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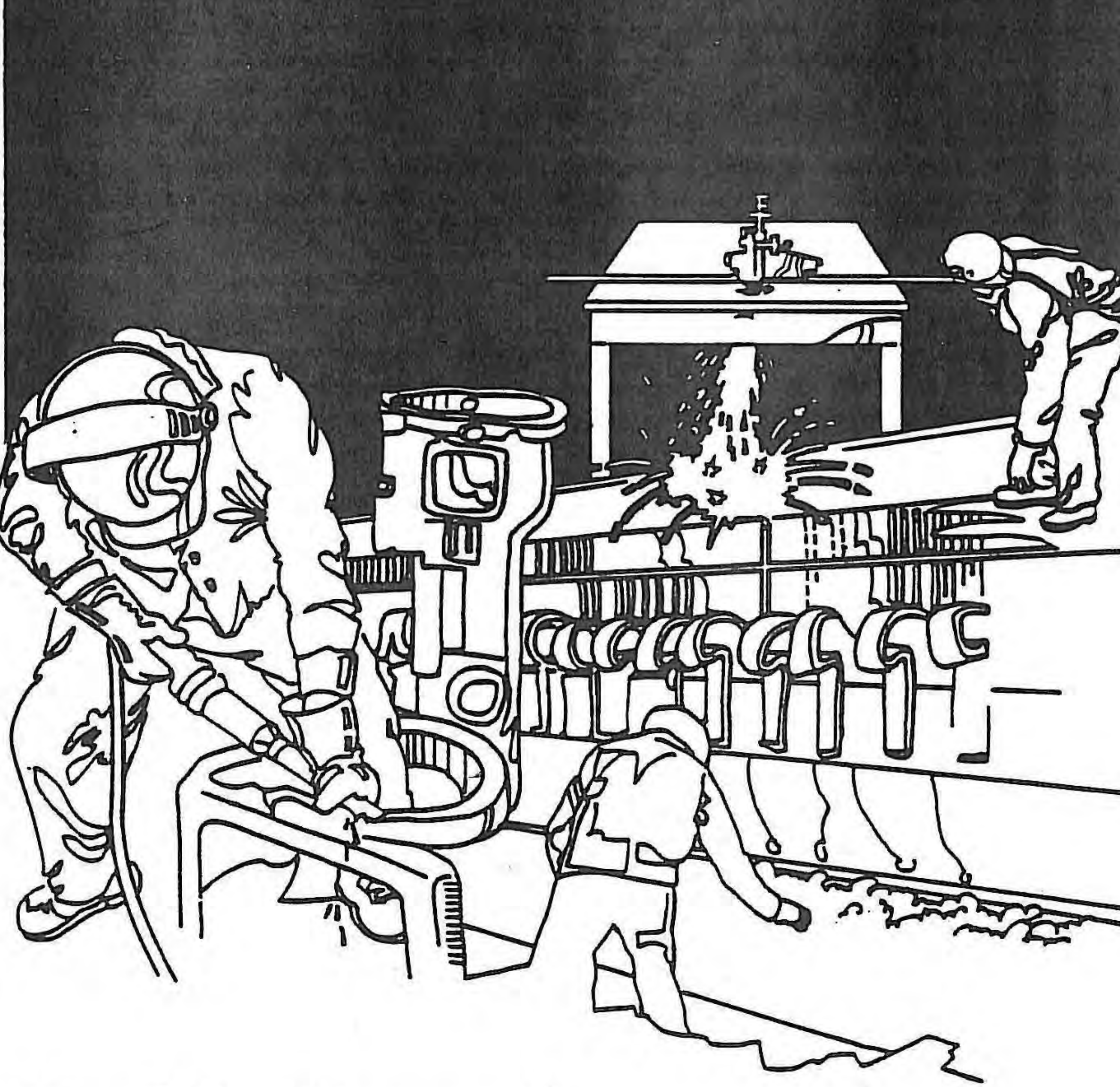
NIOSH



Health Hazard Evaluation Report

HETA 85-030-1693
FRUEHAUF CORPORATION - PARTS PLANT
DELPHOS, OHIO

HETA 85-030-1693
MAY 1986
FRUEHAUF CORPORATION - PARTS PLANT
DELPHOS, OHIO

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I. SUMMARY

On October 24, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a joint request from representatives of both union and management to evaluate exposures at the Fruehauf Corporations Parts Plant in Delphos, Ohio during welding operations. Worker complaints of eye irritation, nausea, and headaches were reported in the request and were believed to be associated with welding activities. An evaluation of the painting shop was also requested during the initial NIOSH survey.

An initial walk-through survey was conducted on December 11-12, 1984 at which time a medical questionnaire was also administered to 33 welders. A followup industrial hygiene survey was conducted on February 25-27, 1985 and included evaluations of exposures during welding and painting operations. Air samples, collected during welding operations, were analyzed for total welding fume, metals, carbon monoxide, oxides of nitrogen, and ozone.

Total welding fume concentrations in thirty-two personal breathing zone (under the helmet) samples ranged from 1.5 to 23.4 milligrams per cubic meter (mg/m^3) with a mean of 8.6. Nine area samples ranged from 0.4 to 3.7 mg/m^3 with a mean of 2.4. Three sample results exceeded the OSHA standard of 15 mg/m^3. However, twenty-four of 32 (75%) sample results exceeded the ACGIH TLV of 5 mg/m^3.

Since welding was on mild steel using a copper-coated electrode, iron was the predominant metal found. Measurable quantities of aluminum, copper, magnesium, manganese, molybdenum, nickel, lead, tin, and vanadium were detected; however, only one sample for copper (163 ug/m^3) and one sample for manganese (1060 ug/m^3) were above applicable exposure criteria (OSHA PEL of 100 ug/m^3 for copper and ACGIH TLV of 1000 ug/m^3 for manganese). Chromium was detected in eight air samples ranging in concentration from 2 to 35 ug/m^3. Further evaluation was recommended to confirm the valence state of the chromium. Chromium in the +6 valence state, insoluble form, is considered to be carcinogenic. The majority of chromium from the type of welding evaluated, however, would be expected to be in the +3, non-carcinogenic, valence state.

