NIOSH HEALTH HAZARD EVALUATION REPORT

HETA #2003-0237-2986
Morton Metalcraft
Welcome, North Carolina

December 2005

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

PREFACE

The Hazard Evaluation 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 employers 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 Bradley King and Ayo Adebayo of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Field assistance was provided by Chandran Achutan. Analytical support was provided by DataChem Laboratories, Inc. Desktop publishing was performed by Shawna Watts. Editorial assistance was provided by Ellen Galloway.

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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 Exposure to Welding Fumes

NIOSH received a request for a health hazard evaluation (HHE) at Morton Metalcraft in Welcome, North Carolina. This request noted that employees had concerns regarding potential health effects due to exposure to welding fumes. Symptoms reported by employees included sore throat, runny nose, eye irritation, coughing, migraines and vomiting.

What NIOSH Did

- We tested the air for components of welding fumes (primarily metals). We also sampled the air for carbon monoxide and ozone, two gases produced during the welding process.
- We asked employees about health symptoms they felt were associated with exposures to welding.

What NIOSH Found

- The concentrations of components of welding fumes were found to be below occupational exposure limits.
- Low levels of ozone were found in the air.
- Except for one brief peak above the ceiling limit, carbon monoxide exposures were low.
- Several employees reported symptoms such as eye, nose, and throat irritation.
- Workers who reported symptoms said that symptoms were generally worse during the winter months.
- Painting was performed without gloves despite the manufacturer's recommendation that the paint not come in contact with bare skin because it is a noted sensitizer.
- Employees without hearing protection worked in very close proximity to areas where hearing protection is required.

What Morton Metalcraft Managers Can Do

- Allow workers more control in turning the general ventilation fans on and off during the winter months when the factory's doors and windows are typically closed.
- Improve general dilution ventilation.
- Consider implementing local exhaust ventilation for welding operations.
- Improve the training provided to workers on hazard communication and personal protective equipment (PPE) use.
- Evaluate the use of protective gloves for employees working in the paint booths.
- Conduct a thorough noise exposure evaluation

What the Morton Metalcraft Employees Can Do

- Refrain from eating, drinking, or smoking on the factory floor.
- Use personal protective equipment as directed.
- Report all potential work-related health symptoms to appropriate health care personnel.

CDC Workplace Safety and Health

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 #2003-0257-2986

NIOSH

Health Hazard Evaluation Report 2003-0237-2986
Morton Metalcraft
Welcome, North Carolina
December 2005

Bradley King, MPH
Ayo Adebayo, MD, MPH

SUMMARY

On April 25, 2003, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request for a health hazard evaluation (HHE) at Morton Metalcraft in Welcome, North Carolina. The request concerned potential exposures to emissions from a plasma cutter. In particular, the plasma cutter produced a dense smoke that was reported to circulate throughout the facility, enhanced by an inadequate ventilation system. Employees associated exposure to the smoke with health problems including sore throat, runny nose, eye irritation, coughing, migraines, and vomiting.

On February 25, 2004, an industrial hygienist and medical officer from NIOSH conducted an initial site visit to better understand the facility's processes and procedures and to plan a return site visit to conduct sampling. Before the return site visit, the use of the plasma cutter was discontinued at the facility. Concerns of exposure to welding fumes, however, continued to be expressed, as well as continuing reports of inadequate ventilation, particularly during the winter months when many of the facility's doors and windows are closed. On March 7-10, 2005, a site visit was conducted to perform sampling for welding fumes, including individual metals, carbon monoxide, and ozone. Confidential employee interviews were conducted with a random sample of employees.

Exposures to metals in the welding fumes were below applicable occupational exposure limits (OELs). For personal breathing zone (PBZ) and area air samples, the most prominent metal collected was iron. The PBZ samples with the highest airborne concentrations of iron (4.0 milligrams per cubic meter (mg/m^3) and 3.7 mg/m^3) were less than half of the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) of 10 mg/m^3, but were nearing the NIOSH recommended exposure limit (REL) of 5.0 mg/m^3. Time-weighted average (TWA) concentrations of carbon monoxide (CO) were below both the NIOSH REL and the OSHA PEL. Instantaneous readings for ozone did not reveal levels above the NIOSH REL. Confidential interviews did reveal complaints of eye, nose, and throat irritation, with some reported to be work-related. Individuals with symptoms reported welding or working in the vicinity of welding activities as their main job duties.

NIOSH investigators determined that no hazard from exposure to metal fumes, CO, and ozone existed at the time of the NIOSH site visit. The sampling results indicated that the employees were not exposed to levels of metals or gases above permissible levels. Eye, nose, and throat irritation, particularly during winter months, were reported during confidential interviews. Included in this report are recommendations for improvements in general ventilation during winter months and in training on hazard communication and use of personal protective equipment.

