U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT
HE 78-32 -507

CHALFANT MANUFACTURING COMPANY
1000 W. RIVER ROAD
ELYRIA, OHIO 44035

JULY 1978

I. TOXICITY DETERMINATION

Welders at Chalfant Manufacturing Company were exposed to a health hazard. This determination is based on a clinical diagnosis of metal fume fevey by a physician using data collected by confidential employee interviews on December 21, 1977, environmental air sampling results, and evaluation of ventilation systems and work practices conducted on March 28-29, 1978. Samples were taken at breathing zone locations inside and outside the welding helmet. Employee (welder) exposures to ozone gas and copper metal fume during aluminum and pre-galvanized steel welding constituted a potential health hazard. Instantaneous ozone concentrations ranged from 0.005 - 1 part of ozone per million parts of air (ppm), whereas the acceptable ceiling Threshold Limit Value (TLV) is 0.3 ppm. Three welders were exposed to time weighted average concentrations of copper fume ranging from 0.4 - 0.7 milligrams of copper per cubic meter of air (mg/M^3). These concentrations exceeded the current Occupational Safety and Health Administration (OSHA) standard of 0.1 mg/M^3 for copper fume.

Recommendations to install local ventilation systems at all welding sites are made in the report in order to reduce employee exposures to welding emissions.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

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

Copies of this report have been sent to:

a) Chalfant Manufacturing Company, Elyria, Ohio
b) Authorized Representative of Employees - Upholsterer's Union Local #48, Cleveland, Ohio
c) Upholsterer's International Union of North America, Philadelphia, Pennsylvania
d) U.S. Department of Labor - Region V
e) NIOSH - Region V

For the purpose of informing the approximately 11 "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 an emergency request from an authorized representative of employees of the Upholsterer's Union Local #48, Cleveland, Ohio. The request said that employees were becoming ill from welding and painting operations and desired an evaluation from NIOSH immediately. A walk-through environmental/medical survey was conducted the following day. In a SHEFS I Report of January 4, 1978, preliminary results and recommendations were stated before a follow-up survey was planned.

IV. HEALTH HAZARD EVALUATION

A. Conditions of Use

Chalfant Manufacturing produces support systems for electrical, pneumatic, and hydraulic systems. The "cable trays" produced are in the shape of a ladder, and are made from fabricated and extruded aluminum and from hot/cold rolled and pre-galvanized steel. There are approximately 40 production workers over a two shift per day operation. During the day shift, there are usually six welders: two pairs, on separate jigs, weld rungs to the rails of cable trays ranging from 10-20 feet long and three feet wide. The welded piece is removed from the jig and parts for the next are positioned on the jig. The last two welders weld trays of different shapes on layout tables. The welding techniques used are as follows:

Aluminum	gas metal arc welding (MIG) using Argon as an inert shielding gas
steels - cold/hot rolled, and pre-galvanized	gas metal arc welding (MIG) using carbon dioxide as a shielding gas.

Two or three laborers will use 15 oz. aerosol paint cans to cosmetically treat the welded surfaces of finished cable trays. Any one laborer may spend a maximum of two hours painting. Production is conducted in a building with dimensions of 200 feet long by 120 feet wide, by 12 feet high. The company moved into this building in March 1977. There are no local exhaust ventilations systems in use. There is one ceiling exhaust fan located near the cable tray welding jig for warm weather use but normally ventilation is provided through natural air currents (windows, cracks, etc.).

The survey was conducted to evaluate exposures during aluminum and pre-galvanized steel welding, and cosmetic painting.

During MIG welding of aluminum (with argon shielding) employees may be exposed to ozone gas (O_3), total particulate matter, and fumes of aluminum, copper, and beryllium metals. During MIG welding of pre-galvanized steel, employees may be exposed to ozone gas and or zinc oxide, iron, copper, and cadmium metal fumes and total particulate matter. During cosmetic painting, employees may be exposed to organic vapors (xylene and acetone) used as paint thinners or solvents.

B. Evaluation Methods

1. Environmental

The hazard potential from fumes and gases generated by a welding operation depends on the chemical composition of materials used, the concentration of the substances in the employee's breathing zone, and the duration of exposure.

