

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 78-76-548

WESTERN GEAR CORPORATION
FLIGHT STRUCTURES DIVISION
HIGHWAY 20 NORTH
JAMESTOWN, NORTH DAKOTA 58401

December 1978

I. TOXICITY DETERMINATION

The following determinations have been based on environmental air sampling conducted during June 5-8, 1978, confidential employee interviews, evaluation of ventilation systems and work practices, and available toxicity information. Employee exposures to various organic vapors in the Paint Shop, acid mists in the Anodize Line, oil mist in the Machine Shop, and metal fumes in the welding/soldering shops did not constitute a health hazard during the survey. However, a potential over exposure to welders from ozone gas may exist. This condition may exist during gas metal arc (MIG) welding of aluminum in the facility.

Of twenty-four employees interviewed using non-directed questionnaires, seven said they experienced skin problems occasionally when working with solvents, caustic solutions or cutting oils when working either in the Paint Shop, Anodize Line or Machine Shop. It is recommended that employees wear proper personal protective clothing to prevent these substances from contacting the skin.

Recommendations to modify certain local exhaust ventilation systems are presented in the report, along with other general recommendations.

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) Western Gear Corporation, Jamestown, North Dakota.
- b) NIOSH - Region VIII.
- c) U.S. Department of Labor - Region VIII.

For the purpose of informing the approximately 150 "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 the Western Gear Corporation to evaluate employee exposures to organic vapors, acid mists, welding fumes, oil mist, noise, and illumination. While these last two are physical agents and not normally covered under Section 20(a)(6), they were addressed during the initial survey since the project was employer requested. An interim report (SHEFS I) was sent to the company on June 20, 1978, with certain results and recommendations for illumination and noise control.* A Health Hazard Evaluation was conducted in 1976 (Report HE 76-23-319)² to determine if any potential health hazards existed. The present request was to serve as a follow-up survey. Since 1976, the Anodize Line was remodeled, fans in the spray booths were geared down, and a few walls were taken down.

IV. HEALTH HAZARD EVALUATION

A. Conditions of Use

The Flight Structures Division manufactures systems and components for the aerospace industry. Operations are housed in an approximately 126,000 square-foot facility providing precision machining operations, mechanical and electrical assembly, sheet metal forming and assembly, finish processing, etc. The operations were begun in 1971 and approximately 320 production workers are employed. There are several areas of the facility where potential exposures to various air contaminants exist. The areas, specific air contaminants, and number of employees exposed are listed in the following table:

*Since the environmental survey, the company has obtained a noise control consultant. This topic will not be discussed further in this report.

<u>Location</u>	<u>(All Shifts) No. Employees</u>	<u>Air Contaminant(s)</u>
Machine Shop	125	Oil Mist
Process (Anodize) line	3	nitric, sulfuric, chromic acids, trichloroethylene
Paint Shop:		
Paint Prep	12	organic vapors
Paint Booths	4	(methyl ethyl ketone, toluene, etc.)
Welding Booth	2	ozone, aluminum, chromium, copper
Soldering Room	2	silver, cadmium
Food Service-Refrigerator	1	toluene diisocyanate(TDI)

Specifically, machine operators work with a water soluble cutting fluid during metal machining. All operators monitored for oil mist exposure were using an "oil spray" technique with one or two exceptions. These operators employed an "oil flooding" technique on metal parts. The process line technicians were responsible for the electroplating of parts in various tanks containing nickel and chromium solutions. The paint prep employees clean small parts (usually with methyl ethyl ketone) in a room adjacent to the spray booth room. There are three adjacent dry filter equipped booths in the spray room. Air is supplied to the room through supply grilles on the walls opposite the booths. The welding is conducted inside a curtained area under a canopy hood. A gas metal arc welding technique (MIG) is employed for aluminum and stainless steel. While aluminum is welded daily, stainless steel is welded one to three times per week. Silver soldering is conducted in an adjacent room under a canopy hood. One of two solders used contains cadmium, a very toxic metal. In the Food Service Department, a polymeric isocyanate foam is poured into the back of a refrigerator. The operation occurs approximately once a week for a half hour.