Keywords: NAICS , 333120 (Construction Machinery Manufacturing) Welding fumes, metals, carbon monoxide, ozone, total particulates, ventilation, eye irritation, headaches, sore throat, coughing, migraines, vomiting

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INTRODUCTION

On April 25, 2003, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request for a health hazard evaluation (HHE) at Morton Metalcraft in Welcome, North Carolina. The requesters were concerned about potential exposures to emissions from a plasma cutter. In particular, a dense smoke produced by the plasma cutter was reported to be present throughout the facility whenever the cutter was used. Poor ventilation in the facility was also described as a concern that contributed to the buildup of smoke. Reported health problems included sore throat, runny nose, eye irritation, coughing, migraine, and vomiting. On February 25, 2004, an industrial hygienist and medical officer from NIOSH conducted an initial site visit to gain a better understanding of the work processes and procedures and to plan a return site visit to conduct sampling. During the time period of March 2004 to January 2005, the use of the plasma cutter was discontinued at the facility. However, new concerns for exposure to welding fumes in general were expressed. There were also continuing reports of inadequate ventilation, particularly during the winter months when many of the facility's doors and windows are closed. On March 7-10, 2005, NIOSH investigators conducted a site visit to sample for metals in the welding fume in the weld shop and near the two robotic welders. In addition, real-time sampling was conducted for other potential welding byproducts, including carbon monoxide and ozone. Confidential employee interviews were conducted with a random sample of employees from each of the shifts. Symptom questionnaires were administered during the interview process to assess the extent of symptoms.

BACKGROUND

Morton Metalcraft produces fabricated metal products for construction, agricultural, and industrial equipment manufacturers in its 180,000 square foot (ft^2) Welcome, North Carolina facility. Approximately 190 individuals, including administrative staff, are employed at the facility. The majority of the 130 direct labor staff work during the 7 AM – 3 PM day shift, with fewer employees working during the second and third shifts. Within the facility, three areas serve as locations where manual and/or robotic welding of fabricated mild steel parts occurs. The first, an open area measuring approximately 50'x100', is called the Great Dane area and is the site of a large C-frame Cloos robotic welder as well as 2-3 manual welders, for a total of 4-5 workers during a typical day shift. The second area, termed the tank cell and measuring approximately 80'x25', is the location for a second, but smaller, Cloos robotic welder. Three to four employees typically work in this area during the day shift. Measuring 120' x 50', the third area is the manual weld shop where 15-20 employees perform manual metal inert gas (MIG) welding. No local exhaust ventilation is used in the three areas. Ventilation is provided by several ceiling fans that pull air from these areas to the outside of the facility. During the summer months, doors and windows of the facility are typically opened, allowing natural ventilation in the building. However, during the colder winter months, these doors and windows are typically closed, and the ceiling fans are operated occasionally.

A safety committee of seven management and employee representatives works to address occupational safety and health issues. Responsibilities include housekeeping and safety audits, addressing health and safety incidents from the previous month, and improving communication among employees and management.

METHODS

Industrial Hygiene

To assess exposure to welding air contaminants, personal breathing zone (PBZ) and area air samples were collected for total particulates and elements during the site visit of March 7-10, 2005. A total of 31 samples were collected using pre-weighed 37-millimeter (mm), 5-micron (µm) pore-size polyvinyl chloride (PVC) filters in 3-piece cassettes. Tygon® tubing connected the sampler and a personal sampling pump that allowed air to be drawn through the sampling train at a calibrated flow rate of 2.0 liters per minute (Lpm). For the PBZ samples, the sampling trains were attached to the workers' collars and placed under the welding helmets to best represent the actual exposure.

Gravimetric analysis was performed on all filters to determine the amount of total particulate concentration collected on each filter, according to the NIOSH Manual of Analytic Methods (NMAM) Method 0500[1] with modifications. The limit of detection was reported as 0.02 milligrams (mg) per sample.

Analysis for elements (metals and minerals) was performed on all filters according to NIOSH Method 7300[1] with modifications. The samples were analyzed using a Perkin Elmer Optima 3000 DV inductively coupled plasma spectrometer. This method allows for a scan of a wide variety of metals, including manganese, iron, chromium, copper, nickel, and zinc.

Measurements were also taken for carbon monoxide (CO), a byproduct of incomplete combustion. Eight individuals in the weld shop wore a Biosystems Inc. ToxiUltra Gas Detector (Middletown, Connecticut) in their breathing zone. These passive diffusion monitors recorded CO concentrations during the workshift; continuous readings were integrated every 60 seconds and then logged by each monitor. The recorded measurements were then downloaded to a computer. The monitor measures CO concentrations from 0-500 parts per million (ppm). Calibration of these monitors was performed before and after sampling according to the manufacturer's specifications.

