NIOSH HEALTH HAZARD EVALUATION REPORT

HETA #2003-0029-2923
Ward Brodt Music Mall
Madison, Wisconsin

February 2004

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 Melissa Finley and Loren Tapp of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Field assistance was provided by Greg Burr, of HETAB, DSHEFS. Analytical support was provided by Ardith Grote, a NIOSH research chemist, and DataChem Laboratories, Inc. (Salt Lake City, Utah). Desktop publishing was performed by Robin Smith. Review and preparation for printing were performed by Penny Arthur.

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HIGHLIGHTS OF THE NIOSH HEALTH HAZARD EVALUATION

Evaluation of Acids and Organic Compounds in the Repair Shop

In October 2002, the National Institute for Occupational Safety and Health (NIOSH) received a Health Hazard Evaluation (HHE) request from employees of Ward Brodt Music Mall, Madison, Wisconsin to evaluate reports of sore throat, sinus headaches, congestion, asthma, persistent cough, allergies, sneezing, and watery eyes among repair shop employees. A site visit was made on January 13 and 14, 2003.

What NIOSH Did

- We took air samples in the repair shop for inorganic acids and volatile organic compounds.
- We checked the ventilation around the repair shop work benches and mechanical equipment as well as in the rooms used for chemical cleaning, buffing, and applying spray lacquer.
- We talked to seven employees in the repair shop about the repair operations they performed, their exposures and their symptoms.

What NIOSH Found

- All air sample results were very low and far below any occupational exposure limits.
- There were areas of poor distribution in the main area of the repair shop.
- Ventilation in the chemical cleaning, buffing, and lacquer rooms was adequate to control exposures.
- Some employees reported recent upper and/or lower respiratory (breathing) symptoms and skin irritation; breathing symptoms improved after the ventilation was improved.

What Ward Brodt Managers Can Do

- Provide employees with and encourage use of appropriate personal protective equipment.
- Install an emergency eyewash station.

What the Ward Brodt Employees Can Do

- Properly use personal protective equipment needed for repair operations.
- Do not eat, drink, or smoke in work areas.
- Report work-related symptoms to health and safety personnel.

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 #2003-0029-2923

Health Hazard Evaluation Report 2003-0029-2923
Ward Brodt Music Mall
Madison, Wisconsin
February 2004

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SUMMARY

On October 18, 2002, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request for a health hazard evaluation (HHE) at Ward Brodt Music Mall in Madison, Wisconsin. The request centered on workers' exposures to acids and solvents during musical instrument repair operations, the adequacy of the ventilation in the chemical room, and reported symptoms of sore throat, sinus headaches, congestion, asthma, persistent cough, allergies, sneezing, and watery eyes. On January 14, 2003, NIOSH investigators conducted an exposure assessment and interviewed repair shop workers. Between the time of the HHE request and the site visit, local exhaust ventilation was installed in the chemical room.

Personal breathing zone and general area air samples were collected and analyzed for inorganic acids (hydrochloric, nitric, and sulfuric) and volatile organic compounds (VOCs). Thermal desorption tubes were used qualitatively to determine the compounds to analyze. A ventilation assessment consisted of "smoke" tube observations and velometer measurements. Hydrochloric acid concentrations ranged from not detected (ND) to 0.049 milligrams per cubic meter (mg/m^3) and nitric acid concentrations ranged from ND to 0.035 mg/m^3. Sulfuric acid concentrations could not be determined due to analytical problems. Based upon thermal desorption tube results, the VOC samples were analyzed for toluene, trichloroethylene (TCE), and total VOCs (reported as octane). Toluene concentrations ranged from 0.06 to 0.29 parts per million (ppm), TCE concentrations ranged from trace to 0.99 ppm, and total VOC concentrations ranged from trace to 0.35 ppm. All of these results were far below applicable occupational exposure limits. Ventilation testing using visual "smoke" indicated little air movement over the workbenches and around mechanical equipment. A ventilation assessment of the slot hood in the chemical room found it within recommended standards. Although no applicable standards exist for the ventilation systems in the buffing and lacquer rooms, each area was under negative pressure in relationship to the repair shop.

Confidential interviews were conducted with repair shop employees. Of the seven brass and woodwind shop employees interviewed, three had experienced upper and/or lower respiratory symptoms they felt were related to acid mist exposure from the chemical room. Two of the three had complete resolution of their symptoms after a new ventilation system was installed. At least two of the seven have had mild to moderate skin irritation related to their work. These symptoms reportedly improved with skin moisturizers and glove use.