Evaluation of the paint shop did not detect concentrations of organic vapors in excess of applicable criteria; but, a number of major deficiencies such as open-air, table-top spraying, unvented dip tanks, and an unvented automatic spraying machine were noted.

A standardized medical questionnaire was completed by 33 randomly selected welders, and additional information was obtained from interviews with others. The questionnaire results demonstrated a relatively high prevalence of reported symptoms of mucous membrane and respiratory tract irritation, including eye irritation (67% of respondents), sinus/nasal congestion (64%), headaches (61%), throat irritation (61%), and cough (60%). The questionnaire also demonstrated a high prevalence of reported cigarette smoking (72%) among the welders, but the high frequency of symptoms cannot be attributed to this factor alone. The welding lines reporting the highest symptom prevalences were department 27 (spring hangers) and department 21 (off-line parts).

Exposures to welding fumes and paint vapors were determined to be potential health hazards and were causing at least short-term health effects. Recommendations aimed at reducing the potential for long-term health effects through using standard local exhaust techniques are presented in Section IX of this report.

KEYWORDS: SIC 3549 (Metalworking Machinery); SIC 3715 (Truck Trailers), welding fume, metals, carbon monoxide, painting, oxides of nitrogen, ozone.

II. INTRODUCTION

In October, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a joint request from representatives of both union (AIWA, Local 259) and management at Fruehauf Corporation - Parts Plant, Delphos, Ohio to evaluate exposures during welding operations. The request cited that employees were complaining of eye irritation, nausea and headache due to excessive exposure to welding fumes.

A NIOSH industrial hygienist and a medical officer conducted an initial survey on December 11-12, 1984, which included a walk-through of the plant and the administering of a standardized questionnaire to a random selection of workers categorized as welder-burners. The paint shop was also visited, as requested after the initial request was received. A detailed account of the activities during this initial survey with several preliminary recommendations was provided to the requestors by letter, dated January 2, 1985.

A followup industrial hygiene survey was conducted on February 25-27, 1985, during which time exposures to emissions during welding and painting were evaluated. Air samples collected during welding activities were analyzed for total welding fume, metals, carbon monoxide, oxides of nitrogen, and ozone. Some results from this survey were reported in a letter dated June 14, 1985. This letter identified several significant deficiencies in the painting operation and provided a number of recommendations regarding both the painting and welding operations, including the recommendation to use local ventilation where feasible to control welding fumes.

An interim report which provided and discussed all of the medical and industrial hygiene data was forwarded in January 1986.

III. BACKGROUND

Although enlarged over the years, the plant has been at its current location for 30 years. Primary welding activity centers around the production of trailer parts and a military, armored-car type vehicle. There is some robotic welding but most is still individual welding. The majority of welding is classified as metal-inert-gas (MIG) on mild steel. The shielding gas is 80% Argon/20% CO_2 and is piped where needed via distribution lines from bulk storage tanks. The copper-clad steel wire (.045 inches diameter) is on reels and automatically fed to the welding gun as needed. Approximately 50% of welding is done at 220-240A and 50% at 240-300A. The wire used in the automatic welding machines is not coated and is .052 inches in diameter. Very rarely, stainless steel and galvanized metal may be welded on, but neither was present during this evaluation. In the past, the number of hourly workers peaked at 373. During this survey there were 232 hourly workers, of which 92 (40%) were classified as welders. These workers manned two shifts, with the majority (190) being assigned to the first (day) shift.

Following welding in the production area, the products are painted in a separate paint shop located next to the main production building.

IV. METHODS

A. Environmental (Welding Operations)

1. Total Welding Fume

Forty-one air samples (32 personal breathing zone and 9 area) were collected on pre-weighed PVC filters at a flow rate of 1 liter per minute (LPM) and analyzed for total particulate. The personal breathing zone (PBZ) samplers were placed to ensure, to the extent possible, that they were under the welding helmet during actual welding activity.

2. Metals

The 41 air samples collected for total welding fume analysis were also analyzed for each of 27 metals using NIOSH method 7300. Sample filters were digested and prepared for analysis by inductively coupled plasma (ICP) emission spectrometry.

3. Carbon Monoxide

The presence of carbon monoxide (CO) in the welding environment was evaluated using both long and short-term Draeger® detector tubes. All samples (7 long-term and 5 short-term) were obtained near welding activity but not in the immediate vicinity of a welding arc.

4. Oxides of Nitrogen

Sixteen air samples were obtained on sorbent tubes at a sampling rate of 200 cubic centimeters per minute (cc/min) and analyzed by visible spectrometry in accordance with NIOSH method P&CAM 231.

5. Ozone

The presence of ozone in the welding environment was evaluated using short-term detector tubes manufactured by Drager®.

B. Environmental (Painting Operations)

Eight air samples (4 PBZ and 4 area) for organic vapors were collected on activated charcoal sorbent tubes at sampling rates from 100 to 500 cc/min and analyzed using gas chromatography and mass spectrometry techniques.

C. Medical

The medical component of the investigation consisted primarily of having the employees complete a standardized questionnaire. This was administered to a random selection of employees who were classified as welders in the personnel records. Thirty-three of 90 welders completed the questionnaire. Twenty-eight of these were selected from the 81 day-shift welders and 5 were from among the 9 evening shift welders. All of those interviewed were potentially exposed to welding fumes and there was no comparison group.

The questionnaire obtained demographic information, a brief occupational history, smoking history, a brief pulmonary history, and a survey for the prevalence, within the preceding three months, of 18 symptoms with an estimation of their work-relatedness. The symptoms assessed were: sinus/nasal congestion or irritation, ulcerated nasal septum, epistaxis [nosebleeds], metallic taste, throat irritation, headaches, lightheadedness/dizziness, fatigue, chills/fever, eye irritation, skin irritation, wheezing/difficulty breathing, chest pain/tightness, shortness of breath, cough, phlegm, anorexia [loss of appetite], and nausea/vomiting.