B. Evaluation Methods

1. Environmental

Atmospheric samples for various organic vapors were collected on activated charcoal tubes. Air was drawn through the tubes at flow rates of 50 milliliters per minute using battery powered vacuum pumps. The samples were collected in the breathing zone of employees. The lower analytical limits of detection were as follows: methyl ethyl ketone - 0.01 milligrams (mg), methyl isobutyl ketone - 0.03 mg, toluene - 0.03 mg, butyl acetate - 0.04 mg, cyclohexanone -0.04 mg, and trichloroethylene -0.01 mg.

Atmospheric samples for oil mist and sulfuric acid were collected on 0.8 micron (u) pore size mixed cellulose ester filters. The filters were mounted in 37 mm diameter three piece closed face cassettes. Air was drawn through the filters at flow rates of 1.5 liters per minute (lpm) using battery powered vacuum pumps, and the samples collected in the employee's breathing zone. The lower analytical limit of detection was 50 micrograms (ug) of sulfuric acid and 0.01 ug of oil mist per filter.

Atmospheric samples for nitric acid were collected by bubbling air through an absorbing solution of 0.1 N NaOH in a midjet impinger at flow rates of 1.0 lpm. The samples were taken near the breathing zone of employees using battery powered vacuum pumps. The lower analytical limit of detection was 0.2 ug per ml of sample.

Atmospheric samples for chromium (VI), total particulate weight, aluminum, silver, and copper were collected on 0.8 u pore size acrylonitrile/polyvinyl chloride copolymer filters. The filters were encased in 37 mm diameter three piece closed face cassettes. Air was drawn through the filters at flow rates of 1.5 lpm using battery powered vacuum pumps and the samples collected in the employee's breathing zone. The lower analytical zone limits of detection were as follows: chromium (VI) - 0.2 ug, aluminum - 5 ug, silver - 2 ug, and copper - 2 ug.

Atmospheric samples for ozone were collected using length of stain direct reading indicator tubes. The range of possible measurements was from 0.05 -1.4 parts per million parts of air by volume. There are no ozone indicator tubes certified by NIOSH yet. Ventilation measurements were taken using a thermoanemometer.

2. Medical

Twenty-four employees were interviewed by the industrial hygienists using non- directed questionnaires to obtain occupational work histories and to find out if employees had any health problems which they thought were associated with their work environment. These employees were from the following areas or departments: Process Line, Machine Shop, Paint Shop, and Welding, Soldering areas. The company gives pre-employment medical examinations including physical examinations, hearing tests, and tetanus screening. Annual examinations are not given.

C. Evaluation Criteria

1. Toxic Effects

Since all contaminants except ozone gas were measured in either trace levels or below detectable limits, the toxic effects of these substances will not be discussed with a few exceptions. The effects of ozone, toluene diisocyanate (TDI), cutting oils, paint solvents, and cadmium will be presented because they deserve special attention due to their toxic properties, or because employees related health problems about them.

Ozone - This gas can be produced during certain types of welding. 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 fatigue³. Stokinger⁴ 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.⁵

Ketones⁶ - (Methyl Ethyl Ketone, Methyl Isobutyl Ketone, Cyclohexanone) These solvents produce a dry, scaly, and fissured dermatitis after repeated exposure by removing the natural oils from the skin. High vapor concentrations may irritate the conjunctiva and mucous membranes of the nose and throat, producing eye and throat symptoms.

Metal Working Fluids - The term "mineral oils" includes all mineral oils such as light oils (motor spirits), paraffin (kerosine), gas oils, heavier burning oils, diesel oils, lubricating and coolant oils. Inhalation of mineral oil mists in sufficient quantities may cause mucous membrane irritation and pulmonary pneumonitis. Mineral oils affect the skin in relation to the amount and duration of exposure and to the type and grade of oil used. These oils produce "oil acne", which is an inflammatory skin condition characterized by the presence of blackheads, pimples, and pustules, due to oil blocking and irritating the pores of the skin. Septic infection from germs entering from the skin surface may follow. More rarely an acute inflammatory condition occurs, generally on the hands or forearms, such as might be produced by any powerful skin irritant with redness, local swelling, and blister formation. The arms are most affected, but the rash may occur on any part of the body where there is contact with oil, or oily clothing.