Employees' reports of upper and lower respiratory symptoms could be related to the low concentrations of air contaminants measured. It is possible that the reported symptoms were related to higher concentration of the irritants that may have been present in the repair shop prior to installation of the new ventilation system. Recommendations are provided to further reduce employees' exposures to these chemicals by increasing the level of personal protection for workers in the repair shop, and improving ventilation and work practices in the facility.

Keywords: SIC Code 7699 (Repair Shops and Related Services, Not Elsewhere Classified), musical instrument repair, inorganic acid, hydrochloric acid, sulfuric acid, nitric acid, toluene, trichloroethylene, TCE, sore throat, headaches, congestion, asthma, cough, allergies, sneezing, watery eyes, upper respiratory symptoms, lower respiratory symptoms, skin irritation.

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INTRODUCTION

On October18, 2002, the National Institute for Occupational Safety and Health (NIOSH) received a confidential Health Hazard Evaluation (HHE) request from employees of Ward Brodt Music Mall in Madison, Wisconsin, to evaluate potential health effects from exposures related to repairing brass and woodwind band instruments. Health symptoms of concern that were reported in the HHE request included sore throat, sinus headaches, congestion, asthma, persistent cough, allergies, sneezing, and watery eyes. Employees felt the symptoms may be due to exposures to chemicals with which they work (including hydrochloric acid, chromic acid, sulfuric acid, aqueous detergent, Carbo-sol™, acetone, lacquer thinner, lacquer, soldering fluxes, and lacquer stripper) and inadequate ventilation in the chemical room. In response to employee concerns, Ward Brodt installed new ventilation in the chemical room between the time of the request and the date of the NIOSH evaluation.

On January 13 and 14, 2003, NIOSH investigators conducted an HHE site visit at Ward Brodt Music Mall. The site visit included an opening conference, walk-through inspection, observation of work practices, collection of air samples for inorganic acids and volatile organic compounds (VOCs) in the repair shop area, assessment of the ventilation in the shop area and adjacent rooms, confidential employee interviews, a review of documents, and a closing conference. An interim report, sent February 20, 2003, described preliminary industrial hygiene and medical findings and recommendations. This final report contains the results of the air sampling and medical interviews, discussion of sampling methods, a review of the potential health effects from the various chemicals to which Ward Brodt employees are exposed, and recommendations.

BACKGROUND

Ward Brodt Music Mall is a 30,000-square feet facility providing a wide range of musical services including sale and rental of a large variety of instruments, sale of sheet music, music lessons, instrument tuning and repair, and delivery of instruments. The company has been in business for 75 years and currently employs 126 workers, including sales personnel, music teachers, repair personnel, and delivery personnel. For the past 20 years, Ward Brodt has rented and occupied a building which is owned by the American TV and Appliance Company. A contracting service maintains the heating, ventilating, and air conditioning (HVAC) and electrical systems in the building.

The repair shop, located in the back of the building, includes electronic, string, band (brass and woodwinds), and percussion sections. Employees from the band instrument group requested the HHE. There are six full-time and two part-time employees in the band instrument repair area. The full-time employees work 40 hours a week plus one Saturday and one Sunday every six weeks. Shop employees are instrument repair technicians that undergo a one-to two-year training program to learn the skills needed for instrument repairs and/or cleaning. In the band instrument section, there are eight workstations equipped with tools, spare parts and acetylene torches. There are three small enclosed areas off the main room of the repair shop housing chemical cleaning, buffing, and spray lacquer operations. The chemical cleaning room has 30-gallon dip tanks of hydrochloric acid (HCl) solution, sulfuric acid solution, and detergent, as well as a 5-gallon container of non-fuming chromic acid solution. The room also has a sink with running water, an air hose, and a chemical storage cabinet. The buffing room houses a buffing/grinding machine with local exhaust ventilation (LEV), and an unvented sanding/strapping machine. The spray lacquer room has a workbench, exhaust fan, and a chemical storage cabinet.

To repair an instrument, a technician first disassembles the instrument and lubricates the slides or keys at his/her own workstation. The technician then cleans the body of the instrument by soaking it in a dip tank located in the chemical cleaning room- hydrochloric acid for brass instruments, sulfuric acid for silver instruments, or detergent. Chromic acid is also

stored in this room and used as a brightener. After soaking for approximately one minute, the technician removes the instrument from the tank and scrubs it with a "snake" or uses compressed air to "blow it out" at the sink. The technician rinses the instrument with water and repeats the soak, if necessary. Alternatively, if the instrument requires a dry cleaning, the technician may use solvents such as acetone or Carbo-sol™, containing trichloroethylene (TCE), at his/her workbench. The technician then dries the instrument, oils the valves, greases the slides, and replaces the pads. For final repairs and finishing, the technician may, as necessary, solder, buff, grind, sand, remove dents, or lacquer the instrument. Soldering takes place at the technician's workbench, including the use of solder fluxes. Buffing, grinding, and sanding the instrument occurs in the buffing room. The lacquering process is confined to the lacquering room and includes the use of lacquer thinner, lacquer stripper, and spray lacquer.