Several additional workers who wished to volunteer information and who had not been selected in the random sample to complete the questionnaire were also interviewed. Information from these individuals was not included in the numerical analysis. Finally, the company's current medical program and procedures were reviewed.

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

B. Welding Fumes

Welding fumes cannot be classified simply since the composition and quantity of welding fume, and, therefore, the potential health effects, are dependent on the alloy being welded, the process, and the electrode used. During this evaluation, the predominant form of welding was on mild steel using a copper-coated steel electrode. The fumes from this type of welding are known to contain iron, in the form of iron oxide, as the major metallic constituent. Since welding fume particles are virtually all smaller than 1.0 micrometer(1) and can therefore penetrate deep into the respiratory system, lung effects are of concern. In fact, inhalation of iron oxide fume may cause a benign pneumoconiosis (siderosis) that can result in structural or functional alterations in the lung.(2,3) At least two in vitro mutagenicity studies(4,5) and an extensive review of world literature on the subject have concluded that iron oxide is not carcinogenic(6).

In addition to iron oxide, welding on mild steel can also result in the emission of ozone, oxides of nitrogen, and carbon monoxide. Overexposure to ozone can cause headache, upper respiratory irritation, chest pain, cough, and pulmonary irritation. Excessive exposure to oxides of nitrogen has been shown to cause such toxic effects as irritation of the eyes, nose, and throat, headache, cough, pulmonary impairment, and emphysema.(7) Exposure to carbon monoxide can cause nausea, vomiting, dizziness, drowsiness, myocardial changes, and pulmonary edema.(8)

It should also be noted that welding fumes can contain certain metals that may cause cancer in humans. These include nickel, arsenic, chromium, cadmium, and beryllium. While carcinogenic potential may not be high for the type welding evaluated in this study, welders should remain keenly aware that welding fume can contain carcinogens, depending on the specific type of welding.

There are two comprehensive review documents on the subject of exposures from welding.(1,9) These documents should be consulted for further information on the characteristic of emissions from numerous types of welding, brazing and cutting and the potential health effects that have been associated with these emissions.

The following table lists applicable exposure criteria for some of the substances evaluated during this welding study that were considered to be potentially the most significant:

Substance	Exposure Criteria
Total Particulate	5 mg/m^3 (ACGIH)
	15 mg/m^3 (OSHA)
Carbon Monoxide	50 ppm (OSHA)
	35 ppm (NIOSH)
	50 ppm (ACGIH)
Oxides of Nitrogen (Nitric Oxide)	25 ppm (OSHA)
	25 ppm (NIOSH)
	25 ppm (ACGIH)
Ozone	0.1 ppm (OSHA)
	0.1 ppm (ACGIH)

VI. RESULTS

A. Environmental (Welding)

1. Total Welding Fumes

Results are presented in Table I. The 32 PBZ welding fume samples ranged from 1.5 to 23.4 mg/m^3 (mean=8.6 mg/m^3). The nine area samples ranged from 0.4 to 3.7 mg/m^3 (mean=2.4 mg/m^3). For reference, applicable exposure criteria include an OSHA standard of 15 mg/m^3 and an ACGIH TLV of 5 mg/m^3. NIOSH has not, as yet, issued a recommended exposure level for total welding fume. Seventy-five percent of the PBZ samples exceeded the ACGIH TLV of 5 mg/m^3. Three of these also exceeded the OSHA standard.

2. Metals

Results for those metals detected are also presented in Table 1. With the exception of a few samples, discussed below, all were below applicable criteria. One sample for copper (163 ug/m^3), from a welder on the V-300 line, exceeded the OSHA PEL of 100 ug/m^3. One sample for manganese (1060 ug/m^3) on a welder working in Dept. 21, Spring Chair, exceeded an ACGIH TLV of 1000 ug/m^3. One sample for iron oxide (10,204 ug/m^3) on a welder working on the Dolly line, weld-out exceeded the OSHA PEL of 10,000 ug/m^3. Seven samples for iron oxide (reported as iron) exceeded the ACGIH TLV of 5000 ug/m^3 and ranged from 5303 to 10,204 ug/m^3.

Chromium was detected in 8 of 41 air samples and ranged in concentration from 2 to 35 ug/m^3. Seven of these samples were on V-150 welders. The other was from a V300 welder. Chromium can be present in either of two valence states (CrIII or CrVI). The insoluble form of CrVI is considered to be carcinogenic. Although the predominant form of chromium from welding, as evaluated, would not be expected to be the carcinogenic form, a recommendation is make in Section VII to further evaluate this issue.

3. Carbon Monoxide

Both short and long-term sampling results are shown in Table 2. All samples were obtained near a welding operation but not in the immediate vicinity of a welding arc, therefore, exposure to welders may have been higher than indicated in Table 2. Carbon monoxide concentrations in seven long-term samples averaged 19 ppm and ranged from 3 to 56 ppm. In five short-term samples, they averaged 30 ppm and ranged from 10 to 80 ppm. The OSHA standard for CO is an 8-hour TWA of 50 ppm and the NIOSH recommended standard is an 8-hour TWA of 35 ppm.

4. Oxides of Nitrogen

Of the 16 air samples analyzed for nitric oxide and nitrogen dioxide, only one was positive. This 15-minute sample, from the breathing zone of a welder inside of and welding on an armored car in the finishing area, represented a worst case situation and detected nitric oxide at a concentration of 6 ppm. The OSHA standard and NIOSH recommended standard for nitric oxide are both 25 ppm. The lower detection limit for the method used was 3 ppm for both nitric oxide and nitrogen dioxide.

5. Ozone

No ozone was detected on any of the four samples obtained using 10 strokes on a Drager® detector tube (cat. no. CH31301). The lower detection limit was 0.05 ppm. The four samples were obtained at the following locations: inside armored vehicle, breathing zone of T-hanger welder, breathing zone of V300 welder, breathing zone of vertical stand welder.