Atmospheric samples for aluminum, copper, iron, beryllium, cadmium, and total particulate matter were collected on 0.8 micron (u) pore size acrylonitrile/polyvinyl chloride copolymer filters. The filters were mounted in 37 mm diameter three-piece closed face cassettes. Similar samples for zinc oxide were collected on the same type of filter but using a 25 mm diameter cassette. Air was drawn through the filters at a flow rate of 1.5 liters per minute (lpm) using a battery powered vacuum pump. The samples were collected near the breathing zone of employees, either inside or outside the welding helmet. The lower analytical limits of detection were as follows:

copper:	1 ug/filter	aluminum:	25 ug/filter
iron:	2 ug/filter	beryllium:	0.3 ug/filter
cadmium:	1 ug/filter	zinc oxide:	0.02 ug/filter

Atmospheric samples for acetone and xylene vapors were collected on activated charcoal tubes. Air was drawn through the tubes at a flow rate of 50 milliliters per minute using a battery-powered vacuum pump. The samples were collected near the breathing zone of employees. Length of stain indicator tubes were also used for direct measurement of the vapors.

Atmospheric samples for ozone were collected using three different methods:

1) AID, Inc.* Model 560 Ozone Analyzer - a portable, continuous ozone analyzer;

2) Drager* length of stain direct reading indicator tubes;

3) Rubber strips[1] - this procedure consisted of exposing uniform unvulcanized and stretched rubber to ozone and determining the number and depth of cracks in a given area by optical examination. Standard rubber strips (1.5 inches by 0.25 inch) folded in the middle with the ends secured together to create reproducible tension were attached near the welder's breathing zone. Samples were collected inside and outside welding helmets to evaluate their effect on employee exposures. The lower analytical limits of detection for acetone, xylene, and ozone (rubber strips) are 0.01 mg, 0.01 mg, and 0.004 ppm, respectively.

2. Medical

The medical evaluation was conducted at the same time as the initial walk-through visit December 21, 1977. The NIOSH medical officer attended the tour. It was noted that no in-plant medical program existed. A first aid kit was kept on the premises. Local ambulance facilities would be called in case of an emergency. A separate eating area was present.

The plant worked two shifts at the time of the survey but only the day shift was interviewed. Reports from the Union Steward indicated that the majority of the complaints originated from the day shift. Also, the greatest majority of the complaints to the shop steward and the manager were from welders, spray painters or operators at the periphery of the welding area. A break down of the workers' job descriptions are in Table 1. Eleven of the day employees were interviewed consisting of eight welders, two laborers performing spray painting, and one machine operator in the welding area. The eight welders and one machine operator in the welding area were asked open-ended questions about symptoms or complaints that they associated with their job.

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

C. Evaluation Criteria

1. Toxic Effects

(Only substances whose atmospheric concentrations exceeded the evaluation criteria will be discussed here.)

Zinc and Copper Oxides[2,3]

Metal fume fever is a syndrome which may be caused by the inhalation of fume of many metallic oxides. This syndrome has been especially associated with zinc oxide and is sometimes called zinc or brass chills. The syndrome has been known throughout the history of metal works.

Zinc and copper both play a vital metabolic role as trace elements in humans. Both metals are widespread in natural foods. Chronic disease due to excesses of zinc has not been established. A chronic over-abundance of copper is only important in a rare condition in which a person has a genetic inability to metabolize and excrete copper. This is called Wilson's disease.

The workers exposed to zinc oxide fumes may complain of upper respiratory irritation, chest pain, cough, malaise (a run down feeling), chills, and fever to 102°F, nausea and vomiting. Symptoms usually begin four to six hours after exposure and may persist one to twelve hours.[4]

Most workers develop an "immunity" called "tachyphylaxis" which is quickly gained and lost.[3] This causes the workers to be more susceptible after some time away from work, such as over a weekend. The use of the term "immunity" does not necessarily indicate an immune mechanism, although this is one theory.[5]

Some gastrointestinal complaints, including ulcers, have been reported in workers with long exposure to the galvanizing process. These were reviewed in the NIOSH criteria document.[3] The more acute effects of metal fume fever to the GI tract in welders were a pressure or disturbed feeling, loss of appetite, cramps of the upper abdomen, gastritis, and of the occasional report of ulcer.[6]

Some laboratory tests that are effected are white blood count and pulmonary vital capacity. These tests are, however, not very specific and not necessary with an adequate history and the presence of exposure.

There is no definitive treatment. Once out of exposure, the symptoms resolve and further development of chronic symptoms have not been reported. Prevention through adequate ventilation is the only solution to the problem.