Area air samples for ozone were collected using a bellows pump and colorimetric detector tubes (Dräger®, Inc., Pittsburgh, PA). Samples were taken at various manual welding stations in the weld shop and Great Dane areas. The detector tubes have a standard deviation of 10%-15% and a measuring range of 0.05 to 0.7 ppm for ozone.

Medical

Confidential interviews were conducted with 29 employees selected from a list of production workers by computer-generated random number selection. Information was gathered on their health status, work practices, and their concerns regarding perceived work hazards. In addition, the NIOSH medical officer reviewed all incident reports and OSHA Logs of Work-Related Injuries and Illnesses (forms 200 and 300) for the years 2000 through 2005.

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),[2] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[3] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[4] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criteria.

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. A ceiling limit is a peak concentration that should not be exceeded at any time during the workday.

Welding Fumes and Metals

The effect of welding fumes on an individual's health can vary depending on such factors as the length and intensity of the exposure and the specific metals involved. The content of welding fumes depends on the base metal being welded, the welding process and parameters (such as voltage and amperage), the composition of the consumable welding electrode or wire, the shielding gas, and any surface coatings or contaminants on the base metal. The flux coating (or core) of the electrode/wire may contain up to 30 organic and inorganic compounds. The primary purpose of the flux is to release a shielding gas to insulate the weld puddle from air, thereby protecting against oxidation.[5] The size of welding fume particulate is highly variable and ranges in diameter from less than 1-micrometer (µm) (not visible) to 50 µm (seen as smoke).[6]

In general, welding fume constituents may include minerals, such as silica and fluorides, and metals, such as arsenic, beryllium, cadmium, chromium, cobalt, nickel, copper, iron, lead, magnesium, manganese, molybdenum, tin, vanadium, and zinc.[6,7,8] Low-carbon steel, or mild steel, is distinguished from other steels by a carbon content of less than 0.30%. This type of steel consists mainly of iron, carbon, and manganese, but may also contain phosphorus, sulphur, and silicon. Most toxic metals present in stainless steel, such as nickel and chromium, are not present in the low-carbon steel used at Morton Metalcraft.

No PEL for total welding fumes has been established by OSHA; however, PELs have been set for individual welding fume constituents (e.g., iron, manganese).[4] NIOSH has concluded that it is not possible to establish an exposure limit for total welding emissions because the composition of welding fumes and gases varies greatly, and the welding constituents may interact to produce adverse health effects. Therefore, NIOSH recommends controlling total welding fume to the lowest feasible concentration (LFC) and meeting the exposure limit for each welding fume constituent.[9]

In addition to welding fume, many other potential health hazards exist for welders. Welding operations can produce gaseous emissions such as CO, ozone, nitrogen dioxide, and phosgene (formed from chlorinated solvent decomposition).[6,7,8] Welders can also be exposed to hazardous levels of ultraviolet radiation from the welding arc if welding screens or other precautions are not used. Ergonomic problems are also a consideration due to the contorted positions welders assume for some welding tasks.

Carbon Monoxide

Carbon monoxide is a colorless, odorless, tasteless gas which can be a product of the incomplete combustion of organic compounds. Carbon monoxide combines with hemoglobin and interferes with the oxygen-carrying capacity of blood. Symptoms include headache, drowsiness, dizziness, nausea, vomiting, collapse, myocardial ischemia (reduced blood flow to the heart), and death.[10] The NIOSH REL for CO is 35 ppm for an 8-hour TWA. NIOSH also recommends a ceiling limit of 200 ppm which should not be exceeded at any time during the workday.[9] The OSHA PEL for CO is 50 ppm for an 8-hour TWA.[4] The ACGIH TLV for CO is 25 ppm as an 8-hour TWA.[3]

Ozone

Low concentrations of ozone (0.01 ppm to 0.05 ppm) may produce a sharp, irritating odor even during brief exposures.[11] Symptoms of ozone exposure include eye irritation, nose and throat dryness, and cough. At higher ozone concentrations, more severe symptoms may develop including headache, pain or tightness in the chest, and shortness of breath or tiredness.[11] Short–term exposure (a few hours) to ozone concentrations on the order of 0.1 ppm has been shown to produce temporary decreases in measured lung volumes in humans.[12] The NIOSH REL for ozone is 0.1 ppm and is to be evaluated as a ceiling limit.[2] NIOSH has also recommended an immediately dangerous to life and health (IDLH) limit of 5 ppm for ozone.[9] The current OSHA PEL for ozone is 0.1 ppm as a TWA.[4] The current ACGIH TLV is based on the amount of physical exertion or work load required for the job and is to be averaged over an 8–hour period. The TLV is 0.1 ppm for jobs requiring light physical exertion, 0.08 ppm for moderate physical exertion, 0.05 ppm for heavy physical exertion. A separate TLV for ozone is 0.2 ppm for heavy, moderate, or light work loads less than or equal to 2 hours in duration.[3]

