NIOSH HEALTH HAZARD EVALUATION REPORT:

HETA #2002-0184-2888
Aero-Classics, Ltd.
Huron, Ohio

January 2003

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

Preface

The Hazard Evaluations and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSHA) Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance to federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

Acknowledgments and Availability of Report

This report was prepared by Gregory A. Burr of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Analytical support was provided by DataChem, Salt Lake City, Utah, and Ardith Grote, a NIOSH research chemist in the Division of Applied Research and Technology. Desktop publishing was performed by Robin F. Smith. Review and preparation for printing were performed by Penny Arthur.

Copies of this report have been sent to employee and management representatives at Aero-Classics, Ltd. and the OSHA Regional Office. This report is not copyrighted and may be freely reproduced. Single copies of this report will be available for a period of three years from the date of this report. To expedite your request, include a self-addressed mailing label along with your written request to:

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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.

Highlights of the NIOSH Health Hazard Evaluation

Evaluation of the Oil Cooler Welding Shop

In March 2002 the National Institute for Occupational Safety and Health (NIOSH) received a health hazard evaluation (HHE) request from the management of Aero-Classics, Ltd. to evaluate reported employee health effects during the welding of aluminum oil coolers, including burning eyes, sore throats, headaches, sinus problems, and exhaustion. A survey was made on April 29, 2002, which included a walk-through of the welding shop and nearby areas. Air sampling was done for a variety of potential contaminants, including metals, ozone, acid gases, aldehydes, phosgene and solvents.

What NIOSH Did

- We took air samples in the welding shop and nearby areas for ozone, phosgene, metals, solvents, acid gases, and aldehydes.
- We talked to the welders, the stacker, and the vapor degreaser operator.
- We checked the ventilation system used by the welders.

What NIOSH Found

- Ozone concentrations were above the NIOSH ceiling limit of 0.1 parts per million as aluminum parts were welded.
- Results from all of the other air samples were very low.
- Local exhaust ventilation was used by the welders when they worked, but it was not enough to keep the ozone levels low.
- There was not enough general ventilation in the welding room.

What Aero-Classics, Ltd. Managers Can Do

- Lower the ozone levels by improving the local ventilation system used by the welders, or by providing more general ventilation for the welding room.
- Lower the ozone levels by limiting the amount of welding done at one time.
- Provide respirators to the welders while ventilation improvements are made to reduce the ozone exposures, or while changes are made in the amount of welding.

What the Aero-Classics, Ltd. Employees Can Do

- Always use the local exhaust ventilation system when welding.
- Wear a respirator while welding until the company can lower the ozone levels by providing better ventilation or changing work rates.

What To Do For More Information:
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2002-0184-2888

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Gregory A. Burr

Summary

In March 2002 the National Institute for Occupational Safety and Health (NIOSH) received a health hazard evaluation (HHE) request from the management of Aero-Classics, Ltd., Huron, Ohio, a small company producing aluminum oil coolers used by the U.S. Army in the Abrams main battle tank. The request described employee health effects during the welding of aluminum oil coolers, including burning eyes, sore throats, headaches, sinus problems, and exhaustion. A site evaluation was conducted on April 29, 2002, which included a walk-through of the areas of concern and personal breathing-zone and area air sampling for a variety of potential contaminants, including metals (in this instance aluminum), ozone, and volatile organic compounds from a nearby vapor degreaser.