The chemical room was originally enclosed about ten years ago, at which time an acid resistant fan was installed. Following replacement of the fan about a year ago, it was discovered that the exhaust from the chemical room was not being vented to the roof, but leaking out into the plenum (space above the ceiling tiles). Employees also noted that the mirror and window in the chemical room "clouded up" and tools left in the room were rusting. After this discovery, an HVAC company was contracted and in mid-October 2002, a new adjustable speed slot hood was installed inches over the dip tanks.

Workers use an assortment of personal protective equipment (PPE), including rubber gloves for working with the chemicals, cotton gloves for buffing, eye goggles, aprons, and dust masks.

METHODS

Industrial Hygiene Evaluation

A sampling protocol was developed by NIOSH investigators after speaking with Ward Brodt employees and reviewing Material Safety Data Sheets (MSDSs) of the chemicals used in these operations. During the sampling survey, NIOSH investigators collected full-shift personal breathing zone (PBZ) samples of inorganic acids and VOCs on two employees. General area (GA) air samples for inorganic acid and VOCs were also taken in the repair shop and adjacent rooms. One 15-minute short-term sample was also taken to collect inorganic acid during a cleaning operation. Sampling for chromic acid was initially anticipated; however, on the day of the survey, chromic acid was not used.

Inorganic Acids

Full-shift PBZ and GA air samples for acids were collected using silica gel sorbent tubes attached by Tygon® tubing to sampling pumps calibrated at a flow rate of 100 cubic centimeters per minute (cc/min) according to NIOSH method 7903- Inorganic Acids.[1] One 15-minute short-term sample was taken at a flow rate of 200 cc/min to collect acids during the cleaning operation. All samples were analyzed by ion chromatography.

VOCs

Area air samples were collected using thermal desorption tubes to identify VOCs. Thermal desorption tubes were used qualitatively to determine which compounds to analyze quantitatively from the charcoal tubes. The thermal desorption tubes were attached by Tygon® tubing to sampling pumps calibrated at a flow rate of 50 cc/min. Each thermal desorption tube contained three beds of sorbent material: Carbopak Y, Carbopak B, and Carboxen 1003. The thermal desorption tubes were analyzed using a Perkin-Elmer ATD 400 automatic

thermal desorption system equipped with a gas chromatograph with a mass selective detector (TD-GC-MSD). The sampling and analytical techniques for this method are in accordance with NIOSH method 2549-Volatile Organic Compounds (Screening).[1]

Full-shift PBZ and GA air samples were collected using charcoal tubes attached by Tygon® tubing to sampling pumps calibrated at a flow rate of 100 cc/min. Based on the thermal tube results, toluene, TCE, and total hydrocarbons (reported as octane) were quantitatively analyzed using a Hewlett-Packard (Palo Alto, California) Model 5890A gas chromatograph equipped with a flame ionization detector.

Ventilation

The ventilation assessment consisted of velometer measurements and smoke tube observations. Velometer (thermoanemometer) measurements were made with the VelociCalc® Model 8386A (TSI, Inc., St. Paul, Minnesota). This instrument measures air velocity in feet-per-minute (FPM). Three measurements of the air velocity were taken across the face of the recently installed ventilation system above the dip tanks and the results averaged to obtain the mean velocity. Velocity measurements were also taken of the ventilation at the buffing wheels and the exhaust fan in the lacquer room. Observations of air flow were made using "smoke" released in various locations around the repair shop, including in and around the shop work benches, chemical room, lacquer room and string repair shop.

Medical Evaluation

Confidential employee interviews were conducted during the site visit. All six full-time brass and woodwind shop employees and one of the two part-time employees participated; the other part-time employee was not available at the time of the evaluation.

The U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Log and Summary of Occupational Injuries and Illnesses, Forms 200 and 300 (OSHA 200 and 300 logs) were reviewed from years 1998 through 2002.

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 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 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.

