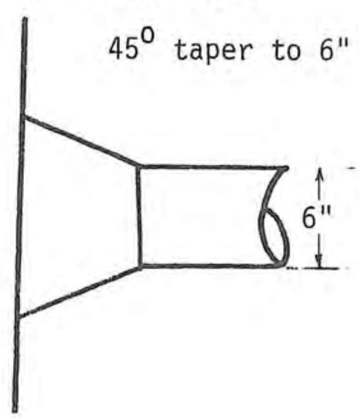
EAZ-Lift Towing Systems
Elkhart, Indiana

Front View



Side View

45° taper to 6" duct



Scale 1" = 6"

Table I

Components of Electrodes

EAZ-Lift Towing Systems
Elkhart, Indiana

Welding Electrodes	Typical Weld Metal Analysis	
AWS 5.1-76 Class E-7016	Carbon	.08%
	Manganese	.80%
	Silicon	.35%
	Phosphorus	.015%
	Sulfur	.020%
	Iron	Bulk
AWS A5.5-69 Class E-7018-A1	Carbon	.05%
	Manganese	.75%
	Silicon	.56%
	Chromium	--
	Molybdenum	.53%
	Iron	Bulk
AWS D1.1-72 Class E-70S-3	Carbon	.11%
	Manganese	1.11%
	Silicon	.5%
	Phosphorus	.020%
	Sulfur	.019%
	Iron	Bulk

Table II

Personal Samples for Metals and Total Welding Particulate

EAZ-Lift Towing Systems
Elkhart, Indiana

September 9, 1977

Job Description	Sampling Time (minutes)	Fe(mg/M^3)	Ni(mg/M^3)	Cr(mg/M^3)	Mn(mg/M^3)	Total Particulate (mg/M^3)
Lead Man	399	0.13	ND*	ND	0.03	0.61
Welder	401	0.59	ND	ND	0.16	1.80
Welder	424	1.22	ND	ND	0.14	3.32
Welder	391	1.34	ND	ND	0.57	4.85
Welder	420	1.03	ND	ND	0.14	2.69
:lder	409	0.49	ND	ND	0.08	1.33
Welder	431	3.52	0.01	0.02	0.29	9.90
Welder	437	0.55	ND	ND	0.09	1.58
Welder	406	2.04	ND	ND	0.57	5.82
Welder	411	0.39	ND	ND	0.07	3.20
Limits of Detection per sample for Analytical Method		0.003 mg	0.003 mg	0.003 mg	0.003 mg	±0.01 mg

*Non-detectable. Below limits of detection.

Table III

Biological and Environmental Samples for Carbon Monoxide

EAZ-Lift Towing Systems
Elkhart, Indiana

September 9, 1977

Job Description	Pre-shift	Post-shift	Average[a] (time in minutes)	Peak[b] (time in minutes)
	[CO, ppm (CoHb)]			
Welder	8[c](2.1)[d]	7(1.9)	3.3 (408)	3(4), 3(11)
Welder	5(1.5)	8(2.1)	4.2 (405)	3(8), 7(8)
Welder	9(2.3)	7(1.9)		
Welder	12(2.9)	8(2.1)		
Welder	6(1.7)	5(1.5)		3(11)
Welder			2 (430)	
Control	6(1.7)	6(1.7)		
Control	7(1.9)	6(1.7)		
Control	5(1.5)	6(1.7)		

a As determined by whole air samplers.
b Taken during a time period which, in the author's opinion, the welding operation would most likely generate high levels of CO.
c Values in ppm, carbon monoxide.
d Parentheses contain equivalent CoHb levels in percent.

Table IV

Ventilation Measurements (fpm)

EAZ-Lift Towing Systems
Elkhart, Indiana
September 9, 1977

Measurement	BOOTH								
	#1	#2	#3	#4	#5	#6	#7	#8	#9
#1	700	650	550	1000	1100	1100	700	750	700
#2	730	650	600	1050	1150	1100	800	700	800
#3	650	600	550	1100	1100	1100	750	750	600
#4	600	750	550	950	1100	1100	700	750	700
#5	650	700	550	1100	1100	1100	900	800	750
#6	640	600	500	1000	1000	1100	900	700	600
#7	600	700	500	900	1050	1050	800	700	750
#8	600	700	600	1150	1100	1050	900	800	700
#9	550	650	550	1100	1100	1050	900	740	650
Average (fpm)	636	667	550	1039	1089	1083	817	743	694
Q (cfm)	318	334	275	520	545	542	409	372	347

Q (quantity of air in cfm) = V (average air velocity in fpm) X A (area of hood opening in FT^2)