The most significant exposures measured during this evaluation were to ozone, ranging up to 0.7 parts per million (ppm) for short-term (5 minute) exposures, measured in the general vicinity of the welders. These short-term concentrations exceeded the NIOSH Ceiling Limit for ozone of 0.1 ppm. Although full-shift sampling for ozone was not performed during this investigation, these concentrations suggest that the OSHA Permissible Exposure Limit (PEL) of 0.1 ppm for an 8-hour time-weighted average (TWA) may also be exceeded if welding is performed throughout a workday. Results of the remaining air samples were well below any pertinent occupational exposure criteria on the day of this survey. Of the 27 different minerals and metals sampled, only aluminum was detected in concentrations above trace levels. Similarly, workers in and near the welding room were exposed to very low (or non-detectable) concentrations of total particulate, solvents (trichloroethylene, the organic solvent used to clean the parts prior to assembly), hydrogen fluoride, hydrogen chloride, aldehydes, and phosgene. The brownish-red residue which accumulated on the visors worn by the welders contained trace amounts of iron and copper.

This NIOSH investigator found that a health hazard existed to the welders from the high concentrations of ozone generated during tungsten inert gas (TIG) and metal inert gas (MIG) welding of the aluminum oil cooler components. Recommendations were made to reduce ozone exposures to the welders through the use of engineering controls (addition of more local exhaust ventilation, the use of larger exhaust hoods, and the addition of more general room ventilation for the welding area) and administrative controls (limiting the amount of welding performed during a workday). A recommendation was also made to provide respiratory protection from ozone while these engineering or administrative controls were implemented.

Keywords: SIC 3714 Motor Vehicle Parts and Accessories, welding, TIG, MIG, ozone, ventilation, respirators.

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INTRODUCTION

In March 2002 the National Institute for Occupational Safety and Health (NIOSH) received a health hazard evaluation (HHE) request from the management of Aero-Classics, Ltd., Huron, Ohio. The request described employee health effects during the welding of aluminum oil coolers, including burning eyes, sore throats, headaches, sinus problems, and exhaustion. This welding operation had been previously evaluated by the Ohio Bureau of Workers Compensation (Ohio BWC, Risk Number 1317389, report dated March 25, 2002). This BWC report included a recommendation that the company contact NIOSH for further evaluation.

A site evaluation was conducted on April 29, 2002, which included a walk-through of the areas of concern and personal breathing-zone and area air sampling for a variety of potential contaminants associated with the manufacturing of the oil coolers. Some of the samples were collected with direct-reading instruments (ozone and phosgene) while the remainder required laboratory analysis. A NIOSH interim letter dated May 21, 2002, was sent to the company which contained the results from the direct-reading samples for ozone and phosgene collected during the initial site visit.

BACKGROUND

Aero-Classics, Ltd., a small company located in a single-story, 25,000 ft^2 facility, produces aluminum oil coolers used by the U.S. Army in the Abrams main battle tank. At the time of this NIOSH evaluation the company had been in production for approximately 15 months and employed nine hourly and six office workers. The oil coolers are constructed of #3003 Series machined aluminum alloy sheets and #356 cast aluminum parts using both Tungsten Inert Gas (TIG) and Metal Inert Gas (MIG) welding for final assembly. For the past 12 months, the TIG and MIG welding has been performed in a room (referred to in this report as the welding shop) which was separated from the remainder of the facility. On the day of this survey there were two welders working in this welding shop (one TIG, one MIG welder). A stacker (an employee who pre-assembles the oil cooler components prior to brazing and welding) works in a room adjacent to the welding shop.

Approximately six oil coolers are constructed on a typical day. The production involves the following four steps:

1) degreasing the machined aluminum parts with trichloroethylene (TCE) to remove a protective oil film;[a]
2) assembling the cleaned aluminum parts to form the core of the oil cooler (a process called stacking);
3) brazing these stacked aluminum cores (done inside an enclosed heated chamber); and
4) final welding of the brazed core and attachment of aluminum casting (done first by MIG, then TIG welding). The wire-fed MIG welding process requires approximately 15 amps of power and is used to initially tack and weld the aluminum castings onto the core. TIG welding, which requires much higher power (about 200 amps), is performed with a welding rod to impart a better welding finish and a superior seal.