Cutting oils also damage the skin by de-greasing. Where the natural protective fat is constantly being removed (de-greased) the skin will become dry, cracked and sore.

Slight injuries to the skin, such as those caused by swarf or metal particles in the oil, make the occurrence of rashes more likely, while neglect or a cut or injury, as for example, by failure to obtain first aid treatment, may lead to a rapid local multiplication of the germs causing infection of the skin. The addition of an antiseptic to the oil for the purpose of preventing infection is not advised, as no useful purpose is served and many antiseptics cause skin irritation.

Long exposure to mineral oil can result in warts or ulcers which may become cancerous. This may particularly occur on the scrotum. Early treatment will provide a certain cure and delay is dangerous.

Toluene Diisocyanate (TDI)⁷ - The greatest practical hazard in the use of isocyanates arises from inhalation of their vapors. Inhalation of isocyanate vapors can produce severe irritation of the mucous membranes in the respiratory tract (nose, throat, lungs, etc.). Short exposure to concentrations of isocyanate vapor at or near the ceiling value of 0.02 ppm has caused a progressive disabling illness characterized by breathlessness, chest discomfort and reduced pulmonary function. Massive exposure to high concentrations has caused, within minutes, irritation of the trachea and larynx and severe coughing spasms. Massive exposure may also lead to bronchitis, bronchial spasm and/or pulmonary edema.

A small percentage of the population can become sensitized to isocyanates. In these sensitized individuals, exposures to minute concentrations of isocyanates may lead to asthmatic attacks and respiratory distress.

Cadmium^{8,9} - Occupational exposure to cadmium, by inhalation, can result in acute or chronic poisoning. Acute cadmium poisoning is an inflammatory reaction in the lungs that can be fatal, but more often results in a mild, permanent decrease in lung function. Manifestations of chronic cadmium poisoning include yellowing of the necks of teeth, nasal discharge, loss of sense of smell, anemia, shortness of breath, gastrointestinal symptoms, metal disturbances, kidney dysfunction, soft tissue swelling, and bone pain.

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 Airborne Exposures Recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) for 1978.
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).

Substance	Source		
	NIOSH	TLV	OSHA
methyl ethyl ketone	200 ppm	200 ppm*	200 ppm
methyl isobutyl ketone	50 ppm	100 ppm	100 ppm
toluene	200 ppm	100 ppm	200 ppm
n-butyl acetate	-	150 ppm	150 ppm
cyclohexanone	25 ppm	50 ppm	50 ppm
trichloroethylene	100 ppm	100 ppm	100 ppm
ozone	-	0.1 ppm (0.3 ppm)	0.1 ppm
nitric acid	5 mg/M ³	5 mg/M ³	5 mg/M ³
sulfuric acid	1 mg/M ³	1 mg/M ³	1 mg/M ³
chromium (VI)	0.025 mg/M ³	0.05 mg/M ³	(0.1 mg/M ³)
total particulate weight	-	10 mg/M ³ **	15 mg/M ³
aluminum (fume)	-	5 mg/M ³	15 mg/M ³
silver	-	0.01 mg/M ³	0.01 mg/M ³
copper (fume)	-	0.2 mg/M ³	0.1 mg/M ³
oil mist	-	5 mg/M	5 mg/M

*Concentrations, in parts of substances per million parts of air (ppm), fibers per cubic centimeter fibers/cc, or milligrams of substances per cubic meter of air (mg/M³), 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.

Whenever possible, the NIOSH recommended standard will be the environmental criteria 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.

D. Evaluation Results and Discussion

1. Environmental

Atmospheric samples for various organic vapors were collected in the paint prep, priming, and spray booth areas. All concentrations of methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), toluene, n-butyl acetate, and cyclohexanone were below all evaluation criteria (Table 1).

Results of atmospheric sampling for various acid mists in the process (Anodize) line are shown in Table 2. Concentrations of nitric, sulfuric, and chromic acids were below all evaluation criteria. An atmospheric sample for trichloroethylene collected near the degreaser tank was also below all evaluation criteria.