Hydrochloric Acid

Hydrochloric acid (HCl), the aqueous form of hydrogen chloride, is irritating and corrosive to any tissue it contacts. Brief inhalation exposure to low concentrations can cause throat irritation. Long-term exposure to low levels can cause respiratory problems, eye and skin irritation, and discoloration of the teeth.[5] Exposure to relatively high concentrations can result in rapid breathing, narrowing of the bronchioles (airways in the lungs), blue coloring of the skin, and accumulation of fluid in the lungs. Exposure to even higher levels can cause swelling and spasm of the throat, suffocation, and even death. Some people may develop an inflammatory reaction to hydrochloric acid. This condition is called reactive airways dysfunction syndrome (RADS), a type of asthma caused by some irritating or corrosive substances.[5] It is unknown if exposure to hydrochloric acid can result in reproductive effects. The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the Environmental Protection Agency (EPA) have not classified hydrochloric acid as to its carcinogenicity. IARC considers hydrochloric acid to be not classifiable as to its carcinogenicity to humans.[6]

The NIOSH REL[2], ACGIH TLV[3], and OSHA PEL[4] for hydrochloric acid are 7 milligrams per cubic meter (mg/m^3), 2 mg/m^3, and 7 mg/m^3, respectively, as ceiling values.

Nitric Acid

Nitric acid is a corrosive liquid which severely irritates the skin and eyes upon contact. Nitric acid mist can irritate the nose, throat, and lungs and cause dental erosion. Lung irritation causes coughing and/or shortness of breath and exposure to high concentrations can cause pulmonary edema (a build-up of fluid in the lungs).[7] Ingestion of nitric acid will result in severe throat and stomach destruction.

NIOSH[2], ACGIH[3], and OSHA[4] have all set TWA exposure limits for nitric acid at 5 mg/m^3. NIOSH and ACGIH also have STELs at 10 mg/m^3 for this substance.

Sulfuric Acid

Sulfuric acid is a severe irritant to the eyes, mucous membranes, and skin. Concentrated sulfuric acid is a corrosive; it can cause severe burns on contact. Sulfuric acid mists can cause eye, nose, and throat irritation, respiratory irritation (manifested by cough and difficulty breathing), and dental erosion. The extent of respiratory irritation depends on factors such as air concentration, particle size, temperature, and humidity.[8] NIOSH[2], ACGIH[3], and OSHA[4] have established an exposure limit for sulfuric acid of 1 mg/m^3 as a TWA to prevent dental erosion and the irritant effects of exposure. ACGIH has recently established a notice of intended change to 0.1 mg/m^3 for their TLV.[3]

Epidemiologic studies have indicated that exposure to sulfuric acid mist and other acid mists are associated with cancer. After review of these studies, the IARC determined that there is sufficient evidence that occupational exposure to strong inorganic acid mists containing sulfuric

acid is carcinogenic.[6] This determination was based on the demonstration of epidemiologic associations between occupational exposures to strong acid mists (mostly sulfuric acid mists) and excess risks for laryngeal cancer[9,10,11,12] and lung cancer.[13,14,15] A study of cancer in the general population (not just workers) found that any exposure to sulfuric acid was associated with cancer of the esophagus, but an association between higher exposure and higher risk was not established.[15]

Chromic Acid

Chromic acid (CrO_3) is a corrosive chemical and can cause severe irritation and burns of the skin and eyes, irritation of the nose, throat, and lungs causing coughing, wheezing and/or shortness of breath. Chromic acid can also cause sores and erosion of the nasal septum, and may cause an allergic skin dermatitis. The hexavalent chromium [Cr(VI)] form is also considered to be a carcinogen in humans by the World Health Organization (WHO), EPA, and NIOSH. Birth defects have been seen in animals exposed to Cr(VI).[16] Exposure limits for airborne chromic acid [measured as Cr(VI)] by NIOSH[2], ACGIH[3], and OSHA[4] are 0.001 mg/m^3, 0.05 mg/m^3, and 0.1 mg/m^3, respectively. The NIOSH REL (10-hour TWA) is 0.001 mg $Cr(VI)/m^3$ for all hexavalent chromium compounds. NIOSH considers all Cr(VI) compounds (including chromic acid) to be potential occupational carcinogens. NIOSH recommends that exposures to potential occupational carcinogens be limited to the lowest feasible concentration.[2]

Trichloroethylene

Trichloroethylene (TCE) is a volatile liquid at room temperature and can affect the central nervous system, heart, skin, and possibly the liver and kidney. The most frequently reported symptoms related to excessive exposure include headache, nausea, vomiting, dizziness, vertigo, fatigue, mental dullness, sleepiness, lightheadedness, insomnia, and burning eyes.[17]