In interviews during this survey, the welders described a chlorine-type odor which was irritating to their eyes and respiratory tract. Other problems described by either the welders or the stacker included nausea, disorientation, fatigue, muscle aches, impaired vision, headache, breathing difficulties, forgetfulness, and lack of appetite. Both welders had noticed a brownish residue accumulating on their welding visors during the workday which they associated with their health effects.

[a] The TCE degreaser was not in operation during this survey since the current oil cooler production order was nearing completion and no new oil cooler parts needed to be cleaned.

A local exhaust ventilation (LEV) system utilizing a flexible hose (snorkel-type design) was present at each welding station and was consistently used by both employees during this evaluation. There was no other ventilation for the welding shop. One of the two welders voluntarily wore a half-mask air purifying respirator (MSA Comfo Classic) equipped with N–95/R-95 organic vapor cartridges.

METHODS

Table 1 summarizes the air and wipe sample methods that were used in this survey. The sampling protocol was developed after observing the welding operation, reviewing the activities performed by the workers, and talking to both welders, the stacker, and the nearby TCE degreasing tank operator about their concerns. Both TIG and MIG welding can produce a variety of airborne contaminants, especially metals (in this instance aluminum) and ozone. Organic compounds were sampled since TCE was used in a nearby vapor degreaser to clean the aluminum parts prior to assembly. Air samples were also collected for phosgene, a potential decomposition product from the heating of organic solvents (such as TCE), as well as aldehydes and inorganic acids, substances which may be present in small quantities in the welding wires and fluxes used in the assembly process. At the request of the workers, wipe samples were obtained of the reddish-brown residue which accumulated during the workday on the visors worn by the two welders. Finally, air flow measurements were made of the exhaust ducts used by the welders to control the welding fumes.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the 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 even though 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 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 increases 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 Recommended Exposure Limits (RELs),[1] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[2] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[3] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

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 STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Ozone

Ozone is a toxic gas that irritates and damages mucous membranes and lung tissues.[4] Symptoms can include nose and throat irritation, coughing, shortness of breath, and chest pain. All of these symptoms can be related to the strong oxidizing effects of ozone. There is research which suggests that the effects of repeated ozone exposure may be cumulative; however, it is not known if changes in the duration, frequency, or size of exposures relate to developing a tolerance to ozone.[4]

Ozone is federally regulated in both the ambient and the occupational environments. The OSHA PEL for ozone in the occupational environment is 0.10 parts per million (ppm), TWA for up to an 8-hour workday.[3] The NIOSH REL is a ceiling concentration of 0.10 ppm and is a level which should not to be exceeded at any time.[1] The ACGIH TLV for full-shift occupational ozone exposures is 0.1, 0.08, and 0.05 for light, moderate, and heavy work, respectively.[2]

RESULTS

Tables 2 and 3 summarize the results of sampling performed in and around the welding room. The most significant exposures measured in the welding room during this evaluation were to ozone. While ozone was measured during both types of welding, much higher concentrations were measured during MIG welding (up to 0.7 ppm) compared to TIG welding (<0.05 to 0.1 ppm). Although these are short-term samples measured over 5-minute periods in the general vicinity of the welders, the results suggest that MIG welding can produce significant quantities of ozone, exceeding the NIOSH Ceiling Limit for ozone of 0.1 ppm. Although full-shift sampling for ozone was not performed during this investigation, these concentrations suggest that the OSHA PEL of 0.1 ppm for an 8-hour TWA may also be exceeded if welding is performed throughout a workday. Similar ozone concentrations were measured on both welders during the Ohio BWC investigation.

Results of the remaining samples were all well below any pertinent occupational exposure criteria on the day of this survey. Of the 27 different minerals and metals analyzed for in the various air and wipe samples collected, only aluminum was detected in concentrations above trace levels. Similarly, workers in and near the welding room were exposed to very low (or non-detectable) concentrations of total particulate, solvents (trichloroethylene, the organic solvent used to clean the parts prior to assembly), acid gases (specifically hydrogen fluoride and hydrogen chloride), aldehydes, and phosgene. The brownish-red residue which accumulated on the visors worn by the welders contained trace amounts of iron and copper.