Results of atmospheric sampling for oil mist in the machine shop are illustrated in Table 3. Concentrations of oil mist were below all evaluation criteria. A bulk sample of new oil was analyzed for the presence of nitrosamines. No nitriles or nitrosamines could be detected. The sensitivity of the analytical method for the presence of nitrosamines was 0.01 ug/ml of oil.

Results of atmospheric samples for various air contaminants in the welding booth and soldering room are illustrated in Table 4. Concentrations of total particulate, and aluminum, chromium (VI), silver, and copper were below all evaluation criteria. Seven direct reading measurements of ozone were collected during MIG (gas metal arc) welding. One sample was approximately 0.3-0.4 ppm, whereas 0.3 ppm is the permissible excursion above the Threshold Limit Value of 0.1 ppm as recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). Although the ACGIH intends for the excursions to be a "rule of thumb" guideline¹⁰, the result may indicate a potential overexposure exists during welding. This determination is based on the findings of another Health Hazard Evaluation (Report HE 78-32-507). Non-certified ozone detector tubes were used then simultaneously with a more accurate ozone analyzer, and the results were very compatible. Ozone concentrations above the evaluation criteria were found during gas metal arc (MIG) welding of aluminum metal - the same type of welding as used at Western Gear Corporation. Also, increasing the arc time during welding will increase the likelihood of ozone formation. During the survey at Western Gear, arc times involved were not as long as sometimes encountered.

2. Medical

Twenty-four employees were interviewed by the industrial hygienists using non-directed questionnaires. Eight workers related that they had health complaints which they thought were related to the work environment. Seven of these employees said they experienced skin problems occasionally when working either in the paint prep, process line or machine shop. None of the problems were observed by the interviewers, though. Previous problems were probably caused by not wearing personal protective clothing. The remaining employee also complained of eye soreness when working with paint.

V. RECOMMENDATIONS

a. Ventilation

Paint Shop - Ventilation measurements were taken in the Paint Shop at the three spray booths. The following table summarizes the results:

Air Velocity Measurements at Face of Spray Booths.

<u>Booth</u>	<u>Number of Readings</u>	<u>Range of Face Velocities (fpm)¹</u>	<u>Average Face Velocity (fpm)</u>	<u>Booth Face Dimensions (feet)</u>
1	54	10-280	80	20 L X 7 H
2	35	10-400	100	14 L X 7 H
3	25	60-400	170	10 L X 7 H

1-feet per minute.

Although environmental sampling did not indicate any problems here, booth performance could be improved. It is recommended that the air flow into a large paint booth be 100-150 cubic feet per minute per square foot of open area (CFM/ sq. ft.), which means an average air velocity of 100-150 fpm at the booth face (Figure 1)¹¹. The wide range of face velocities indicates "dead" areas exist in the booths, especially in Booths 1 and 2. This may be caused by clogged filters or ductwork. It was observed that paint buildup on the filters was greatest in the middle of the booths, resulting in the dead spot formations. Filters should be replaced more frequently in these locations.

The air supply from the wall grilles opposite the booths may be having an effect on booth performance by creating cross currents. The company may wish to lower the speed of the incoming air or experiment with the readjustment of the louvers to observe their effect on hood performance.

Two other observations are mentioned which should require corrective steps:

1. Non explosion proof lighting is fixed at only 21-22 inches from faces of paint booths.
2. A metal paint storage cabinet was not vented to outside the plant.
3. Manometers currently positioned on top of booths 2 and 3 to monitor the dry filter loading should be preferably placed on the booth sides for easier reading. Booth 1 should be equipped with a gauge if not already.

Welding Booth - The atmospheric samples for ozone taken near the MIG welder show a potential for overexposure to this gas. The canopy hood used now, while keeping contaminated air from welding processes from entering other areas, may draw this air past the breathing zone of welders. A smaller flanged hood, as illustrated in Figure 2, could be suspended from the ceiling or other location.¹¹ The ductwork should be flexible enough to move around the welding table. A capture velocity of 100 fpm is recommended at welding emission points. The canopy hood now used exhausts more air than needs to be, and thus an energy savings could be realized. The company should consider evaluating the potential ozone exposure further.