B. Environmental (Painting)

Eleven organic vapors were identified and quantitated in the work environment during spray painting operations (Table 3). Other organic vapors, which were primarily C_7-C_{12} alkanes and C_9-C_{10} alkyl substituted benzenes, are reported as total hydrocarbons. None of the individual organic vapors were detected above their respective exposure criteria. However, the TLV for mixtures was exceeded in the main paint booth. A number of significant deficiencies were noted. These included:

1. Lack of an effective exhaust system on the flow-coater.
2. U-bolt and small parts dip tanks were not ventilated.
3. Open-air, table-top spraying.
4. Lack of use of the airline equipment in the paint booth(s).
5. The source of breathing air for the airline hoods was located in another building. It appeared to be a standard industrial type oil-lubricated compressor. There were no high temperature or carbon monoxide alarms on the distribution panel in the painting area as recommended by the manufacturer of the supplied-air distribution system.

C. Medical

Thirty-three welders completed the questionnaire; they represented the day and evening shifts. All were classified as welders, and all welding lines except dolly (#17) and slide frame (#18) were represented. The lines with the greatest representation were spring hangers (#27) and off-line parts (#21), with 11 and 7 respondents, respectively.

Respondents ranged in age from 24 to 59 years old, with a mean of 33 years (standard deviation=9.4) and a median of 29 years. Their tenure at Fruehauf ranged from 18 months to 24 years, with a mean of 8.7 years (s.d.=5.1) and a median of 7.1 years. Their time as welders ranged from 1 month to 30 years, with a mean of 7.7 years (s.d.=6.6) and a median of 7.0 years. All respondents were males. Twenty-four (75%) of the 32 who answered to the question regarding smoking had a history of smoking, and 21 (72%) of the 29 who answered this question were current smokers.

Four (12%) welders reported having had at least one past episode of metal fume fever [a self-limited, acute syndrome of delayed onset, often seen in welders and typified by metallic taste, respiratory tract irritation, cough, fatigue, aches, chills, and fever]. Four (12%) reported having had pneumonia or tuberculosis in the past. Two (6%) reported having had asthma, and four (12%) reported having been diagnosed as having some form of chronic obstructive pulmonary disease. The most frequently reported symptoms in the prevalence survey (Table 4) were as follows: eye irritation (67% of respondents), sinus/nasal congestion (64%), headaches (61%), throat irritation (61%), and cough (60%). Production of phlegm (45%), wheezing or difficulty breathing (42%), and epistaxis (39%) were also reported frequently. Anorexia (6%), skin irritation (6%), chills/fever (9%), and ulcerated nasal septum (9%) were rarely reported. When symptoms were grouped in categories, at least one symptom of mucosal irritation was reported by 94% of respondents, at least one respiratory tract symptom was reported by 82%, and at least one constitutional/generalized symptom by 67%.

Symptom prevalences were also assessed according to the respondent's perception of work-relatedness, i.e., whether the symptom was associated with or exacerbated by the work environment (Table 1). Although the prevalences of work-associated symptoms were lower, they tended to follow a pattern similar to that outlined above. The most frequently reported work-related symptoms were: eye irritation (39%), headache (30%), and throat irritation (24%). The least common work-related symptoms were anorexia, skin irritation, and chills/fever, none of which were associated with the work environment by any respondent.

Because of the high prevalence of cigarette smoking among the respondents, we assessed the effect of this factor on symptom occurrence by comparing prevalences among current smokers and nonsmokers. There were higher prevalences among smokers only for the following symptoms: wheezing (relative risk [RR]=4.57), chest tightness (RR=1.52), cough (RR=1.78), and phlegm production (RR=2.29). The higher prevalence among smokers was statistically significant ($p<0.05$) only for wheezing ($p=0.04$, Fisher's exact test). Cigarette smokers also reported a higher mean number of symptoms per person (7.2) than did nonsmokers (5.6), which was not statistically significant ($t=.932$, $df=27$; $p>0.10$).

Finally, we assessed symptom prevalences according to the welding line on which the respondent worked (Table 5). The mean number of reported symptoms/person on the line ranged from 4.5 (s.d.=1.9) for department 23 (V-150 commando) to 7.4 (s.d.=3.7) for department 27 (spring hangers) [although the single respondent from department 25 (burn table) reported 8 symptoms]. The line with the second greatest mean number of symptoms was department 21 (off-line parts), whose members reported a mean of 6.9 symptoms/person.

VII. DISCUSSION

The symptom prevalences reported by the welders who completed the questionnaire demonstrate relatively high occurrence rates for a number of symptoms. Although the reported frequencies decreased when association with work was elicited, several symptoms retained relatively prominent prevalences that were explicitly associated with the work environment. These included eye irritation, headaches, and throat irritation. Also, a work-associated prevalence of epistaxis [nosebleeds] of 18% is worthy of note. The high rate of cigarette smoking in this group makes interpretation of some of these results more difficult. Nevertheless, to the extent that we could compare smokers and nonsmokers, smoking seemed related to increase symptom prevalences only of respiratory symptoms and not of symptoms of mucosal irritation (like eye or throat irritation) or constitutional symptoms (like headaches). Thus, it would be inappropriate to attribute all of the high symptom prevalences to smoking.

The lines with the highest prevalences of symptoms were #27 (spring hangers) and #21 (off-line parts). These results only partly coincided with those departments with the highest levels of environmental contaminants, but the numbers of samples and respondents involved are fairly small so this would not be unexpected. Also, the spring hangers line was mentioned in several of the informal conversations as being an area of particular concern.

The majority of welding at this plant is MIG on mild or carbon steel. This is of importance since emissions of significant amounts of highly toxic metals would not be expected. The welding of galvanized or stainless steel parts, or of mild steel parts that have surface coatings (paint or oil), introduces other potentially toxic emissions. Workers complained of irritation at this plant when welding on oil-coated parts that were not effectively cleaned in the washing process. Acrolein, a potent irritant, has been found in emissions from welding on oil-coated mild steel.