Ozone

Ozone is an allotropic chemical form of oxygen produced by and reactive in photochemical pollution of the atmosphere. One of the most common causes of its production in the workplace is in welding operations. Ozone is an irritant to mucous membranes and the respiratory tract. This results in eye, nose and throat irritations and chest cramps. Other effects are headache, vertigo (dizziness), and fatigue.[7] Stokinger[8] reports that if concentrations are high enough, pulmonary edema, hemorrhage and death could result. The concentrations required to cause these types of catastrophic results would be higher than those expected in an open welding operation. Also a tolerance develops to the presence of ozone so that toxic effects are not as severe.[9]

It is evident that many of the toxic side effects of metal fumes and ozone are similar. Since both these agents are generated by the welding process and their effects are similar, the toxic effects might be greater than either agent alone.

Total Particulates

"Nuisance" dusts have a long history of producing little harm on the respiratory system. The relationship between these dusts and effect on the lungs has been given the following characteristics[10]:

1. The architecture of the air spaces remains intact.

2. Scar tissue is not formed to any significant degree.

3. Any tissue reaction is potentially reversible.

Excessive concentrations of these dusts may reduce visibility (iron oxide) and cause unpleasant deposits in the eyes, ears, and nasal passages. Iron oxide can also deposit in the lung and cause siderosis (a benign pneumoconiosis) and X-ray changes.

2. Environmental Criteria

Airborne exposure limits for the protection of the health of workers have been recommended or promulgated by several sources. These limits are established at levels designed to protect workers occupationally exposed to a substance on an 8-hour per day, 40-hour per week basis over a normal working lifetime. For this investigation, the criteria used to assess the degree of health hazards to workers were selected from three sources:

1) NIOSH: Criteria for a Recommended Standard....Occupational Exposure to Various Substances.

2) Threshold Limit Values (TLV): Guidelines for Chemical Substances and Physical Agents Recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) for 1977.

3) OSHA Standard: The air contaminant standards enforced by the U.S. Department of Labor - Occupational Safety and Health Administration - as found in the Federal Register - 29 CFR 1910.1000 (Tables Z-1, Z-2).

Whenever possible, the NIOSH recommended standard will be the environmental standard applied since it represents the most recent knowledge concerning a substance. If one does not exist, the next most stringent recommended or legal standard will be used.

	SOURCE		
	NIOSH	TLV	OSHA
Ozone	--	0.1 ppm*(0.3 ppm)	0.1 ppm
Xylene	100 ppm	100 ppm	100 ppm
Acetone	--	1000 ppm	1000 ppm
Total Particulates	--	10 mg/M^3	15 mg/M^3
Aluminum (fume)	--	5 mg/M^3**	15 mg/M^3
Copper (fume)	--	0.2 mg/M^3	0.1 mg/M^3
Iron Oxide (fume)	--	5 mg/M^3	10 mg/M^3
Beryllium (fume)	0.0005 mg/M^3	0.002 mg/M^3	0.002 mg/M^3
Cadmium Oxide (fume)	0.04 mg/M^3	(0.05) mg/M^3	0.1 mg/M^3
Zinc Oxide (fume)	5 mg/M^3	5 mg/M^3	5 mg/M^3

*Concentrations, in parts of substance per million parts of air (ppm) or milligrams of substance per cubic meter of air (mg/M^3), are based often on an 8-hour time-weighted average exposure (TWA). Values in parentheses represent concentrations which should not be exceeded even instantaneously as commonly measured in a 15-minute period.

**A proposed TLV.

D. Evaluation Results and Discussion

1. Environmental

The results of atmospheric sampling for metal fumes and dust are presented in Table 3. All samples for zinc oxide, aluminum, iron oxide, cadmium, and beryllium fumes were either nondetectable or below all evaluation criteria. However, several samples for copper and total dust exceeded certain evaluation criteria. On March 28, straight section welders #1, 2, and 4 were exposed to copper fume concentrations ranging from 0.1 to 1.5 milligrams of copper per cubic meter of air (mg/M^3). These concentrations represent 8-hour time-weighted average concentrations (TWA) of 0.4, 0.7, and 0.4 mg/M^3, respectively. These concentrations exceeded the current OSHA standard of 0.1 mg/M^3 for copper fume. On March 29, straight section welder #4 was exposed to samples of 12.4 and 18.2 mg/M^3 of total dust, corresponding to an 8-hour TWA of 14 mg/M^3 of total dust. This exceeds the TLV of 10 mg/M^3.

It should be noted that certain of the copper fume samples which exceeded the evaluation criteria were collected inside the welding helmet. This may be seen as an argument against the thinking that the helmet serves as a respirator.