RESULTS

Industrial Hygiene

Results from the PBZ sampling for elements on March 8-9, 2005, are summarized in Table 1. These samples were analyzed for 29 different metals and minerals. Only those 14 elements that returned a detectable result from at least one sample are listed. Results from the area air sampling are summarized in Table 2. Only those 10 elements that returned a detectable result from at least one sample are listed in this table. All samples returned results below the applicable OSHA PELs and NIOSH RELs. For PBZ and area air samples, the most prominent metal collected was iron. The samples with the highest airborne concentrations of iron (4.0 mg/m^3 and 3.7 mg/m^3) were less than half of the OSHA PEL of 10 mg/m^3, but were nearing the NIOSH REL of 5.0 mg/m^3. The rest of the samples had iron concentrations well below these occupational exposure limits.

The total particulates ranged from 0.1 mg/m^3 to 7.6 mg/m^3. The highest exposures of 7.6 mg/m^3 and 7.2 mg/m^3 were measured on individuals performing manual welding in the weld shop and Great Dane areas, respectively, and were the same PBZ samples as those that measured the highest exposures to iron. The lowest exposures of 0.1 mg/m^3 and 0.2 mg/m^3 were measured on individuals performing spot welding.

Colorimetric detector tubes were used to sample the air for ozone in the vicinity of the workers while they were performing manual welding. Results are summarized in Table 3. Although the tubes did show some coloration indicating the generation of ozone during the welding process, none exceeded the 0.1 ppm NIOSH ceiling limit.

Direct-reading instruments placed in the PBZ of welders measured airborne concentrations of CO every 60 seconds for approximately 8-hours. TWA and peak concentrations of CO are summarized in Table 4. TWA concentrations ranged from 8-19 ppm, below both the NIOSH REL of 35 ppm and the OSHA PEL of 50 ppm. Peak exposure concentrations ranged from 33-

281 ppm. The 281 ppm peak concentration for the worker in the weld shop was over the NIOSH ceiling limit of 200 ppm, which is recommended not to be exceeded at any time over the course of the workshift. However, this peak was the only time during the shift at which this high a concentration was measured. It was preceded by a concentration of 6 ppm the previous minute, and proceeded a concentration of 36 ppm the following minute. It did not have a major impact in increasing the overall TWA concentration to which this worker was exposed. Potential causes of the peak could include a surge in CO from either welding emissions or from a gasoline-powered forklift that was operating in the area at the time.

Medical

Interviews

Of the 34 employees selected for interview, 29 were interviewed, 4 were absent from work on the interview date and 1 declined to participate. Twenty-five of the interviewed workers were men. The mean age was 34 years (range 18 to 62). The average length of time these employees had worked at Morton Metalcraft was 3 years (range 1 month to 10 years). There were 13 welders, 11 machine operators, 2 grinders, 2 finish operators and 1 leadsperson. Although the main focus of the evaluation was on welders and employees in areas in the vicinity of welding processes, employees from different areas of the facility (such as finish operators) were included in interviews to determine the full extent of symptoms experienced by the workforce.

Seven workers reported eye, nose, or throat irritation and nine reported cough. Six workers reported occasional dizziness and fatigue while at work. Two of those with cough and three of those with dizziness and fatigue and three with mucous membrane irritation were of the opinion that their symptoms were related to work with significant improvement away from work.

Workers who reported these symptoms were either welders or worked near welders. Overall, workers who reported symptoms disclosed that these symptoms were worse during winter; this was attributed to decreased ventilation during the winter months.

All but two of the interviewed workers indicated that they used gloves to perform their tasks. Our observation of the finish operators, in particular, showed that they did not use gloves when painting. All workers were required to put on safety glasses or face shields and welders were required to use welding helmets when welding. Nine people reported having no formal training on work hazards and PPE use. Although not a hazard, workers complained of having to wash their hands with cold water as warm water was not available throughout the facility.

Incident Reports

Review of the incident reports and OSHA 200 and 300 logs 2000-2005 revealed musculoskeletal injuries and cuts, hearing loss, and metal in eyes. No respiratory or mucosal irritation symptoms were documented.