Experimental studies in animals have shown that TCE may be carcinogenic.[18] After a special review of experimental and epidemiologic data, NIOSH concluded that TCE a potential occupational carcinogen, although not a potent one.[19] NIOSH recommends that exposures to potential occupational carcinogens be limited to the lowest feasible concentration.[2] In addition, NIOSH recommends a REL of 2 ppm (as a 60-minute ceiling) during the usage of TCE as an anesthetic agent and 25 ppm (as a 10-hour TWA) during all other exposures. The ACGIH TLV is 50 ppm for an 8-hour time-weighted average.[3] The OSHA PEL for trichloroethylene is 100 ppm with a 15-minute STEL of 200 ppm.[4]

Toluene

Toluene is a colorless, aromatic organic liquid containing a six carbon ring (a benzene ring) with a methyl group (CH_3) substitution. It is found in paints and other coatings, and is used as a raw material in the synthesis of organic chemicals, dyes, detergents, and pharmaceuticals.

Inhalation and dermal absorption are the major routes of entry in occupational exposures. Excessive exposure to toluene can cause acute irritation of the eyes, respiratory tract, and skin. Since it is a defatting solvent, repeated or prolonged skin contact will remove the natural lipids from the skin which can cause drying, fissuring, and dermatitis.[20, 21] Studies have shown that subjects exposed to 100 ppm of toluene for six hours complained of eye and nose irritation, and in some cases, headache, dizziness, and a feeling of intoxication (narcosis).[22,23,24] No symptoms were noted below 100 ppm in these studies. The main effects reported with excessive (inhalation) exposure to toluene are CNS depression and neurotoxicity.[20] There are a number of reports of neurological damage due to deliberate sniffing of toluene-based glues resulting in motor weakness, intention tremor, ataxia, and cerebellar and cerebral atrophy.[25] Recovery is complete following infrequent episodes of this type of exposure, however, permanent impairment may occur after repeated and prolonged glue-sniffing abuse. Exposure to extremely high concentrations of toluene may cause mental confusion, loss of coordination, and unconsciousness.[26,27]

The NIOSH REL for toluene is 100 ppm for up to a 10-hour TWA.[2] NIOSH has also set a recommended STEL of 150 ppm for a 15-minute sampling period. The ACGIH TLV is 50 ppm for an 8-hour exposure TWA with a skin notation, indicating that cutaneous exposure contributes to the overall absorbed inhalation dose and potential systemic effects.[3] The OSHA PEL for toluene is 200 ppm for an 8-hour TWA.[4]

RESULTS

Industrial Hygiene Evaluation

The limits of detection (LOD) describe the amount of substance below which it cannot be detected on the sample. The limits of quantification (LOQ) describe an amount of substance above the LOD, but not enough to quantify accurately. The LOD and LOQ are values determined by the analytical procedure used to analyze the samples, and are not dependent on sample volume. Minimum detectable concentrations (MDCs) are the minimum detectable air concentrations and are determined by dividing the LODs by air sample volumes appropriate for the given set of samples. Minimum quantifiable concentrations (MQCs) are determined by dividing the LOQs by air sample volumes for the given set of samples, and reflect a concentration above the MDC but not enough to quantify accurately. In determining the MDC and MQC for this study, the highest sample volumes were used from the area air sampling data and from the PBZ air sampling data for each type of sample. These values are included in the tables, as appropriate.

Inorganic Acids

The results of the analysis of the silica gel tubes for HCl, nitric, and sulfuric acids are summarized in Table 1. All results were well below any occupational exposure criteria. Analysis revealed the presence of all three acids on the field blanks.[*] Because of this, the exposure concentrations included in this report represent the blank-corrected results. Additionally, analysis revealed the presence of sulfuric acid on the media blanks.[**] Because of this, the results for sulfuric acid are not included in this report.

VOCs

Charcoal tube air samples were quantitatively analyzed for toluene, TCE, and total hydrocarbons (as octane). Results are summarized in Table 2. All results revealed individual concentrations to be well below applicable occupational evaluation criteria.

Ventilation

On the day of sampling, the temperature inside the building ranged from 69-70°F and the relative humidity (RH) ranged from 16-20 percent (%). The results of the ventilation assessment in the acid room showed a face velocity of 1000 FPM and a flow of 220 cubic feet per minute (CFM) with the dial controlling the fan speed at its lowest setting. According to information provided by North American Mechanical Corporation (the company responsible for the installation of the new ventilation), the fan speed can be adjusted to allow a flow of 500 CFM. Even at its lowest setting, the ventilation appropriately created negative pressure in the chemical room in relation to the rest of the shop.