Considering the type and extent of welding, the most appropriate overall exposure criterion for comparison would be the ACGIH TLV of 5 mg/m^3 for total welding fume particulate. There were a few samples that exceeded other criteria, as discussed in Section IV; however, complying with the 5 mg/m^3 would also reduce the concentrations of the individual metals to below their respective criteria. Twenty-four of the 32 PBZ samples for total welding fumes exceeded 5 mg/m^3 using under-the-helmet sampling techniques. Background concentrations of welding fume were found to be as high as 3.7 mg/m^3 in the vertical support area. The most effective means of control is a properly designed and well maintained local exhaust system.

There is epidemiologic evidence that smoking further increases the risk of long-term lung disease. Smokers should be advised of this risk and counseled accordingly.

VIII. CONCLUSIONS

Based on the results of the industrial hygiene and medical data evaluated, we concluded that exposures to welding fumes and paint solvent vapors are potential health hazards and were causing at least short-term health effects. Long-term health effects are not easily evaluated, but the risk of long-term effects can be minimized by reducing exposures. Data thus far have been obtained during cold weather when exposure potential is the highest.

IX. RECOMMENDATIONS

A. Welding Operations

1. Welding fume exposures should be controlled by the use of local ventilation where feasible. Emission from stationary welding operations (i.e., bench top) can be controlled either via bench hoods or a more portable flanged hood connected to flexible ducts. Illustrations of both systems (VS-416, VS-416.1), which were extracted from ACGIH's 18th Edition of Industrial Ventilation, are shown in Appendix A. Non-stationary welding operations can be controlled by a flanged hood/flexible duct system similar to VS-416.1 but on a counter-balanced arm to facilitate the positioning of the hood for most efficient fume capture. There are also low-volume, high-velocity exhaust systems that are compatible with some types of welding. The American Welding Society (550 N. Leuene Road, Miami, Florida 33126) may have more information on this technique regarding specific application needs and can be contacted by calling (305) 443-9353.

An effective local exhaust system requires good design and maintenance. The system in place at the time of the survey was not properly designed or maintained, and it serviced only a portion of the welding work station.

2. The use of appropriate respirators for protection against welding fumes should not be used as a long-term control measure. They can provide protection for specific short-term tasks, or as an interim measure, but only those types certified by NIOSH should be used. (Respirator supply houses will be able to advise you on which types they stock that have NIOSH certification.) The use of respirators will require a complete respirator program which includes all the provisions of OSHA Standard 1910.134.

B. <u>Painting Operations</u>

1. The main paint spray booth should be upgraded to provide adequate air movement. The enclosed illustration (VS-606) in Appendix A provides design guidelines. Note that if paint systems are adaptable to airless spray painting technique, the volume of air movement necessary can be reduced by as much as 40% due to less overspray.

2. Due to the number of different solvents used and the spray tasks required, use of the airline hoods in the main spray booth should be mandatory. Increasing the air movement in the booth should help reduce buildup of paint overspray on the "tear-off" face shields.

3. The breathing air delivery system should be inspected carefully to insure compliance with OSHA Respiratory Air Regulation 1910.134(d). Specifically, a CO monitor which is offered as an option by the manufacturer (Dynamation) of the breathing air system, should be included along with the other filters in the Filter Purifying Panel on the wall of the paint booth.

4. The flow-coater exhaust system should be repaired to maintain a negative pressure in the spray and drying compartments. The spray compartment is now under positive pressure due to the compressed air from the revolving spray nozzles. The intended exhaust has not been connected to the top of the spray unit. There are numerous other problems with this unit. If the spray coater cannot be repaired to work properly, it should be taken out of service and the parts sprayed in the main paint booth.

5. The paint dipping operations should be serviced by adequate local exhaust systems. The table-top spraying should be accomplished in a spray booth.

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XII. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. Health and Safety Director, AIWA
2. President AIWA, Local 259
3. Manager, Industrial Relations, Fruehauf-Parts Plant
4. NIOSH, Region V
5. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1
Total Welding Fume Particulate and Metals
Fruehauf Corporation
HETA 85-030
February 26-27, 1985