The results of air sampling for ozone gas are presented in Table 4 (rubber strips) and Table 5 (detector tubes and ozone meter). The least reliable method, using rubber strips, indicated samples of ozone ranging from non-detectible to 0.05 ppm, or approximately one half the acceptable standard during aluminum welding. These represent the only personal samples collected during the survey over an 8-hour period. More reliable results are presented in Table 5. The AID ozone meter, evaluated by NIOSH and found to be reliable, indicated instantaneous ozone concentrations ranging from 0.005 - 1.0 ppm during welding. These concentrations, found at various locations near the breathing zone of employees, often exceeded the ceiling concentration (TLV) of 0.3 ppm set by the ACGIH. The instantaneous measurements determined with detector tubes ranged from 0.05 - greater than 1.4 ppm (beyond scale). While these tubes have not been certified by NIOSH, the results were comparable to those of the AID Meter. The concentrations increased often whenever welding of aluminum was sustained for several minutes. The results are in general agreement with reports associating aluminum (MIG) welding with argon shielding and high ozone concentrations.[11] Mild steel welding with CO_2 shielding did not cause ozone concentrations to exceed the evaluation criteria.

The results of air sampling for xylene and acetone are presented in Table 6. All concentrations of both compounds contained in the paint used for cosmetic purposes were below the evaluation criteria. Thus no potential hazard is seen in this operation, as long as the painting is not conducted in unventilated or confined spaces.

2. Medical

The complaints elicited through the open ended questions to the workers described in Section B are listed in Table 2. In this table, the symptoms described by the workers are listed and the number of workers complaining of each symptom are listed. All persons interviewed expressed some work associated symptom, and all explained that their symptoms were much worse when the welding process involved galvanized steel.

In welding operations on zinc galvanized steel, one would expect the possibility of metal fume fever. The complaints elicited from the welders describe metal fume fever. These symptoms are also attributable to the presence of ozone, and these two agents combined are probably intensifying the effect.

The paint sprayers complained of dizziness, headache and upset stomach when painting in poorly ventilated areas. This problem was considered minor by the workers interviewed but still of some concern.

Solvents present in paint may vary greatly, but most are organic hydrocarbon solvents. Many of these solvents may cause an euphoria effect with dizziness and nausea. The complaints made by the painters are certainly consistent with this description.

The conclusions of these medical symptoms are that the welders and the machine operators near the welding interviewed have sufficient symptoms for the diagnosis of metal fume fever. Oxides of copper and probably oxides of zinc are probably the indicated agents. These symptoms are also due to or intensified by the presence of ozone generated by the welding process. Spray painters may have been exposed to excessive solvents when painting in a poorly ventilated area.

Both of these problems have no long term toxic effects unless long term or very high exposure to ozone or solvents are present and neither require treatment other than termination of exposure in short term low exposure situations. Prevention of exposure through adequate ventilation is the method of control.

V. RECOMMENDATIONS

1. It is recommended that local exhaust ventilation be installed in all welding locations. Systems for the two straight section welding locations have been proposed by the company and by NIOSH representatives. The company proposed that local exhaust slots be placed along the length of the jig on each side, and at the same height that welding occurs. Welding fumes and gases would be exhausted laterally and not flow into the welder's breathing zone. This modification would not change the basic fabrication technique to any degree. The NIOSH proposal would be to install a fixed lateral exhaust hood approximately 1-2 feet above the jig. The jig would be modified by putting it on rollers, allowing it to pass under the lateral exhaust hood. The welders, instead of moving down the jig to weld, would remain stationary next to the hood and weld sections of the cable tray there. Welding emissions would be drawn away from their breathing zone. Either method should lower employee exposures to welding emissions, provided that a capture velocity of 100 feet per minute (fpm) exists at all points where emissions are generated.

2. A flanged hood could be suspended from the ceiling over welding operations on layout tables where fittings welders work. The ductwork should be flexible enough to move around the table, since many metal pieces to be welded are large and might strike a stationary hood. A capture velocity of 100 fpm is recommended at welding emission generation points. See Figures 1 and 2 for related designs.[12]

3. Should the automatic welder (not currently used) be used for straight section parts, a design such as that in Figure 3 is recommended for consideration. In this figure, Q equals the air volume rate.

4. There is a potential noise problem concerning the metal saw used near one of the layout tables. Although the saw operator wears hearing protection, employees working nearby may be overexposed to noise. The company may wish to consult an accoustical engineer to evaluate the problem and to reduce noise levels if necessary.

5. All punch presses should be equipped with hand restraints or other controls to protect operators.

6. Welding curtains should be installed at certain locations, such as at both layout tables, to protect other workers from flash burns.

7. Make-up air should be added to the building to replace that removed through local exhaust systems. The lack of make-up air will reduce the efficiency of local exhaust systems and may cause cross drafts throughout the plant.