The exhaust air velocity at the left buffing wheel was 200 FPM, and the velocity at the right

[*]A field blank is a piece of sampling media that undergoes similar handling of the sampling media to be used, including being opened and exposed to the field environment, but on which no sample is collected. Analysis of this blank is important to detect any contamination that may occur during the transport and handling of the samples.

[**]A media blank is a piece of sampling media taken from the lot of sampling media to be used, but is not opened in the field. Analysis of this blank is important to detect any contamination on the sample media material itself.

buffing wheel was 400 FPM. The fan in the lacquer room was measured at 120 FPM. Both the buffing and spray lacquer rooms were under negative pressure in relation to the repair shop when the exhaust fans were operating.

Based on the smoke tube observations, some areas of stagnant air existed over the work benches and metal- and woodworking machines located around the shop. The air in these areas is vented only by the general HVAC system in the room. This air in the shop is not circulated in the rest of the store.

Workplace Observations, Work Practices and PPE

NIOSH investigators spoke with repair shop technicians to learn about typical work practices. Findings are summarized below along with observations made by NIOSH investigators of the workplace and work practices on the day of the survey.

- Tasks such as acid washes, buffing, and lacquering take very little time (only one to ten minutes). This has lead to a general feeling that personal protective equipment, such as respirators, gloves, and goggles, is not needed. Additionally, its use is not enforced by management for normal operations.
- Filtering facepiece respirators were worn by less than half of the employees when buffing, and respiratory protection was never worn during lacquering.
- Three employees used gloves fairly regularly in the chemical room. Outside of the chemical room, gloves were seldom worn except for big jobs that increased the potential for skin exposure to acid solutions. No gloves were worn when applying Carbo-sol™ (TCE) since employees stated that they would fold up a rag and dip it into the solvent without getting it on their skin.
- Goggles were worn routinely when working on the buffing, lathe, or band saw machines, but rarely in the chemical room or lacquer room.
- A break room is available near the repair shop, but employees are allowed to eat and drink at their workbench.
- No emergency eye wash station was provided in the immediate vicinity of the acid dip tanks.
- The dip tanks containing the acids and solutions used in the cleaning operation were unlabeled.
- Acids and oxidizers were placed in the same storage cabinet as organic compounds.
- The sprinkler head in the lacquer room was not protected.
- Water-damaged ceiling tiles were noticed in the repair shop area. The reason for the damage was unknown.

Medical Evaluation

Of the seven employees interviewed, 4 were male; the average age was 39 years (ranging from 25 to 46 years); and the average length of time from first hire was 10 years (ranging from 1.5 to 18 years). Of these seven employees, three reported experiencing upper and/or lower respiratory symptoms (irritated throat, hoarse, raspy voice, and persistent cough) they felt were related to acid mist exposure from the chemical room. Symptoms of irritated throat and hoarse voice would reportedly develop at work, gradually worsen by the end of the day, and then resolve when away from work in the evening. Medical treatment had been sought in the past by two of the symptomatic workers. Two of the three had complete resolution of their symptoms after a new ventilation system was installed. At least two of the seven employees have had mild to moderate skin irritation that they thought was work-related; the skin problems reportedly improved with use of skin moisturizers and gloves.

OSHA 200 and 300 logs, from years 1998 through 2002, revealed there were four entries for repair technicians; one for shoulder strain (2002), one for a finger laceration, one for a broken ankle (2001), and one for skin eczema (2000).

DISCUSSION AND CONCLUSIONS

Industrial Hygiene Evaluation

Air Sampling

None of the air samples collected by NIOSH for VOCs or acids yielded concentrations that exceeded any occupational exposure limit (OEL). However, many of these chemicals have low odor thresholds (meaning they can be smelled at low concentrations) or could possibly cause mucous membrane irritation at low concentrations in sensitive individuals.

Sampling was conducted over the full work-shift for HCl. Although no standard for an eight-hour TWA for HCl exists, this sampling was conducted to represent the worst-case scenario. Since the workers were only present in the chemical room for a few minutes at a time, the actual exposure would be even lower throughout the day. The very low HCl concentrations measured over the full shift are consistent with the lack of HCl detected on the 15-minute short-term sample. Although sulfuric acid was potentially present in the air of the repair shop, the results of the air sampling for this analyte could not be determined because of possible sample contamination. However, based on observations of the technician's tasks and work practices, exposures to sulfuric acid in this work setting are unlikely to be above any relevant OEL.