Location/Job	Sample Type(2)	Sample Time	Total Particulate (mg/m^3)	Metals (ug/m^3)(3) AL	B	CA	CR	CU	FE	MG	MN	MO	NI	PB	SN	V	ZN
V-150, welder	P	0714-1510	5.1	17	*(4)	30	2	46	2394	9	268	15	4	*	*	*	10
V-150, welder	P	0718-1507	5.2	26	24	54	2	46	2143	14	243	14	4	*	*	*	24
V-150, welder	P	0718-1523	6.5	28	*	69	4	58	2958	16	254	23	4	*	*	*	14
Dept. 21, between dolly and com. assem.	A	0842-1525	2.5	*	*	37	*	13	1100	12	112	*	*	*	*	*	4
V-150, tack-up	P	0721-1515	6.3	31	*	52	2	62	2817	12	338	24	4	*	*	*	13
V-150, welder	P	0724-1510	7.9	36	*	67	2	77	3428	16	429	24	5	*	*	*	16
V-150, welder	P	0727-1505	4.4	*	*	34	*	43	1857	9	243	11.1	2.6	*	*	*	16
V-150, (wire brushing)	P	0853-1518	23.4	152	25	433	35	30	7000	113	183	25	9	*	*	3	35
V-150, welder (finishing)	P	0728-1515	4.1	23	*	57	3	30	1571	16	104	12	3	*	*	*	20
V-150, welder (finishing)	P	0729-1515	6.4	14	*	43	*	54	2143	19	329	17	2	*	*	*	20
T-Hanger, welder	P	0750-1510	8.5	23	*	77	*	45	4091	15	348	6	2	*	*	*	8
V-150, by tumbler	A	0821-1525	2.6	28	*	39	*	19	1156	9	63	9	2	*	63	6	8
Dept. 21, shock absorber, welder	P	0752-1515	12.9	*	*	27	*	48	6818	6	767	4	*	*	*	*	4.5
V-150, welder	P	0725-1515	1.9	*	16	19	*	16	771	7	101	5	2	*	*	*	5
Dept. 21, lock rod, welder	P	0726-1510	3.5	17	*	39	*	23	1571	9	137	8	*	*	*	*	7
V-150, between V150-V300	A	0827-1509	2.4	30	*	30	*	13	1050	9	78	7	*	*	*	*	5
Dept. 21, spring chair	P	0741-1505	19.4	49	36	69	*	66	7113	22	1060	3	2	*	*	*	27
Dept. 21, sand shoes	P	0745-1510	9.2	*	*	30	*	36	4776	10	403	2	4	*	*	*	9
Dept. 21, T-hanger	P	0748-1510	11.0	44	41	83	*	61	5303	17	485	6	2	*	*	*	6
Dept. 21, near T-hanger	A	0837-1527	2.0	*	*	40	*	8	806	15	73	2	*	*	*	*	2
V-150, finishing center	A	0847-1525	2.1	17	*	37	*	17	900	10	42	5	3	*	*	*	14
Dept. 21, T-hanger	P	0710-1502	4.7	*	*	32	*	23	2340	8	119	*	*	*	*	*	5
Weld-Out, leg line	P	0712-1516	6.0	*	*	22	*	37	3061	6	200	12	3	*	*	4	6
Welding cuff, leg line	P	0712-1510	7.7	*	*	21	*	38	3750	4	271	10	3	*	*	40	6
Mounting bracket, leg line	P	0714-1510	9.4	*	48	23	*	50	4792	5	396	11	4	*	*	8	9
Dolly line, weld-out	P	0715-1525	20.4	53	35	167	*	94	10204	31	918	8	5	*	*	35	18
Dolly line, frame assembly	P	0719-1520	10.8	27	24	96	*	49	4898	19	592	4	2	*	*	*	11
Dolly line, tac-up	P	0720-1525	8.2	29	*	79	*	65	3750	17	417	6	4	*	*	8	11
V-300	P	0706-1447	14.8	28	*	65	4	163	7174	14	957	39	9	6	26	*	20
Spring hanger	P	0721-1510	3.9	*	*	*	*	16	1915	6	153	3	*	*	*	*	6
Spring hanger, hinges	P	0722-1516	6.0	*	*	12	*	28	3106	*	234	*	*	*	*	*	5
Spring hanger, rear hanger	P	0723-1359	12.4	*	*	25	*	60	5750	6	475	3	3	5	*	*	14
Bulkhead, nose piece	P	0718-1517	6.5	*	*	40	*	29	3125	11	250	*	2	*	*	*	15
Springhanger, saddle machine	P	0730-1525	2.0	21	*	*	*	60	553	7	53	*	*	*	*	155	2
V-300	P	0707-1450	8.5	26	*	57	*	87	3696	11	500	26	6	*	*	11	14
Bulkhead, front frame assem.	P	0737-1516	5.4	*	*	28	*	28	2609	7	239	*	2	*	*	*	12
Between V-300 & com. assem.	A	0750-1533	3.6	35	35	57	*	28	1457	14	152	11	3	*	*	*	9
Vertical support, near washer	A	0803-1535	3.7	*	*	17	*	22	1733	4	147	8	*	*	*	*	5
Vertical support, near paint room	A	0805-1535	1.9	44	*	*	*	14	778	6	76	6	*	*	*	*	5
Spring hanger, assembly equalizer	P	0808-1520	1.5	*	*	*	*	12	1233	4	98	*	*	*	*	*	*
Spring hanger, central area	A	1030-1530	0.40	*	*	*	*	*	147	*	11	*	*	*	57	*	*
Limit of Detection (ug)(5)			10	10	10	5	1	1	1	1	1	1	1	2.5	10	1	1

Note: (1) Samplers were positioned to insure that, to the extent possible, they were under the welding helmet during welding activities.
(2) P=Personal Breathing Zone Sample; A=Area Sample
(3) AL (aluminum), B (boron), CA (calcium), CR (chromium), CU (copper), FE (iron), MG (magnesium), MN (manganese), MO (Molybdenum), NI (nickel), PB (lead), SN (tin), V (vanadium), ZN (zinc)
(4) * Symbol indicates none detected
(5) Limit of detection is the "analytical" limit of detection in micrograms (ug). This value divided by the air volume sampled (ranged from 0.4-0.7 m^3) gives the lowest detectable airborne concentration.

Table 2

Carbon Monoxide(1)

Fruehauf Corporation
Delphos, Ohio
February 26-27, 1985

HETA 85-030

Location	Sample Type	Sample Time	CO Concentration (ppm)(2)
Dept. 21, between dolly and com. assem.	Area	0842-1525	22
V-150, by tumbler	Area	0821-1525	6
V-150, between V300-V150	Area	0827-1509	13
Dept. 21, by T-hanger	Area	0837-1527	3
V-150, finishing area	Area	0847-1525	56
Post G-7	Area	0756-1533	13
Vertical support	Area	0803-1535	19
V-150 area	Area	1030 (short-term)	10
Vertical support	Area	1355 (short-term)	20
T-hanger	Area	1352 (short-term)	30
Inside armored car welding 1/2 time	Area	1040 (short-term)	10
Inside armored car welding continuously	Area	1103 (short-term)	80
Exposure Criteria:		OSHA (8 hr-TWA)	50
		NIOSH (8-10 hr TWA)	35

(1) Carbon monoxide was measured by both long-term and short-term Drager® detector tubes. The short-term samples, which are indicated in the table, were obtained using 10 pump strokes on the Draeger® tube.