8. Recirculation of contaminated exhaust air, as desired by the company, is feasible as a means of conserving energy. Besides the recirculation approach for recommendations #1 and #2 above, a "smoke exhaust system" which incorporates local exhaust ventilation around the end of a MIG welding gun could be considered. Ideally, emissions are to be removed from the arc area, and ducted through the gun unit into a filter contained in a canister; "clean" air would then be readmitted into the work area. The air volume must be sufficient to capture emissions but not enough to take away the shielding gas also. Any commercial unit should only be accepted when proven effective in actual use.

9. It is important to assure that the readmitted air is clean so as not to present a health hazard to employees. In locations where the exterior air is unhealthful, less contaminated air will be introduced into the workplace. The proceedings of a symposium on recirculation of exhaust air is included with the report as a guideline.[13]

10. For the installation of any ventilation systems, it is recommended that a consultant experienced in industrial ventilation be contacted.

11. This specific medical problem of actual metal fume fever and the possibility of paint solvent vapors may be controlled through industrial hygiene methods and no medical recommendations are necessary.

VI. REFERENCES

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Table 1

CHALFANT MANUFACTURING COMPANY
ELYRIA, OHIO

December 21, 1977

Job Description of Workers

TOTAL WORKERS IN PLANT*

Welders	14
Press Operators	10
Machinists	8
Labor	10
Helpers	6
Maintenance	2

*As reported in the opening conference by the plant manager.

Table 2

CHALFANT MANUFACTURING COMPANY
ELYRIA, OHIO

December 21, 1977

Complaints of Nine Interviewed Welders and Machine Operators

	Number of Persons Expressing each Entry below
Headache	5
Bodyaches	2
Chills (shaking)	2
Malaise	3
Nausea	5
Anorexia	2
Dizziness	1
Diarrhea	1
Burning Eyes	2
Chest Pains	1
Shortness of Breath	2
Cough	1
Metallic taste in month	3
Reported symptom began 2-4 hours after beginning work	3
Reported symptoms began the evening after work	2
Did not report time onset of symptoms	4

Table 3

RESULTS OF AIR SAMPLING FOR VARIOUS WELDING FUMES AND DUST
CHALFANT MANUFACTURING COMPANY
ELYRIA , OHIO

PERSONAL SAMPLES

Date	Job Title	Sample Number	Sample Location[1]	Sampling Period (hr/min)	Metal Being Welded	Zinc Oxide	Copper	Aluminum	Iron Oxide	Total Particulates	Cadmium	Berylium
						CONCENTRATION (mg/M^3)[2]						
3/28	straight section welder #1	DM 118	O	2/45	Pre-gal steel		0.6		0.1	8.4	N.D.[3]	
3/28	straight section welder #1	DM 102	O	4/10	Pre-gal steel		0.4		0.3	3.6	N.D.	
3/28	straight section welder #1	DM 1	O	2/45	Pre-gal steel	0.6						
3/28	straight section welder #1	DM 3	O	4/10	Pre-gal steel	0.2						
3/29	straight section welder #1	DM 107	O	8/05	aluminum		0.001	1.9		5.1		N.D.
3/28	straight section welder #2	DM 108	O	2/45	Pre-gal steel		1.5		0.1	11.5	N.D.	
3/28	straight section welder #2	DM 121	I	4/10	Pre-gal steel		0.4		0.6	5.0	N.D.	
3/28	straight section welder #2	DM 2	I	2/45	Pre-gal steel	1.0						
3/28	straight section welder #2	DM 4	I	0/30	Pre-gal steel	N.D.						
3/29	straight section welder #2	DM 115	I	3/35	aluminum		0.01	2.6		11.3		N.D.
3/29	straight section welder #2	DM 103	I	3/45	aluminum		N.D.	1.8		6.0		N.D.
3/28	straight section welder #3	DM 111	O	7/55	aluminum		0.1	0.6		2.7		N.D.
3/29	straight section welder #3	DM 117	I	8/0	aluminum		0.002	1.0		3.5		N.D.
3/28	straight section welder #4	DM 114	I	2/45	aluminum		1.0	0.4		8.8		N.D.
3/28	straight section welder #4	DM 119	I	5/10	aluminum		0.1	0.7		4.0		N.D.
3/29	straight section welder #4	DM 113	O	3/35	aluminum		0.003	0.9		12.4		N.D.
3/29	straight section welder #4	DM 105	O	3/45	aluminum		N.D.	0.8		18.2		N.D.
3/28	fittings welder #1	DM 112	O	7/30	aluminum		0.02	1.1		3.9		N.D.
3/29	fittings welder #1	DM 106	I	7/55	aluminum		0.002	0.8		3.4		N.D.
3/28	fittings welder #2	DM 110	O	8/05	mild steel		0.2		0.8	3.8	N.D.	
3/29	fittings welder #2	DM 120	I	7/45	aluminum		N.D.	0.2		1.3		N.D.