Soldering Room - The canopy hood under which soldering is conducted did not seem to be functioning properly during the survey nor is it the proper type to use. As designed, the hood would draw contaminated air past the solderer's breathing zone; the distance between the soldering point and hood should be decreased, with designs such as those illustrated in Figures 2 and 3 used as a basis for a local ventilation system.¹¹ Since cadmium, a highly toxic metal, is present in one of the solders used, it is very important to keep employee exposures to a minimum.

b. General

1. The respirator currently used for paint spraying is NIOSH approved for protection against "organic vapors". However, there is no protection afforded against dusts or mists of solid or liquid particles arising during the spraying. It is recommended that respirators for "paint, lacquer, and enamel mists - PLE", be used instead, as they will offer protection against organic vapors, dusts, and mists.

2. Employees pouring the polymeric isocyanate foam in the Food Service Department should avoid skin or respiratory contact with this substance. It contains 65% toluene di-isocyanate (TDI), a potent sensitizer of these areas of the body. The company should evaluate this operation periodically, possibly with direct reading indicator tubes as a screening method.

3. In the welding area, the compressed gas cylinders below the steps need to be secured.

4. In the "honing" operation of the machine shop, where small parts are cleaned by dipping them in mineral spirits, the use of bulky protective gloves has been minimal. It is recommended that the thinnest gauge neoprene or milled nitrile hand wear be chosen so that employees will use them there or at other needed locations. A NIOSH Publication on the control of exposure to metal working fluids is enclosed.

5. Although no health hazard from ammonia was observed in the blueprint copier area, the room should be ventilated properly. The compressed gas cylinder should be frequently tested for gas leakage.

VI. REFERENCES

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2. Gunter, B.: Health Hazard Evaluation Determination Report No. 76-23-319, Western Gear Corporation, Jamestown, N.D. U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, August, 1976.
3. Patty, F.A., Ozone. Industrial Hygiene and Toxicology. 2nd Ed., 1963. Interscience Publishers, New York. pp. 916.
4. Stokinger, H.E., Ozone Toxicology. Archives of Environmental Health, Vol. 10, 1965, pp. 719-731.
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7. Precautions for the Proper Usage of Polyurethanes, Polyisocyanates and Related Materials, Upjohn Chemical Division, Technical Bulletin 107, 1973.
8. National Institute for Occupational Safety and Health. Criteria for a recommended standard . . . occupational exposure to cadmium. HEW Publication No. (NIOSH) 76-192, 1976.
9. Metals and Metalloids, in Zenz C (ed): Occupational Medicine. Chicago, Year Book Medical Publishers, 1975, pp. 636-643.
10. Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio, 1978.
11. Industrial Ventilation - A Manual of Recommended Practice, American Conference of Governmental Industrial Hygienists, Lansing, Michigan, 1974.

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Table 1
Results of Personal Air Sampling for Organic Vapors

WESTERN GEAR CORPORATION
JAMESTOWN, NORTH DAKOTA

June 5 - 8, 1978

Date	Location	Job Title	Sample Number	Sampling Time(Hrs/Min)	Concentration (PPM)				
					Methyl Ethyl Ketone (MEK)	Methyl Isobutyl Ketone (MIBK)	Toluene	Butyl Acetate	Cyclohexanone
6/6	Spray Booth 1	Painter	CT2	5/36	1	0.2	0.2	N.D.	N.D.
"	" " 3	Painter	CT1	6/24	0.7	0.3	0.5	N.D.	N.D.
6/7	" " 2 & 3	Painter	CT7	4/28	N.D.	N.D.	N.D.	N.D.	N.D.
"	" " "	Painter	CT12	3/43	0.9	N.D.	N.D.	N.D.	N.D.
"	Paint Prep	Prep Worker #1	CT 3	4/0	0.2				
"	" "	" "	CT 9	4/18	9				
"	" "	" " #2	CT 4	4/12	1				
"	" "	" " "	CT 8	4/0	7				
"	" "	" " #3	CT 6	4/19	0.3				
"	" "	" " "	CT11	3/55	12				
"	Primp Dept.	" "	CT 5	4/42	1				
"	" "	" "	CT10	5/35	0.3				
"	Spray Booth 2	Painter	CT14	3/55	1	N.D.	0.4	N.D.	N.D.
"	" " "	" "	CT22	3/53	1	N.D.	--	N.D.	N.D.
"	Paint Prep/Primp Dept.	Prep Worker 1	CT13	4/0	5				
"	" "	" "	CT18	4/05	1				
"	" "	Prep Worker 2	CT15	4/03	6				
"	" "	" "	CT20	3/52	1				
"	Primp Dept.	Prep Worker 3	CT17	4/02	3				
"	" "	" "	CT19	4/01	2				
"	" "	" "	CT16	3/56	3				
"	" "	" "	CT21	4/09	1				