DISCUSSION AND CONCLUSIONS

Monitored exposures to welding fume components (metals, minerals, gases) did not reveal levels of exposure above applicable occupational exposure limits (OEL) on the days the site visit was conducted, although exposures to iron fume did near the NIOSH REL on two PBZ samples. Confidential interviews conducted with 29 employees, including 13 welders, did reveal several individuals with irritant symptoms. Of those interviewed, 34% reported upper respiratory or mucous membrane irritation, although only 17% reported a temporal association between their work and these symptoms. These symptoms were reportedly worse during the winter. Several scientific studies have shown these symptoms to be prevalent in welders.[13,14,15,16,17] These are attributed to the various irritant and sensitizing gases and particles of metals that constitute welding fumes.[18] Therefore, reduction of exposure to these agents may lead to a resultant decrease in the prevalence of these symptoms. In addition, tobacco smoke not only produces similar symptoms, but may also act in synergy with welding fumes.[15]

Morton Metalcraft has relied on ceiling and wall exhaust fans rather than local exhaust ventilation (LEV) to manage workplace exposures. These ceiling fans are only run occasionally during winter months in an effort to prevent a negative pressure build-up inside the facility. The exhaust fans create a negative pressure environment because doors and windows are typically closed in winter. While this exhaust may result in some reduction in the visible haze and overall contaminant levels, typically its impact is more limited in reducing exposures for welders compared to LEV. The benefit of LEV is efficiency by contaminant capture at the point of generation. Local exhaust ventilation, alone or in conjunction with general dilution ventilation, generally provides superior protection to the welder as compared to just a general exhaust system for the facility. As such, we encourage the use of LEV for welding operations such as those found at Morton Metalcraft. Given that exposures were below current OELs, however, improvements in the general ventilation may be an important first step, including the provision of conditioned make-up air, rather than relying on natural ventilation through open doors and windows.

To reduce hazards of welding fume exposures, the following hierarchy of controls is generally recommended: automation, substitution, isolation, and ventilation. Examples of these controls include:

- Partial or complete automation so the welder is less exposed to welding fumes.
- Process changes to limit hazards. For example, determine if different joining process other than welding can be used, if lower fume-producing welding processes, such as submerged arc welding or gas tungsten arc welding (GTAW or TIG) are feasible; or if low-fume electrodes can be substituted for the electrodes currently used.
- Isolating or enclosing the welding process to limit the hazard to workers.
- Ventilation to remove the fumes and gases from the welder's breathing zone. For more information on LEV, see Appendix A.

The issue of noise exposure in the facility was not included in the HHE request. However, the NIOSH investigators observed that employees without hearing protection worked close to the areas where hearing protection was required. Management noted that only certain areas of the work floor required hearing protection. Signs on the factory floor designated these areas. However, due to their proximity to these areas, these employees may still be exposed to high levels of noise, yet are not currently required to wear hearing protection. Further evaluation can determine if these additional employees should be included in the required hearing conservation program.

In addition, we observed that the paint used by paint booth employees was classified as a skin sensitizer. Therefore, the manufacturer's safety recommendations included that it not come in contact with bare skin. However, we observed painting being performed without gloves. The reason given for this was that it was necessary for grounding purposes due to the nature of the electrostatic paint process. Due to the sensitizing nature of the paint, Morton Metalcraft management should investigate controls that could both satisfy the requirements of the painting process and prevent contact with the employees' bare skin.

RECOMMENDATIONS

1. Develop a system to allow workers more control in turning the general ventilation fans on and off during the winter months when the factory's doors and windows are typically closed. Such a system can be tried on a trial basis to determine if it improves conditions, maintains the current conditions, or make conditions worse, as agreed upon by employee and management representatives. Prior to

implementation, decide who among the employees is specifically responsible for changing fan controls.

2. Consider using local exhaust ventilation for welding operations as a more effective engineering exposure control. Although the levels of welding fumes were below applicable occupational exposure limits on the days of the NIOSH evaluation, LEV can provide additional control of fumes and could alleviate eye, nose, and throat irritation reported by employees, as such irritative symptoms are possible at exposure levels below the PEL or REL.

3. Improve the training provided to workers on hazard communication and PPE use, as several workers reported having no formal training on work hazards and PPE use.

4. Encourage workers to report all potential work-related health symptoms to appropriate health care personnel. Morton Metalcraft should monitor reported health complaints in a system designed to identify particular job duties, work materials, or areas that may be associated with particular health effects.

5. Re-evaluate the effectiveness of the current hearing conservation program, particularly in light of hearing loss records found in the OSHA 200 and 300 logs. This would also entail conducting a thorough noise exposure evaluation to ensure that all employees who could be exposed to hazardous noise levels are included in the hearing conservation program and are required to wear hearing protection.

6. Evaluate the use of protective gloves for employees working in the paint booths to avoid direct skin contact with the paint.

7. Provide warm water in the bathroom so employees will be more likely to wash their hands thoroughly because of inappropriate water temperature.

8. Refrain from eating, drinking, or smoking in work areas. In fact, workers should be encouraged to quit smoking. Many adverse health effects have been associated with tobacco use including, but not limited to, various forms of cancer and respiratory diseases. Smoking may also act synergistically with some of the hazards that are present at work places. Additional information on smoking cessation programs available in the state can be obtained by calling 1-800-QUIT NOW (1-800-784-8669).