Table 3

Organic Vapor Sampling Results (ppm)

Freuhauf Corporation
HETA 85-030

February 27-28, 1985

Location/Job	Sample Type[1]	Sample Time	Sample Volume m^3	Iso.	n-But.	MIBK	Tol.	Ace.	Diac.	Xyl.	Cellu.	Hydro.[2]	Trich.	Acetone	MEK	TLV for Mixtures[3]
Main Booth/Painter	P*	0715-1510	.05	ND	5.4	42.96	64.22	9.72	1.05	36.44	12.03	6.46	ND	.67	2.17	2.50
Main Booth/Painter	P*	0715-1510	.05	ND	2.11	36.62	52.55	12.63	1.31	44.68	11.71	6.01	ND	.59	2.17	2.35
Back Booth/Painter	P	0722-1510	.05	ND	1.78	6.35	18.68	3.03	0.42	8.29	3.19	2.35	ND	33.68	9.56	.79
Paint Shop/Flow Coat Operator	P	1645-2215	.033	1.65	LLOQ	ND	13.00	ND	ND	40.77	ND	21.52	ND	-	-	0.61
Flow-Coater	A	1645-2215	.034	1.19	LLOQ	ND	7.25	ND	ND	56.20	ND	20.78	ND	-	-	0.69
Main Booth-Front	A*	2030-2215	.052	0.69	ND	ND	4.78	ND	ND	37.31	ND	13.20	ND	-	-	0.46
Solvent Storage Room Corner	A	2030-2215	.052	ND	ND	ND	24.00	ND	ND	5.30	ND	15.40	ND	-	-	0.32
Paint Shop/Dip Coat U-Bolts	P	2030-2215	.052	.33	LLOQ	2.86	15.13	3.58	ND	20.38	1.51	6.60	0.37	-	-	0.51
Criteria:	NIOSH			-	-	50	100	-	50	100	-	-	350	250	200	
	ACGIH			50	50	50	100	150	50	100	25	-	350	750	200	
	OSHA			100	100	100	200	150	50	100	50	-	350	1000	200	

Note: Iso. = Isobutanol, n-But. = n-Butanol, Tol. = Toluene, Ace. = n-Butyl Acetone, Diac. = Diacetone alcohol, Xyl. = Xylenes, Cellu. = Butyl cellusolve, Hydro. = Total hydrocarbons, Trich. = 1,1,1-Trichloroethane

Charcoal Tube Detection Limit - 0.02 mg/sample or 0.1 ppm considering the air volume collected.
Ambersorb Detection Limit - 0.01 mg/tube or 0.2 ppm considering the air volume collected.

1. P = personal breathing zone; A = area sample; * = minimum values since sample breakthrough occured.
2. Total Hydrocarbons: C_7 - C_{12} alkanes and C_9 - C_{10} alkyl substituted benzenes
3. Total hydrocarbons were assigned a 500 ppm threshold limit value (TLV) for calculating the mixture TLV; NIOSH's criteria was used for acetone and the ACGIH's criteria for the remaining organics.

Table 4

Symptom Prevalences

Fruehauf Corporation
Delphos, Ohio
December 1984

HETA 85-030

Symptom	#	Reported (%)	#	Work-Associated (%)
1. sinus/nasal congestion	21	(64%)	5	(15%)
2. ulcerated nasal septum	3	(9%)	1	(3%)
3. epistaxis	13	(39%)	6	(18%)
4. metallic taste	11	(33%)	7	(21%)
5. throat irritation	20	(61%)	8	(24%)
6. headaches	20	(61%)	8	(24%)
7. lightheadedness/dizziness	10	(30%)	4	(12%)
8. fatigue	11	(33%)	4	(12%)
9. chills/fever	3	(9%)	-	-
10. eye irritation	22	(67%)	13	(39%)
11. skin irritation	2	(6%)	-	-
12. wheezing/trouble breathing	14	(42%)	3	(9%)
13. chest pain/tightness	10	(30%)	3	(9%)
14. shortness of breath	11	(33%)	1	(3%)
15. cough	20	(60%)	5	(15%)
16. phlegm production	15	(45%)	4	(12%)
17. anorexia	2	(6%)	-	-
18. nausea/vomiting	5	(15%)	2	(6%)

Table 5

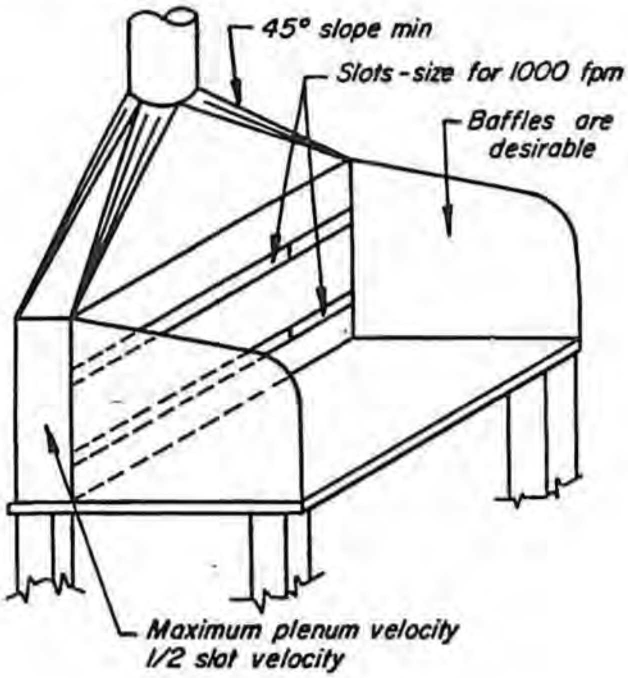
Mean Number Symptoms per Person by Department

Fruehauf Corporation
Delphos, Ohio
December 1984

HETA 85-030

Department	# Respondents	Mean Number (s.d.) Symptoms/Person
#12 - Vertical support	5	6.4 (4.0)
#19 - Slider frame	3	5.0 (6.9)
#21 - Off-line parts	7	6.9 (5.5)
#23 - V-150 commando	4	4.5 (1.9)
#25 - Burn table	1	8 (-)*
#27 - Spring hangers	12	7.4 (3.7)

* Single respondent



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

OR

A. For open areas, where welding fume can rise away from the breathing zone:
cfm required = 800 x lb/hour rod used

B. For enclosed areas or positions where fume does not readily escape breathing zone:
cfm required = 1600 x lb/hour rod used