I PPM = Parts of organic vapor per million parts of air by volume

EVALUATION CRITERIA

NIOSH
TLV
OSHA

-- -- 200ppm -- --
200 ppm 100ppm 100 " 150ppm 50 ppm
200 ppm 100ppm 200 " 150 " 50 "

Table 2

Results of Personal Air Sampling for Various Air Contaminants
in the Process LineWestern Gear Corporation
Jamestown, N. D.

June 5 -8, 1978

Date	Job Title or Location	Sampling Time (hrs./min.)	Concentration ¹ (mg/M ³)			
			Nitric Acid	Sulfuric Acid	Chromium (VI)	Trichloro- ethylene
6/7	Anodizer #1	3/46	0.01 mg/M ³			
"	"	4/25	0.03 mg/M ³			
"	Anodizer #2	3/50	0.01 mg/M ³			
"	"	4/16	0.03 mg/M ³			
"	Anodizer #3	4/0	0.03 mg/M ³			
"	"	4/20	0.13 mg/M ³			
"	Anodizer #1	8/11			N.D. ²	
"	Anodizer #2	8/10			N.D.	
"	Anodizer #3	8/15			N.D.	
6/8	Anodizer #1	4/02	0.03 mg/M ³			
	Anodizer #2	4/47	0.03 mg/M ³			
	Anodizer #3	4/39	0.01 mg/M ³			
6/8	Anodizer #1	6/06		N.D.		
"	Anodizer #2	7/52		N.D.		
"	Anodizer #3	6/42		N.D.		
"	Near Degreaser	8/0				3 mg/M ³

1. mg/M³ = milligrams of substance per cubic meter of air

2. N.D. = nondetectible

Evaluation Criteria:

NIOSH	5 mg/M ³	1 mg/M ³	0.025 mg/M ³	100 ppm
OSHA	"	"	0.05 mg/M ³	"
TLV	"	"	(0.1 mg/M ³)	"

TABLE 3
Results of Personal¹ Air Sampling for Oil Mist

Western Gear Corporation
Jamestown, North Dakota

June 5-8, 1978

Date	Location	Job Title	Sample Number	Sampling Time (hrs./min.)	Concentration (mg/M ³) ²
6/7	Machine 0830D	Machine Operator	14	7/53	0.3
6/7	Machine 0830E	Machine Operator	8	7/52	0.1
6/7	Machine 57B	Machine Operator	1	7/43	0.5
6/7	Machine 55D	Machine Operator	11	7/36	0.3
6/7	Machine 24B	Machine Operator	13	7/53	1.5
6/7	Machine 0857A	Machine Operator	2	7/19	0.3
6/7	Machine 0824A	Machine Operator	3	7/09	0.2
6/8	Machine Mill(vert.)	Machine Operator	4	7/42	0.2
6/8	Machine 0855D	Machine Operator	20	7/40	0.2
6/8	Machine 0830E	Machine Operator	30	7/58	0.1
6/8	Machine 0857B	Machine Operator	24	7/36	0.2
6/8	Machine 0856A	Machine Operator	31	7/32	0.1
6/8	Between Machines 0824B & 0856B	Machine Operator	7	7/29	0.1

1. with one exception - sample #7 is an area sample
2. mg/M³ - milligrams of oil mist per cubic meter of air