DISCUSSION AND CONCLUSIONS

It was apparent from the air sampling results that ozone was the predominant exposure to both welders, with personal breathing-zone (PBZ) exposures regularly exceeding the NIOSH Ceiling Limit of 0.1 ppm. Ozone at these levels can produce many of the employee health effects described in the HHE request, including burning eyes and sore throats. Since all of the ozone samples collected as part of this evaluation were short-term (each approximately 5 minutes in duration), these results cannot be directly compared to the OSHA PEL of 0.1 ppm, TWA over an 8-hour workday. However, it is reasonable to assume that if welding was performed throughout the entire workday, at the pace similar to that observed in this evaluation, then the OSHA PEL also may be exceeded.

Air flow measurements were made at the face of both of the movable rectangular LEV hoods used by both welders to capture the welding fumes. Each slot measured 2.5" by 19" and was connected to a 6" diameter flexible exhaust duct (see following chart for airflow measurements). Both welders positioned the movable exhaust hoods near the welding fume generation. At the time of this evaluation, there was no other local exhaust or general ventilation present in the welding room. The LEV system appeared to be functioning adequately.

Welding Location	Airflow, feet per minute (Avg. of 3 measures)
MIG	550, 1100, 650 (Avg. 770)
TIG	500, 900, 450 (Ave. 620)

The half-mask air purifying respirator (MSA Comfo Classic, equipped with N–95/R-95 organic vapor [charcoal] cartridges) that was voluntarily worn by one of the welders does not offer respiratory protection for ozone. For ozone, the chemical cartridges must be equipped with non-oxidizable sorbents.

Although phosgene gas was not detected during this survey,[b] it can be formed by decomposition of chlorinated hydrocarbon solvents, such as TCE, by ultraviolet radiation (generated during TIG and MIG welding). It reacts with moisture in the lungs to produce hydrogen chloride, which in turn destroys lung tissue. For this reason, any use of chlorinated solvents should be well away from welding operations or any operation in which ultraviolet radiation or intense heat is generated.

RECOMMENDATIONS

1. Reduce ozone exposures to the welders during TIG and MIG welding. This may be accomplished with engineering controls by the addition of more LEV, the use of larger exhaust hoods, and the addition of more general room ventilation for the welding area. Administrative controls, such as limiting the amount of welding performed during a workday, may also be utilized to lower exposures.

2. Respiratory protection from ozone should be provided for the TIG and MIG welders while any engineering or administrative controls are implemented. NIOSH recommends that respiratory protection be used for worker protection only when engineering controls are not technically feasible, during the interim while the controls are being installed or repaired, or when an emergency or other temporary situation arises.[5] In this instance, air-purifying respirators equipped with chemical cartridges containing a non-oxidizable sorbent would provide appropriate protection from the concentrations of ozone measured in this evaluation.

   If respirators are provided, an effective respiratory protection program must be implemented which, at a minimum, must comply with the requirements described in the OSHA respiratory protection standard (29 Code of Federal Regulations [CFR] 1910.134).[6] Publications developed by NIOSH can also be referenced when developing an effective respirator program, including the NIOSH Respirator Decision Logic and the NIOSH Guide to Industrial Respiratory Protection.[5] A comprehensive respiratory protection program should include the following elements:

   - written operation procedures
   - appropriate respirator selection
   - employee training
   - effective cleaning of respirators
   - proper storage
   - routine inspection and repair
   - exposure surveillance
   - program review
   - medical approval
   - use of approved respirators

[b] The vapor degreaser was not in operation during this evaluation since oil cooler production was ending for the season.

The respiratory protection program should also include a provision that restricts workers from having any facial hair that comes between the sealing surface of the facepiece and the face. Respirators should be cleaned and inspected daily. Workers should be instructed to immediately report any problems with their respirators to the company representative in charge of health and safety issues.