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Table 1 - Personal Breathing Zone Sample Results for Elements
HETA 2003-0237-2986 Morton Metalcraft Co.March 8-9, 2005

Date	Sample No.	Department	Aluminum (mg/m^3)	Beryllium (mg/m^3)	Cadmium (mg/m^3)	Calcium (mg/m^3)	Chromium (mg/m^3)	Copper (mg/m^3)	Iron (mg/m^3)
3/8	100	Weld shop	ND	ND	ND	0.011	ND	0.012	0.87
3/8	101	Weld shop	0.002	ND	ND	0.007	ND	0.032	1.84
3/8	103	Brakes and forming area	ND	0.000014	ND	0.008	ND	0.003	0.25
3/8	104	Weld shop	0.004	ND	0.0001	0.030	0.001	0.087	4.00
3/9	105	Tank cell	ND	0.000024	ND	0.010	ND	0.018	1.14
3/9	107	Weld shop	0.003	0.000011	0.0001	0.011	0.001	0.016	1.60
3/8	112	Weld shop	0.002	ND	ND	0.007	ND	0.012	1.07
3/8	113	Tank cell	ND	ND	ND	0.013	ND	0.020	1.50
3/9	116	Tank cell	ND	ND	ND	0.009	ND	0.009	0.60
3/9	119	Weld shop	ND	ND	ND	ND	ND	0.009	0.48
3/8	120	Weld shop	ND	ND	0.0001	0.011	ND	0.019	1.70
3/9	122	Spot weld	ND	ND	ND	ND	ND	0.001	0.04
3/8	126	Spot weld	ND	0.000045	ND	0.006	ND	ND	0.06
3/8	133	Tank cell	ND	ND	ND	0.013	ND	0.016	1.08
3/9	137	Weld shop	ND	ND	ND	ND	ND	0.019	1.23
3/9	142	Brakes and forming area	0.004	ND	ND	0.011	0.001	0.003	0.43
3/8	157	Great Dane area	ND	ND	ND	0.006	ND	0.003	0.20
3/9	165	Weld shop	0.006	ND	ND	0.009	0.001	0.013	0.96
3/9	169	Great Dane area	0.004	ND	0.0002	0.009	0.001	0.051	3.71
3/9	171	Weld shop	ND	ND	ND	0.005	0.001	0.009	0.76
3/9	186	Great Dane area & Tank cell	ND	ND	ND	ND	ND	0.013	0.86
3/9	187	Tank cell	ND	ND	ND	ND	ND	0.003	0.23
		NIOSH REL	**10**	**0.0005**	**LFC**	**varies***	**0.5**	**0.1**	**5**
		OSHA PEL	**15**	**0.002**	**0.005**	**varies***	**0.5**	**0.1**	**10**

Table 1 (continued). Personal Breathing Zone Sample Results for Elements
HETA 2003-0237-2986 Morton Metalcraft Co.
March 8-9, 2005

Date	Sample No.	Department	Magnesium (mg/m^3)	Manganese (mg/m^3)	Nickel (mg/m^3)	Phosphorus (mg/m^3)	Sodium (mg/m^3)	Titanium (mg/m^3)	Zinc (mg/m^3)
3/8	100	Weld shop	ND	0.08	ND	ND	ND	ND	0.002
3/8	101	Weld shop	ND	0.15	0.0006	ND	ND	0.0004	0.004
3/8	103	Brakes and forming area	ND	0.02	ND	ND	ND	0.0008	0.001
3/8	104	Weld shop	0.004	0.41	0.0026	ND	ND	0.0005	0.041
3/9	105	Tank cell	ND	0.10	ND	ND	ND	ND	0.010
3/9	107	Weld shop	ND	0.12	ND	ND	0.001	ND	0.003
3/8	112	Weld shop	ND	0.15	ND	ND	ND	ND	0.001
3/8	113	Tank cell	ND	0.12	ND	ND	0.002	ND	ND
3/9	116	Tank cell	ND	0.06	ND	ND	0.001	ND	0.004
3/9	119	Weld shop	ND	0.05	0.0008	ND	ND	ND	0.001
3/8	120	Weld shop	ND	0.18	ND	ND	0.003	ND	0.014
3/9	122	Spot weld	ND	0.003	ND	ND	ND	ND	0.020
3/8	126	Spot weld	ND	0.003	ND	ND	0.002	ND	0.005
3/8	133	Tank cell	ND	0.09	ND	ND	ND	0.0002	0.006
3/9	137	Weld shop	ND	0.12	ND	ND	0.003	ND	0.009
3/9	142	Brakes and forming area	ND	0.02	0.0005	0.006	ND	0.0011	0.002
3/8	157	Great Dane area	0.001	0.02	ND	ND	ND	0.0002	0.001
3/9	165	Weld shop	ND	0.11	0.0008	ND	0.001	0.0004	0.024
3/9	169	Great Dane area	0.001	0.50	0.0011	ND	0.008	0.0007	0.044
3/9	171	Weld shop	ND	0.06	0.0007	ND	ND	ND	0.004
3/9	186	Great Dane area & Tank cell	ND	0.05	0.0008	ND	ND	0.0002	0.003
3/9	187	Tank cell	ND	0.02	ND	ND	ND	ND	0.001
		NIOSH REL	**10**	**1**	**0.015**	**0.1**	**--**	**--**	**--**
		OSHA PEL	**15**	**5 (C)**	**1**	**0.1**	**--**	**--**	**--**