Evaluation Criteria

OSHA
TLV
NIOSH

5 mg/M³
5 mg/M³
-

Table 4

Results of Personal Air Sampling for
Welding or Soldering EmissionsWESTERN GEAR CORPORATION
JAMESTOWN, NORTH DAKOTA

JUNE 5 - 8, 1978

DATE	JOB TITLE	SAMPLE NUMBER	SAMPLING TIME (Hrs./Min. or Actual Time)	CONCENTRATION ¹					
				OZONE	TOTAL PARTICULATES	ALUMINUM	CHROMIUM (VI)	SILVER	COPPER
6/7	Welder	D8-437	7/55		0.6 mg/M ³	0.02 mg/M ³			N.D. ²
"	"	D8-570 ₃	7/55				N.D.		
"	"	DT-1	2:00 pm	0.05ppm					
6/8	Solderer	D8-445	7/58						
"	Welder	D8-441	7/45		0.4 mg/M ³	N.D.		N.D.	
"	"	D8-572	7/45				N.D.		N.D.
"	"	DT-2	8:25 am	0.07ppm					
"	"	DT-3	8:35 am	0.05 "					
"	"	DT-4	10:30 am	0.3-0.4ppm					
"	"	DT-5	1:05 pm	N.D.					
"	"	DT-6	1:20 pm	N.D.					
"	"	DT-7	2:50 pm	0.1 ppm					

1 mg/M³ = Milligrams of substance per cubic meter of air

ppm = Parts of substance per million parts of air by volume

2 N.D. = Non detectible

3 = Detector tube samples taken outside of welding helmet near breathing zone.

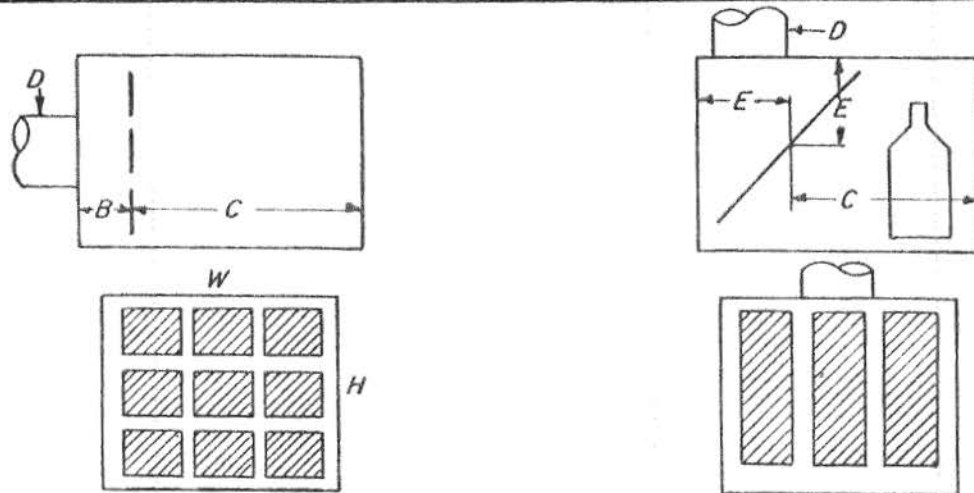
Evaluation Criteria:

NIOSH

TLV

OSHA

--	--	--	0.025mg/M ³	--	--
0.1ppm(0.3)	10 mg/M ³	5 mg/M ³	0.05 "	0.01mg/M ³	0.2mg/M ³
0.1 ppm	15 "	15 "	(0.1 ") "		0.1"



1. Split Baffle or Filters

$$B = 0.75 D$$

$$\text{Baffle or filter area} = 0.75 WH$$

Filter combustibility Class 2 or better.

Consult AIA or insurance underwriters

Air spray paint design data

Any combination of duct connections and baffles may be used. Large, deep booths do not require baffles. Consult manufactures for water-curtain designs. Use explosion proof fixtures and non-sparking fan. Electrostatic spray booth requires automatic high-voltage disconnects for conveyor failure, fan failure or grounding.