1 - I = inside helmet O = outside helmet
2 - mg/M^3 = milligrams of fume or dust per cubic meter of air
3 - N.D. = non detectable

EVALUATION CRITERIA:

	Zinc Oxide	Copper	Aluminum	Iron Oxide	Total Particulates	Cadmium	Berylium
NIOSH	5 mg/M^3					0.04 mg/M^3	0.0005 mg/M^3
TLV	5 mg/M^3	0.2 mg/M^3	5 mg/M^3	5 mg/M^3	10 mg/M^3	0.05 mg/M^3[4]	0.002 mg/M^3
OSHA	5 mg/M^3	0.1 mg/M^3	15 mg/M^3	10 mg/M^3	15 mg/M^3	0.1 mg/M^3	0.002 mg/M^3

4 - This represents a ceiling value which should not be exceeded.

Table 4

RESULTS OF AIR SAMPLING FOR OZONE DURING MIG WELDING
CHALFANT MANUFACTURING COMPANY
ELYRIA, OHIO

PERSONAL SAMPLES

Date	Job Title	Sample Location	Sampling Period (hr/min)	Concentration(ppm)[1]
3/28	straight section welder #1	O	8/0	N.D.[2]
3/28	straight section welder #2	I	8/0	N.D.
3/28	straight section welder #3	I	8/0	N.D.
3/28	straight section welder #4	I	8/0	N.D.
3/28	fittings welder #1	O	8/0	N.D.
3/28	fittings welder #2	I/O[3]	8/0	0.042
3/29	straight section #2	I	8/0	0.004
3/29	straight section #3	O	8/0	N.D.
3/29	straight section #4	I	8/0	0.004
3/29	fittings welder #1	I	8/0	N.D.
3/29	fittings welder #2	I	8/0	0.052

1 - PPM = parts of ozone per million parts of air
2 - N.D. = non detectable
3 - I = inside helmet   O = outside helmet

EVALUATION CRITERIA

NIOSH	0.1 ppm
TLV	0.1 ppm
OSHA	0.1 ppm

Table 5

RESULTS OF AIR SAMPLING FOR OZONE DURING MIG WELDING
CHALFANT MANUFACTURING COMPANY
ELYRIA, OHIO

Date	Job Title	Sample Time	CONCENTRATION (ppm)[1] Detector Tube	AID® Meter	Comments
3/28	straight section welder #2	9:40 am		0.1-0.6	aluminum welding
	" " "	11:20 am		0.02-0.3	" "
	" " "	3:00 pm		0.05-0.6	" "
		1:00 pm	0.4		aluminum welding/between arc & helmet
3/29	straight section welder #2	9:00 am	0.15		during 24 ft. ladder welding
	" " "	10:00 am	0.2		during aluminum trough ladder welding
3/28	straight section welder #1	10:00 am		0.04-0.08	galvanized steel welding during 24 ft. trough ladder welding
3/29	straight section welder #1	9:30 am	0.8		24 ft. trough ladder welding
	" " "	9:35 am	1.2[2]		24 ft. ladder welding
	" " "	11:15 am	0.6		" " "
	" " "	2:00 pm	>1.4		" " "
	" " "	2:05 pm	trace		in general area near jig
3/29	straight section welder #4	9:15 am	0.5		during 24 ft ladder welding
3/28	fittings welder #1	10:30 am		0.005	mild steel welding
	" " "	10:45 am		0.005-0.01	" " "
3/28	fittings welder #2	10:15 am		0.1-0.6	aluminum welding samples
	" " "	"		0.05-0.2	inside helmet sample
	" " "	"		0.05-0.6	between helmet and arc
		10:25 am		0.2-1.0	sample inside helmet near ear
	" " "	10:40 am		0.2-0.6	sample inside near nose
	" " "	1:00 pm	0.05		sample made helmet near ear
	" " "	1:10 pm	0.2		sample in-between arc and helmet

1 - ppm = parts of ozone per million parts of air
2 - this sample was taken during welding of a 24 ft. trough cabletray. With 92 welding sites needed, welding may occur for approx. 6 minutes continuously.