mg/m^3 = milligrams per cubic meter
C = ceiling limit
LFC = lowest feasible concentration
ND = non-detected
*Calcium occupational exposure limits vary according to the form of calcium present
**Dashed lines = no occupational exposure limits for that element

Table 2. Area Air Sample Results for Elements
HETA 2003-0237-2986 Morton Metalcraft Co.
March 8-9, 2005

Date	Sample No.	Department	Arsenic (mg/m^3)	Calcium (mg/m^3)	Chromium (mg/m^3)	Copper (mg/m^3)	Iron (mg/m^3)
3/8	127	Spot weld	ND	ND	ND	ND	0.04
3/8	132	Tank cell	ND	0.006	ND	0.001	0.11
3/8	134	Great Dane area	ND	0.006	ND	0.001	0.09
3/9	136	Brakes and forming area	ND	ND	0.0007	0.006	0.42
3/9	138	Tank cell	ND	0.006	ND	0.003	0.22
3/9	140	Weld shop	ND	0.006	ND	0.003	0.28
3/8	156	Weld shop	ND	0.006	ND	0.003	0.24
3/8	159	Brakes and forming area	ND	ND	ND	0.003	0.24
3/9	174	Weld shop	0.002	ND	ND	0.002	0.18
		NIOSH REL	**0.002 (C)**	**Varies***	**0.5**	**0.1**	**5**
		OSHA PEL	**0.010**	**Varies***	**0.5**	**0.1**	**10**
			Manganese (mg/m^3)	**Silver (mg/m^3)**	**Sodium (mg/m^3)**	**Titanium (mg/m^3)**	**Zinc (mg/m^3)**
3/8	127	Spot weld	0.004	ND	ND	ND	0.019
3/8	132	Tank cell	0.011	ND	ND	ND	ND
3/8	134	Great Dane area	0.007	0.0005	0.007	0.0003	0.001
3/9	136	Brakes and forming area	0.46	ND	0.008	ND	0.002
3/9	138	Tank cell	0.020	ND	0.007	0.0003	0.001
3/9	140	Weld shop	0.028	ND	0.010	0.0002	0.001
3/8	156	Weld shop	0.020	ND	0.007	0.0002	0.002
3/8	159	Brakes and forming area	0.025	ND	0.006	0.0002	0.001
3/9	174	Weld shop	0.018	ND	0.005	ND	0.001
		NIOSH REL	**1**	**0.01**	**--**	**--**	**--**
		OSHA PEL	**5 (C)**	**0.01**	**--**	**--**	**--**

mg/m^3 = milligrams per cubic meter
C = ceiling limit
ND = non-detected

*Calcium occupational exposure limits vary according to the form of calcium present
**Dashed lines = no occupational exposure limit set for that element

Table 3. Direct-Reading Results for Ozone
HETA 2003-0237-2986 Morton Metalcraft Co.
March 8-9, 2005

Date	Department	Concentration (ppm)
3/8	Great Dane area	ND
3/8	Weld shop	< 0.1
3/8	Tank cell	< 0.1
NIOSH REL		**0.1 (C)**
OSHA PEL		**0.1 (TWA)**

ppm = parts per million
C = ceiling limit
TWA = time weighted average
ND = Non-detected
< = less than

Table 4. Sampling Results for Carbon Monoxide
HETA 2003-0237-2986 Morton Metalcraft Co.
March 8-9, 2005

Date	Department	8-hr TWA (ppm)	Peak Concentration (ppm)
3/8	Weld Shop	13	85
3/8	Great Dane area	19	101
3/8	Weld Shop	10	57
3/8	Weld Shop	9	33
3/9	Tank cell	8	54
3/9	Weld Shop	9	76
3/9	Weld Shop	14	281
3/9	Weld Shop	12	55
NIOSH PEL		**35**	**200 (C)**
OSHA REL		**50**	**--**

ppm = parts per million
TWA = time weighted average
C = ceiling limit
Dashed lines = no occupational exposure limit set