NIOSH recommends that exposures to TCE be limited to the lowest feasible concentration because of its potential carcinogenicity. Although TCE concentrations in the air of the repair shop are currently very low, its presence could be eliminated by using solvents which do not contain TCE. The most probable source of TCE in the repair shop environment is from Carbo-sol™. Since repair shop employees claim that this solvent is used rarely and in small quantities, its substitution is not likely to adversely affect operations.

Ventilation

Based on ventilation recommendations from ACGIH, the chemical room ventilation is adequate.[28] Because no sampling was performed before the ventilation was installed, the concentrations of the contaminants in the air at that time are unknown. However, our sampling data support the conclusion that the current ventilation is adequately controlling exposures and containing them within the chemical room.

The buffing wheel system LEV appeared to adequately control exposures, although the capture hood could be located closer to the wheel. Employees reported that the exhaust hood needed to be adjustable to accommodate the various sizes of instruments used on the machine.

The wall-mounted exhaust fan in the lacquer room was sufficient to keep the room under negative pressure in relation to the repair shop. This situation helps control exposures during the lacquering operations.

As illustrated by the smoke tubes, the air over the work benches and metal- and woodworking machines located around the shop was vented only by the normal HVAC system in the room. This arrangement may not be desirable since this general ventilation is not intended to provide LEV for the repair operations such as cutting, grinding, soldering, and lathing.

Air temperatures measured on the sampling date were within acceptable limits of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE).[29] However, the RH levels were below the ASHRAE comfort guidelines of 30-60%.[29] Despite this, humidification is not generally recommended since the ventilation system was not designed for humidification and high humidity levels can also be problematic. Although not in use on the day of sampling, humidifiers were reported to be used in the building for comfort, as needed. These units use a moistened pad that must be properly maintained and cleaned to avoid problems with

microbial contamination. As long as these units are routinely cleaned, they can be used for humidification purposes.

PPE

Skin contact can be a significant route of exposure to solvents, and contact dermatitis of the hands and forearms can be a problem for workers exposed to these chemicals. Therefore, gloves, aprons, and eye goggles to protect skin and eyes from solvents and acids are recommended. Eye goggles would be more effective than eye glasses in protecting the eyes from contact with chemicals in the event of a splash or spill during mixing. For the nature of the operations at this facility, gloves made of butyl rubber would be appropriate to protect against inorganic acids (HCl, nitric, sulfuric, and chromic acids) and solvents such as acetone. If different acids or solvents are used in the future, a further glove material evaluation may be needed.

Workplace Observations

Allowing employees to eat and drink at their workstations is undesirable because of lead-containing solder and solvents used. Contaminated hands can lead to ingestion of metals and chemicals. To avoid contamination and possible ingestion of potentially harmful substances such as residue from soldering and solvents on hands, workers should be discouraged from eating and drinking at their work bench.

According to OSHA, employers must provide an emergency shower and eye-wash station close to the dipping or coating operation when employees work with liquids that may burn, irritate, or otherwise harm their skin. In place of this equipment, a water hose that is at least four feet (1.22 meters) long and at least 3/4 of an inch (18 millimeters) thick with a quick-opening valve and carrying a pressure of 25 pounds per square inch (1.62 kilogram/centimeter^2) or less may be used. [30]

OSHA also requires employers to ensure that each container of hazardous chemicals in the workplace is labeled, tagged or marked to identify the hazardous chemical contained therein and to provide at least general information regarding the hazards of the chemicals so employees will have specific information regarding the physical and health hazards of the hazardous chemical.[31]

Allowing materials such as acids, oxidizers, and organic compounds to be stored in the same cabinet is undesirable because these materials are incompatible. Accidental mixing or spilling of these chemicals could cause an adverse chemical reaction.

The sprinkler head in the lacquer room was unprotected, a situation which could potentially allow lacquer to accumulate on the sprinkler mechanism and cause it to malfunction.

Medical Evaluation

Air sampling revealed exposures to very low concentrations of substances in use at the facility. Although acid concentrations measured during our site visit were below recommended exposure limits, symptoms consistent with work-related acid exposures (respiratory symptoms and irritated throat, eyes, and skin) were indicated on the request and reported in this evaluation. It is possible that repair shop employees may have been exposed to greater concentrations of these substances in the past. The types and severity of symptoms depend in part on the extent of the individual's exposure, and the susceptibility of the individual (for example, whether they have pre-existing allergies, eczema, or asthma). The NIOSH investigators found that most employees reported resolution of their symptoms after the ventilation was improved.