EVALUATION CRITERIA:

NIOSH	0.1 ppm
TLV	0.1 ppm (0.3)C*
OSHA	0.1 ppm

*C = ceiling value

Table 6

Results of Air Sampling for Organic Vapors

Chalfant Manufacturing Company
Elyria, Ohio

PERSONAL SAMPLES

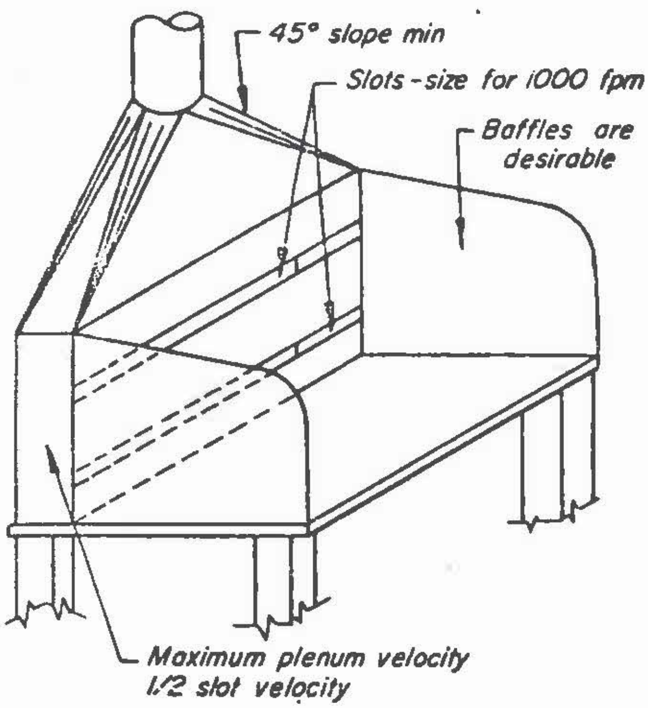
Date	Job Title	Sample Number	Sampling Period (hrs./min.)	Concentration (ppm)[1] Xylene	Acetone
3/28	General Laborer (painter) #1	C1	3/20	0.7	4.0
"	" " " "	C4	3/50	N.D.[2]	N.D.
"	" " " #2	C2	3/20	0.5	1.0
"	" " " "	C5	3/50	N.D.	N.D.
"	" " " #3	C3	3/15	0.9	1.0
"	" " " "	C6	3/50	0.2	0.3
3/29	General Laborer (painter) #1	C7	3/35	N.D.	3.1
"	" " " #2	C8	3/35	0.5	0.5
"	" " " #3	C9	3/35	0.7	0.8
"	" " " "	C10	3/45	0.9	1.0
"	" " " #4	C11	3/15	0.5	0.9

[1]ppm=Parts of vapor per million parts of air
[2]N.D.=Non-Detectable

Evaluation Criteria:

	Xylene	Acetone
NIOSH	100 ppm	-
TLV	100 ppm	1000 ppm
OSHA	100 ppm	1000 ppm

FIGURE 1



Q = 350 cfm/lineal ft of hood
Hood length = required working space
Bench width = 24" maximum
Duct velocity = 1000 - 3000 fpm
Entry loss = 1.78 slot VP + 0.25 duct VP

GENERAL VENTILATION, where local exhaust cannot be used:

Rod, diam	cfm/welder*
5/32	1000
3/16	1500
1/4	3500
3/8	4500

*For toxic materials higher airflows are necessary and operator may require respiratory protection equipment.

OTHER TYPES OF HOODS

Local exhaust: See VS-416.1
Booth: For design See VS-415, VS-604
Q=100 cfm/sq ft of face opening

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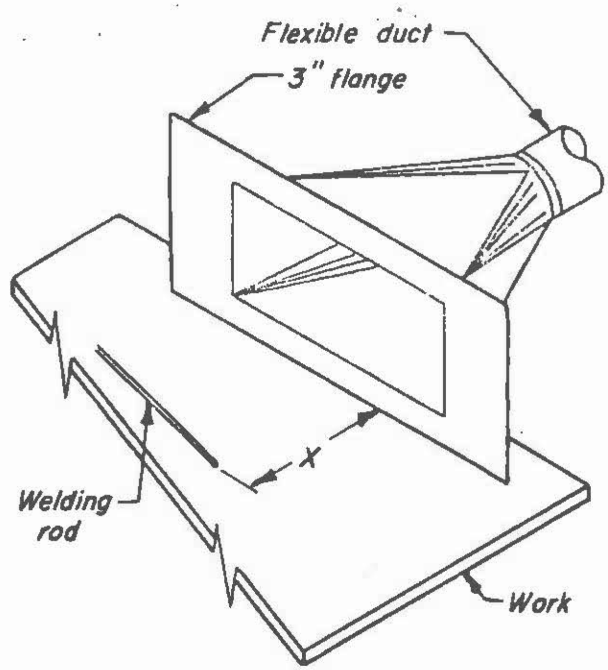
WELDING BENCH