Walk-in booth

$$W = \text{work size} + 6'$$

$$H = \text{work size} + 3' \text{ (minimum} = 7')$$

$$C = \text{work size} + 6'$$

$$Q = 100 \text{ cfm/sq ft booth cross section}$$

May be 75 cfm/sq ft for very large, deep, booth. Operator may require approved respirator.

$$\text{Entry loss} = \text{Baffles: } 1.78 \text{ slot VP} + 0.50 \text{ duct VP}$$

$$= \text{Filters: Dirty filter resistance} + 0.50 \text{ duct VP}$$

$$\text{Duct velocity} = 1000-2000 \text{ fpm}$$

Operator outside booth

$$W = \text{work size} + 2'$$

$$H = \text{work size} + 2'$$

$$C = 0.75 \times \text{larger front dimension}$$

$$Q = 100-150 \text{ cfm/sq ft of open area, including conveyor openings.}$$

Airless spray paint design

$$Q = 60 \text{ cfm/sq ft booth cross section, walk-in booth}$$

$$= 60-100 \text{ cfm/sq ft of total open area, operator outside of booth}$$

Note: Baffle arrangements shown are for air distribution only. Filters and/or other air cleaning devices may be required to meet air pollution codes or local conditions.

For construction and safety requirements consult NFPA⁽¹¹³⁾

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LARGE PAINT BOOTH

DATE

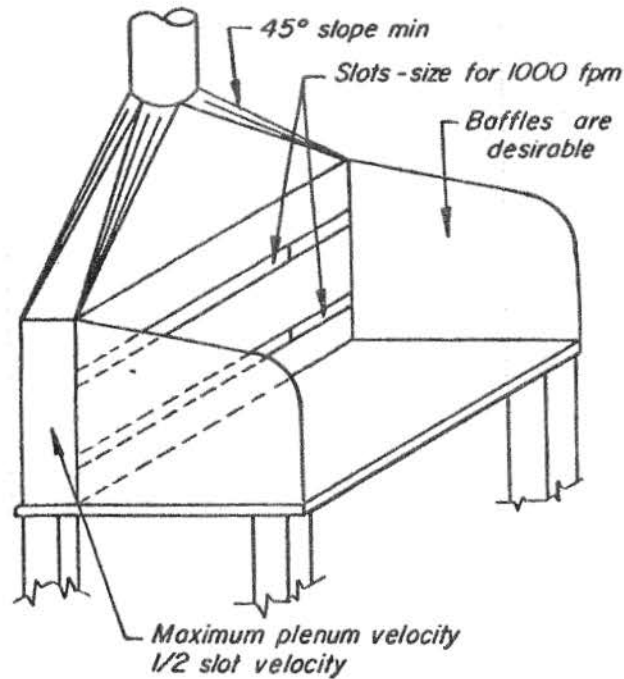
1-74

VS-603

Figure 2

5-52

INDUSTRIAL VENTILATION



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

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

$Q = 100 \text{ cfm/sq ft of face opening}$

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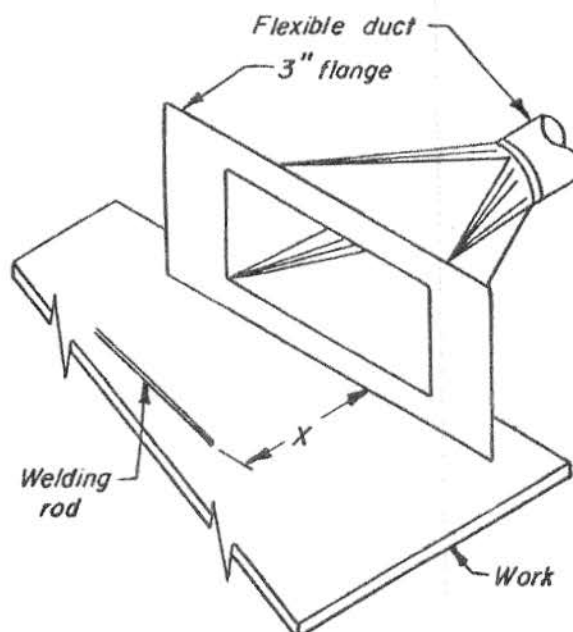
WELDING BENCH

DATE 1-74

VS-416

Figure 3
SPECIFIC OPERATIONS

5-53



PORTABLE EXHAUST

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

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:

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

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