Workers should not be permitted to make any modifications to the respirators, such as attaching rubber hoses to the facepiece (where the filters attach), running the hoses over the shoulders and attaching the filters to the end of the hoses located at the center of the back. Making such modifications will void their NIOSH–approved status. Using respiratory protection not approved by NIOSH does not satisfy the requirements of the OSHA respiratory protection standard (29 CFR 1910.134).

3. Since no oil cooler components were being cleaned in the vapor degreaser during this evaluation, additional air sampling for phosgene in the welding room is recommended when both the vapor degreaser and welding activities are being conducted.

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Table 1 Summary of Air and Wipe Sampling Methods Aero-Classics, Ltd., Huron, Ohio (HETA 2002-0184-2888) Survey Date: April 29, 2002				
Material Sampled	**Type of Sample**	**Sample Period**	**Sampling Method**	**General Comments**
Elements (metals and minerals)	PBZ	9:40 am to 3:25 pm	NIOSH Method No. 7300. Samples collected on tared PVC filters at 2 LPM. Analysis of 27 different elements by ICP-AES.	Samples collected on both welders
Ozone	GA	Direct-reading	Colorimetric detector tubes (SKC, Inc.)	In the breathing zone of each welder
Volatile organic compounds (VOCs)	PBZ	9:40 am to 3:25 pm	NIOSH Method No. 1003. Samples collected on activated charcoal tubes. Analysis by GC-FID.	Collected on both welders and at the stacking station
Qualitative scan for VOCs	GA	9:45 am to 11:50 am	NIOSH Method No. 2549. Samples collected on a tube containing 3 beds of sorbent materials. Analysis using a thermal desorber interfaced directly to a GC/MS.	Above each welding table
Phosgene	GA	Direct-reading	Colorimetric detector tubes (SKC, Inc.)	In the breathing zone of the welder and in the adjacent areas
Inorganic acids	GA	10:00 am to 3:34 pm	NIOSH Method No. 7903. Samples collected on silica gel sorbent tubes. Analysis by ion chromatography.	Near each of the welding tables
Aldehydes	GA	1:00 pm to 3:30 pm	NIOSH Method No. 2539. Samples collected on XAD-2 sorbent tubes. Analysis by GC-FID.	At each of the welding tables
Elements (metals and minerals)	Wipe	Not applicable	Modification of NIOSH Method 7300. Collected on dry wipe. Analysis of 27 different elements by ICP-AES.	Welding visors

PBZ = personal breathing zone air sample
PVC = polyvinyl chloride sample filter
ICP = inductively coupled plasma
GC = gas chromatography
GA = general area air sample
LPM = liters per minute
AES = atomic emission spectrophotometry
FID = flame ionization detection

Table 2 Results of Direct-Reading Samples for Ozone and Phosgene Aero-Classics, Ltd., Huron, Ohio (HETA 2002-0184-2888) Sampling Date: April 29, 2002				
Ozone				
Sampling Period		**Activity or Location**	**Result**	**Comments**
Start	**Stop**			
10:50 am	10:55 am	MIG welding	0.5 ppm	In the breathing-zone of the workers during MIG welding.
10:55 am	11:00 am	TIG welding	0.1 ppm	In the breathing-zone of the workers during TIG welding.
11:05 am	11:10 am	Stacker area	ND †	Area immediately outside of the welding room.
11:10 am	11:15 am	MIG welding	0.15 ppm	Tack welding the center casting.
11:20 am	11:25 am	MIG welding	0.7 ppm	Welding the center casting.
11:25 am	11:30 am	TIG welding	0.05 ppm	In the breathing-zone of the workers during TIG welding.
2:45 pm	2:50 pm	MIG welding	0.7 ppm	In the breathing-zone of the workers during MIG welding.
NIOSH Ceiling Limit			0.1 ppm	This concentration should not be exceeded.
OSHA Permissible Exposure Limit			0.1 ppm	Time-weighted average exposures up to an 8-hour workday.
Phosgene				
10:40 am	10:50 am	MIG welding	ND ‡	In the breathing-zone of the workers during MIG welding.
11:30 am	11:40 am	Welding room	ND ‡	In the breathing-zone of the workers during TIG welding.
NIOSH Recommended Exposure Limit			0.1 ppm	Time-weighted average exposures up to a 10-hour workday.
OSHA Permissible Exposure Limit			0.1 ppm	Time-weighted average exposures up to an 8-hour workday.