*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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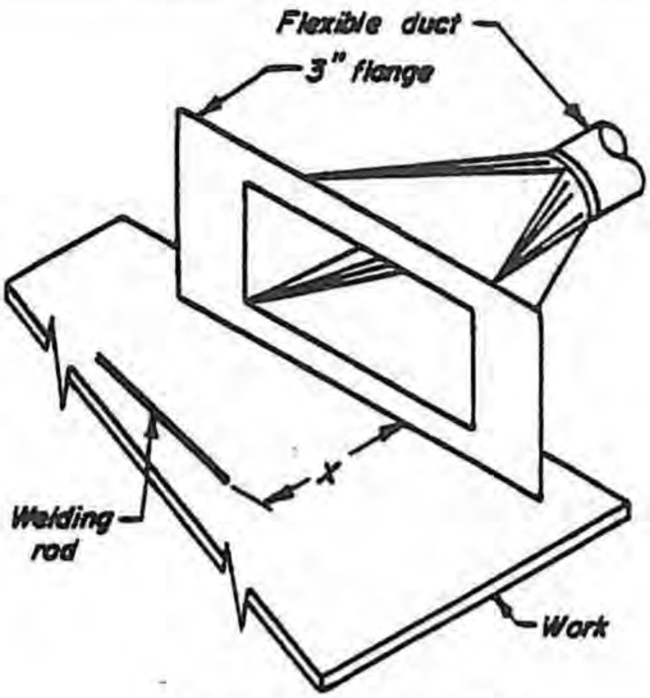
WELDING BENCH

DATE 1-76 | VS-416

Note: Extracted from the 18th Edition of ACGIH "Industrial Ventilation"

Appendix A



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
Plain duct entry loss = 0.93 duct VP
Flange or cone entry loss = 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

OR

A. For open areas, where welding fume can rise away from the breathing zone:
cfm required = 800x lb/hour rod used

B. For enclosed areas or positions where fume does not readily escape breathing zone:
cfm required = 1600x lb/hour rod used

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
"Granite Cutting" VS-909

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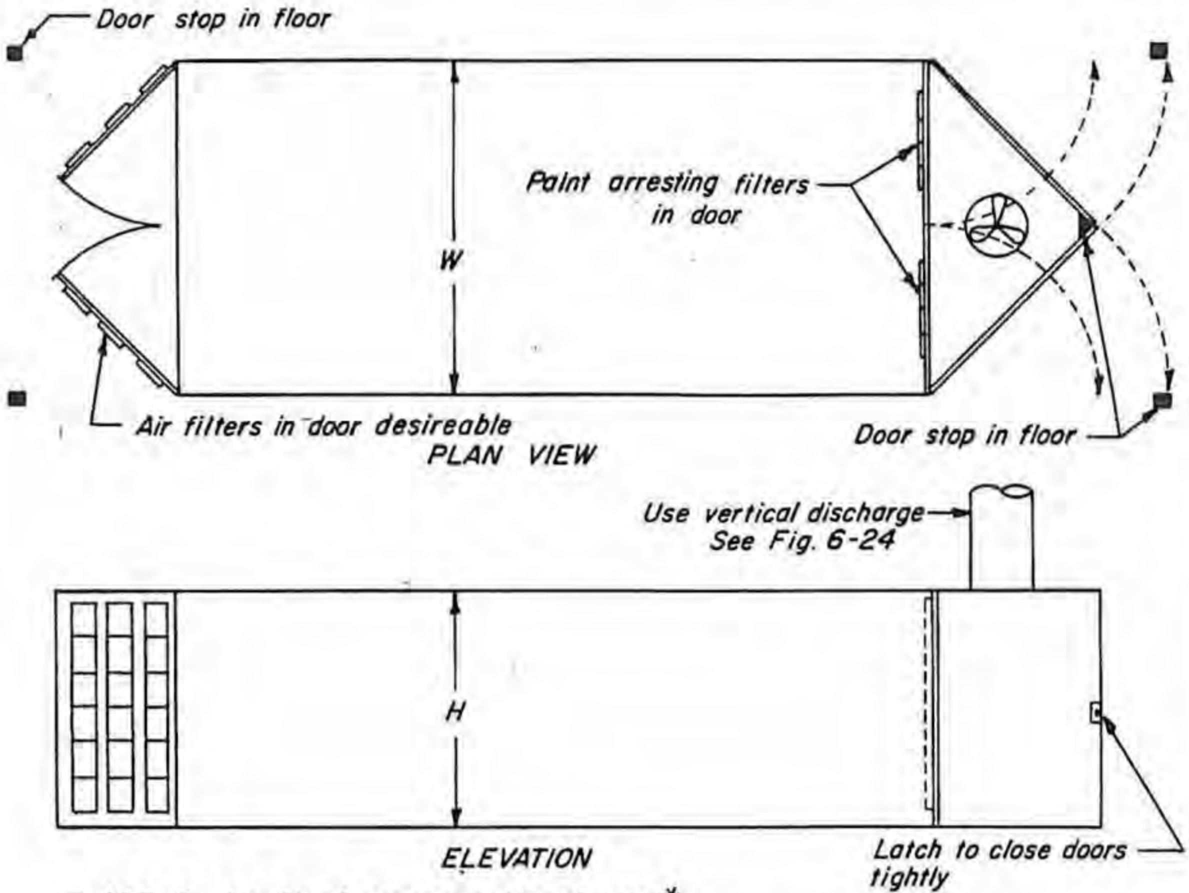
WELDING BENCH

DATE 1-78 | VS-416.1

NOTE: Extracted from the 18th Edition of ACGIH "Industrial Ventilation"



*Q=100 cfm/sq ft of cross-sectional area**
(when WxH is greater than 150 sq ft, Q= 50 cfm/sq ft)
Entry loss = 0.50 VP plus resistance of each filter bank when dirty
Duct velocity = 1000 - 3000 fpm

Notes:

1. *Exhaust fan interlock with make-up air supply and compressed air to spray gun is desirable.*
2. *Paint arresting filters usually selected for 100-500 fpm. Consult manufacture for specific details.*
3. *For construction and safety, consult NFPA.*[113]

**Airless spray painting Q=60 cfm/sq ft of cross-section area*

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LARGE DRIVE-THROUGH SPRAY PAINT BOOTH

DATE	VS-606

Note: Extracted from the See NOTICE OF INTENDED CHANGES
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