DATE 1-74 | VS-416



PORTABLE EXHAUST

X, inches	Plain duct cfm	Flange or cone cfm
up to 6	335	250
6 - 9	755	560
9 -12	1335	1000

Face velocity = 1500 fpm
Duct velocity = 3000 fpm minimum
Entry loss= 0.25 duct VP
Also see "Granite Cutting" VS-909

GENERAL VENTILATION, where local exhaust cannot be used:

Rod, diam	cfm/welder
5/32	1000
3/16	1500
1/4	3500
3/8	4500

For toxic materials higher airflows are necessary and operator may require respiratory protection equipment.

OTHER TYPES OF HOODS
Bench: See VS-416
Booth: For design See VS-415, VS-604
Q=100 cfm/sq ft of face opening

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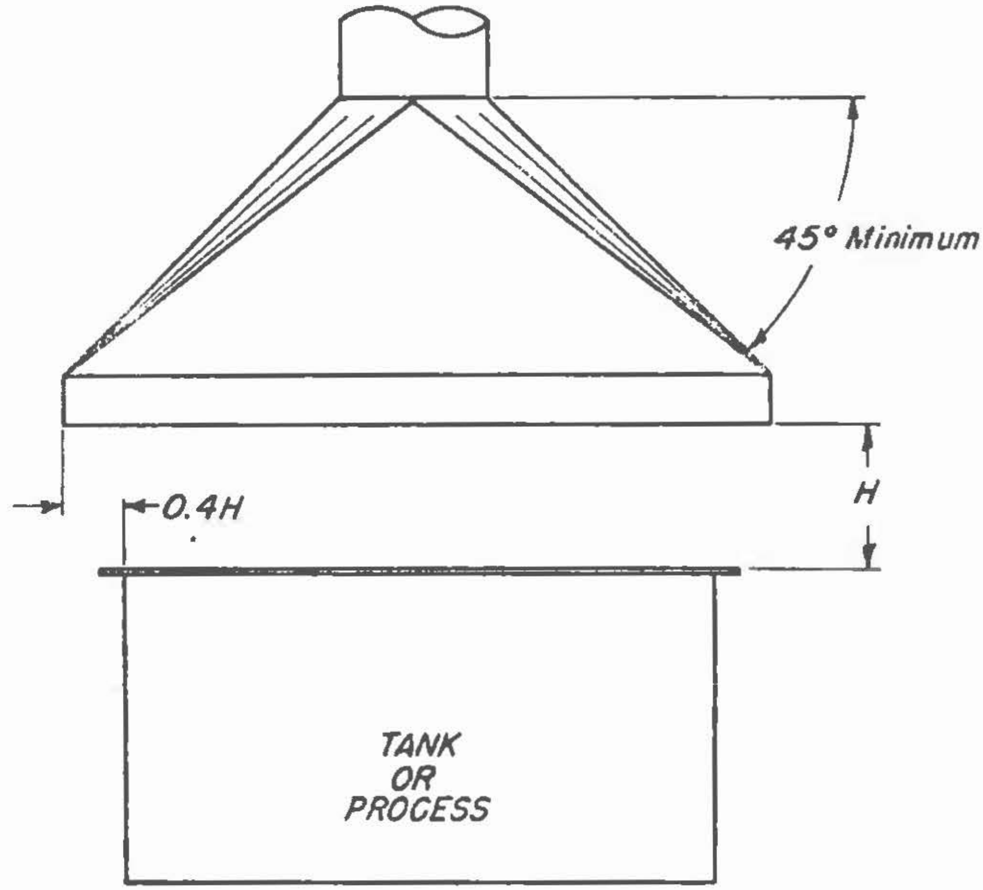
WELDING BENCH

DATE 1-74 | VS-416.1

FIGURE 3



Not to be used where material is toxic and worker must bend over tank or process.
Side curtains are necessary when extreme cross-drafts are present.

Q = 1.4PHV	for open type canopy. P= perimeter of tank, feet. V= 50-500 fpm. See Section 4
Q =(W+L)HV	for two sides enclosed. W & L are open sides of hood. V = 50-500 fpm. See Section 4
Q = WHV or LHV	for three sides enclosed. (Booth) V= 50-500 fpm. See Section 4

Entry loss= .25 duct VP
Duct velocity=1000-3000 fpm

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CANOPY HOOD

DATE 1-70 | VS-903