Appendix A:

Local Exhaust Ventilation

A number of ventilation systems are commercially available to help control emissions during welding operations. Local exhaust ventilation (LEV) controls capture the air contaminants directly at the point of generation and are generally positioned no more than 12 inches away from the source. LEV systems are more effective than general ventilation systems because the air contaminants can be captured and removed before they can reach the welder's breathing zone. However, the effectiveness of the LEV system often depends on how the welder positions the hood. If the hood is placed too far from the welding operation, it may not adequately capture the air contaminants, depending on the capture velocity. LEV systems used during industrial welding operations can include fixed movable hoods, portable movable hoods, fume extraction guns, and, to some extent, canopy hoods.

OSHA 29 CFR 1910.252 recommends that "(movable hoods) should be placed as near as practicable to the work being welded and provided with a rate of airflow sufficient to maintain a velocity in the direction of the hood of 100 fpm in the zone of welding when the hood is at its most remote distance from the point of welding." To maintain a capture velocity of 100 feet per minute, OSHA provides the following values when using a 3" wide, flanged hood.

OSHA GUIDELINES FOR MOVABLE HOOD AIRFLOW RATES:

Distance from Arc to Hood (inches)	**Airflow (cubic feet per minute)**	**Duct Diameter (inches)**
4-6	150	3
6-8	275	3.5
8-10	425	4.5
10-12	600	5.5

The ACGIH Ventilation Manual also provides guidelines on the use of movable exhaust hoods for welding operations.[19] The airflow rates suggested by ACGIH are more conservative than those recommended by OSHA.

ACGIH GUIDELINES FOR MOVABLE HOOD AIRFLOW RATES:

Distance from Arc to Hood (inches)	**Plain Duct Airflow (cubic feet per minute)**	**Flange or Cone Hood Airflow (cubic feet per minute)**
up to 6	335	250
6-9	755	560
9-12	1335	1000

Fume extraction guns are high vacuum, low volume controls. Two types of fume extraction guns are available. One type of gun incorporates the ventilation directly into the gun design. Lines for the shielding gas and exhausted air are encased in a large, single line leading from the gun. The second type of gun is a conventional, non-ventilated model with a suction attachment connected to the gun nozzle. On this model, the shielding gas and exhausted air lines remain separate. The type of gun used often depends on the welder's personal preference. Welders who find the all-in-one fume extraction gun bulky and cumbersome may prefer to use a conventional gun with the suction attachment. There can be additional drawbacks to using the various types of local exhaust ventilation controls. For example, welders may resist using fume extraction guns if they consider them to be too cumbersome or if they believe the ventilation is exhausting the shielding gas in addition to the fumes. Movable hoods are only effective if welders continually position the hood close to the point of fume generation. Portable ventilated units may be too large to maneuver through the work in progress on the factory floor.

If local exhaust ventilation controls cannot be implemented, general dilution ventilation controls should be considered. A drawback to this system is that, although it may help to reduce overall fume levels in the facility, it may not have a significant impact on reducing the exposure levels of the welder. OSHA 29 CFR1910.252 recommends a minimum exhaust ventilation rate of 2000 cfm per welder when welding in a space of less than 10,000 ft^3 per welder, or when in a room with a ceiling height of less than 16 ft, or when in confined spaces or where the welding space contains structural barriers to the extent that they significantly obstruct cross ventilation. The ACGIH Ventilation Manual suggests the following general ventilation airflow rates: (1) for open areas where welding fume can rise away from the breathing zone the airflow required (cfm) = 800 x lb/hour of rod or wire used; (2) for enclosed areas or positions where fume does not readily escape the breathing zone the airflow required (cfm) = 1600 x lb/hour of rod or wire used. Examples of general dilution ventilation controls include suspended air filtration units and roof ventilators.

In addition to engineering controls, other factors such as work practices, personal protective equipment, and administrative controls should be investigated to help reduce worker exposures to welding fumes. Examples of work practices that may help to lower worker fume exposures include educating welders to keep their heads out of the weld plume and to remain aware of air currents to ensure welding is performed upwind of the fumes as much as possible. Examples of personal protective equipment include proper use of respirators, use of welding glasses/goggles/hoods by welders and workers in the vicinity, and availability of welding screens to place around weld operations. Examples of administrative controls include job rotation to limit welders' exposures, training and education of welders on hazards and controls associated with their jobs, and ensuring welders use ventilation and other supplied control measures.

Reference

19. ACGIH [2004]. Industrial ventilation: a manual of recommended practice. 25th Ed. Cincinnati, Ohio. American Conference of Governmental Industrial Hygienists.

DEPARTMENT OF HEALTH AND HUMAN SERVICES
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