RECOMMENDATIONS

Modified work practices and use of appropriate personal protective equipment will likely reduce skin contact with substances used by repair shop employees. Additionally, although none of the sample results exceeded any occupational exposure limits, steps may be taken to further reduce employees' inhalation exposures to chemicals used in the repair shop. The

following recommendations are based on observations made during the survey and are intended to help ensure the safety and health of the repair shop workers by further reducing employees' exposures.

1) Encourage the use of safety glasses during buffing operations and butyl rubber gloves when handling acids and acetone. In addition to butyl rubber gloves, safety goggles and an apron should be worn during mixing in the chemical room.

2) Install an emergency eyewash station in the chemical room.

3) Do not store incompatible materials, such as acids and oxidizers, near organic compounds. One option would be to store organic solvents in the lacquer room cabinet.

4) Ensure that all tubs and containers of chemicals are labeled with the appropriate information.

5) Restrict eating and drinking in the repair shop area. Workers should wash hands prior to eating and drinking during their shift.

6) Although the ventilation in the repair shop is adequately controlling exposure, further steps could be taken to minimize employees' occupational exposures.

    a) Provide LEV for the metal- and woodworking machines located in the shop during the repair operations and to help reduce the overall dustiness of the shop.

    b) Adjust the exhaust hood at each buffing wheel closer to the part during buffing operations.

    c) Install a passive vent in the door or wall of the chemical room to permit the exhaust fan to operate more efficiently.

7) Substitute a less toxic chemical for the solvent containing TCE.

8) Protect the sprinkler head in the lacquer room.

9) Encourage employees to report all suspected work-related health problems to designated health and safety personnel at Ward Brodt Music Company. Those employees who continue to experience health symptoms should be evaluated by a physician experienced in occupational illnesses.

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Table 1 Results of Acid Sampling

January 14, 2003

Ward Brodt Music Mall

HETA 2003-0029-2923

Sample Type	Person/ Location	Sample Volume (L)	Concentration, mg/m^3	
			Hydrochloric Acid	Nitric Acid
PBZ	**Tech 1**	35	trace	0.035
PBZ	**Tech 2**	35	trace	ND
PBZ-ST	**Tech 1**	3	ND	ND
GA	**Outside Chemical Room**	37	0.010	ND
GA	**Inside Chemical Room**	38	0.049	0.030
GA	**Tech 3 Workbench**	34	trace	ND
GA	**Tech 4 Workbench**	35	trace	trace
Minimum Detectable Concentration		38	0.0027	0.0053
Minimum Quantifiable Concentration		38	0.0108	0.0132

Occupational Exposure Limits

OSHA PEL[1]	7 [C]	5
NIOSH REL[2]	7 [C]	5; 10 [STEL]
ACGIH TLV [3]	3 [C]	5; 10 [STEL]

1-Occupational Safety and Health Administration Permissible Exposure Limit
2- National Institute for Occupational Safety and Health Recommended Exposure Limit
3- American Conference of Governmental Industrial Hygienists Threshold Limit Value
L = liter
mg/m^3 = milligrams per cubic meter
PBZ = personal breathing zone
PBZ-ST = personal breathing zone - short term
GA = general area
trace = detected value was between MDC and MQC
ND = not detected, value below MDC
C = ceiling exposure limit
STEL = short-term (15 minutes) exposure limit.
*Sulfuric Acid levels are not reported due to possible contamination on the sample collection media.

Table 2 Results of VOC Sampling

January 14, 2003

Ward Brodt Music Mall

HETA 2003-0029-2923

Sample Type	Person/ Location	Sample Volume (L)	Concentration, ppm		
			Toluene	TCE	Total VOC [Octane]
PBZ	Tech 2	34	0.29	0.99	0.35
PBZ	Tech 5	25	0.12	0.14	trace
GA	Tech 1 Workbench	36	0.07	0.10	0.16
GA	Outside Lacquer Room	38	0.06	0.08	0.13
GA	Inside Lacquer Room	39	0.08	trace	0.15
GA	Tech 3 Workbench	35	0.08	0.06	0.31
Minimum Detectable Concentration		39	0.0061	0.0143	0.0384
Minimum Quantifiable Concentration		39	0.024	0.0477	0.1098

Occupational Exposure Limits

OSHA PEL[1]	200	100	500
NIOSH REL[2]	100	25	75
ACGIH TLV [3]	50	50	300

1-Occupational Safety and Health Administration Permissible Exposure Limit
2- National Institute for Occupational Safety and Health Recommended Exposure Limit
3- American Conference of Governmental Industrial Hygienists Threshold Limit Value
L = liter
ppm = parts per million
PBZ = personal breathing zone
GA = general area
trace = detected value was between MDC and MQC
LFL = lowest feasible level

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