ppm = parts per million
MIG = metal inert gas welding
Stacker = core assembly area, prior to welding
ND = not detectable
TIG = tungsten inert gas welding

† Limit of detection for ozone was 0.05 ppm (using colorimetric detector tubes).
‡ Limit of detection for phosgene was 0.02 ppm (using colorimetric detector tubes).

Table 3
Results of Air and Wipe Samples for Elements, Total Particulate, Trichloroethylene, Aldehydes, and Acid Gases
Aero-Classics, Ltd., Huron, Ohio (HETA 2002-0184-2888)
Sampling Date: April 29, 2002

Sample No.	Activity or Location	Exposure Concentration	Occupational Exposure Limit	Comments
Elements (Aluminum)				
#267	Stacker	0.017 mg/m^3 (Al)	10 mg/m^3 (NIOSH REL) 15 mg/m^3 (OSHA PEL)	Only aluminum was present in quantifiable amounts. Trace amounts of manganese, iron, and titanium were also detected.
#283	MIG Welder	0.25 mg/m^3 (Al)		
W-1	Visor wipe	not applicable	not applicable	Trace amounts of iron and copper were detected on both wipe samples.
W-2	Visor wipe	not applicable	not applicable	
Total Particulate				
#485	TIG Welder	0.56 mg/m^3	No NIOSH REL 15 mg/m^3 (OSHA PEL)	The OSHA PEL and ACGIH TLV are for total particulate, not otherwise regulated, and are intended for up to an 8-hour TWA exposures.
#283	MIG Welder	1.3 mg/m^3		
#267	Stacker	0.11 mg/m^3		
Trichloroethylene (TCE)				
CT#1	MIG Welder	7.1 ppm (TCE)	25 ppm (NIOSH REL) 100 ppm (OSHA PEL)	NIOSH considers TCE to be a potential occupational carcinogen.
CT#2	TIG Welder	7.6 ppm (TCE)		
TD	Welding Area	not applicable	not applicable	Major compound was trichloroethylene
Aldehydes (formaldehyde)				
Two general area air samples were collected during MIG and TIG welding. Trace concentrations of formaldehyde were measured (between 0.02 and 0.06 mg/m^3).				
Acid Gases (hydrofluoric and hydrochloric acids)				
SG#1	Welding Room	0.009 mg/m^3 (HF)	2.5 mg/m^3 (NIOSH REL) 2.5 mg/m^3 (OSHA PEL)	Samples collected in the breathing-zone of the workers during MIG and TIG welding.
		0.25 mg/m^3 (HCl)	7 mg/m^3 (NIOSH REL) 7 mg/m^3 (OSHA PEL)	
SG#2	Degreaser Tank	Trace amounts	See above NIOSH and OSHA exposure limits.	Trace HF: between 0.002 and 0.006 mg/m^3 Trace HCl: between 0.005 and 0.017 mg/m^3

mg/m^3 = milligrams per cubic meter
REL = Recommended Exposure Limit
MIG = metal inert gas welding
TD = thermal desorption (qualitative scan)
HCl = hydrochloric acid
ppm = parts per million
PEL = Permissible Exposure Limit
TIG = tungsten inert gas welding
HF = hydrofluoric acid
TCE = trichloroethylene

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