HETA 99–0185-2787
Wonder Industries
Wyoming, Minnesota

Robert E. McCleery, MSPH

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 Robert E. McCleery, MSPH of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Field assistance was provided by Gregory Burr, CIH. Analytical support was provided by Ardith Grote, and Data Chem Laboratories, 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 Plastic Injection–molding Fumes

On April 22, 1999, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) at the Wonder Industries facility in Wyoming, Minnesota. The confidential employee request mentioned poor ventilation and fumes from the various plastics used in the injection processes in the plant. The employees reported symptoms of headaches, dizziness, sore throat, skin rashes, chronic ear problems, and shortness of breath.

What NIOSH Did

We took area air samples for formaldehyde, acetaldehyde, volatile organic compounds, hydrocarbons, and carbon monoxide.

We talked to employees about plastic injection–molding and any health and safety questions they had.

We looked at how employees did their jobs.

What NIOSH Found

Formaldehyde and acetaldehyde levels were below OSHA standards.

Low levels of many different volatile organic compounds in the injection–molding area.

Hydrocarbon levels were very low.

Carbon monoxide levels were very low.

What Wonder Industries Managers Can Do

Check the noise levels in the facility to make sure they are below OSHA standards.

Watch out for heat stress to employees from the heat generated by injection–molding machines.

Arrange the respirators, hearing protection, gloves, and arm sleeves into one personal protective cabinet.

Keep the exhaust fans running in the injection–molding area to help bring in fresh air.

What the Wonder Industries Employees Can Do

Keep up the good housekeeping in the injection–molding and warehouse areas.

Wash your hands before eating or drinking.

You may want to wear hearing protection if working the injection–molding machines and respirators if working in a dusty area.

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

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 # 99–0185-2787

National Institute for Occupational Safety and Health
NIOSH

Health Hazard Evaluation Report 99–0185-2787
Wonder Industries
Wyoming, Minnesota
March 2000

Robert E. McCleery, MSPH

SUMMARY

On April 22, 1999, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) at the Wonder Industries facility in Wyoming, Minnesota. The confidential employee request expressed concern about the inadequate ventilation and possible generation of fumes from the various plastics used in the injection–molding processes in the facility. The employees reported symptoms of headaches, dizziness, sore throat, skin rashes, chronic ear problems, and shortness of breath.

In response to this request, NIOSH investigators conducted an environmental investigation at the facility on November 17 and 18, 1999. NIOSH investigators collected five real–time, data–logged, area air samples for carbon monoxide (CO); five area air samples for aldehydes (formaldehyde and acetaldehyde); seven area air samples for hydrocarbons; and eight area thermal tube air samples for volatile organic compounds (VOCs).

In general, aldehydes (formaldehyde and acetaldehyde) were found around all injection–molding machines in operation throughout the facility. The formaldehyde area air sample concentrations were below the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) of 0.75 ppm and the NIOSH Recommended Exposure Limit (REL) of 0.016 ppm. The acetaldehyde area air sample concentrations found were below the OSHA PEL of 200 ppm. However, for both formaldehyde and acetaldehyde, due to their potential carcinogenicity, NIOSH recommends that occupational exposures be limited to the lowest feasible concentration. All of the real–time, data–logging instruments indicated that CO concentrations were below relevant evaluation criteria. Various VOCs were detected in area air samples. Hydrocarbon area air samples resulted in low levels and were well below relevant evaluation criteria.

The low concentrations of formaldehyde, acetaldehyde, carbon monoxide, and hydrocarbons measured in area air samples suggest that personal breathing–zone exposures should be below relevant evaluation criteria. However, NIOSH recommends a lowest feasible concentration for formaldehyde and acetaldehyde. Suggestions to improve the health and safety of employees in this facility are presented in the Recommendations section of this report.

Keywords: 3089 (Plastic Products, Not Elsewhere Classified), injection–molding, plastic, resin, polyethylene, polypropylene, headaches, dizziness, sore throat, rash, carbon monoxide, formaldehyde, acetaldehyde, hydrocarbons.

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INTRODUCTION

On April 22, 1999, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) at the Wonder Industries facility in Wyoming, Minnesota. The confidential employee request expressed concern about inadequate ventilation and possible generation of fumes from the various plastics used in the injection–molding processes. The employees reported symptoms of headaches, dizziness, sore throat, skin rashes, chronic ear problems, and shortness of breath. In response to this request, NIOSH investigators conducted an environmental investigation at the site on November 18, 1999.

On November 17, 1999, NIOSH representatives conducted an opening conference with management and an employee representative. Following this meeting, a walk–through inspection of the facility was conducted to identify specific work areas and job tasks of employees, leading to selection of potential air sampling sites. On November 18, 1999, area air samples were collected for carbon monoxide (CO), aldehydes (specifically formaldehyde and acetaldehyde), hydrocarbons, and volatile organic compounds (VOCs). Work practices were observed in all operating areas of the facility. This report summarizes the entire NIOSH evaluation and provides recommendations for improving occupational health and safety at the facility.

BACKGROUND

Wonder Industries (WI) is located in Wyoming, Minnesota. WI is a plastic injection–molding facility, which has been in business since 1972 and in this location since 1988. WI is involved primarily in the manufacture of plastic corner guards and handles for mattresses, pallet legs and diaper pales. This facility currently has 14 injection–molding machines; 5 to 7 of which are operating on a day–to–day basis. WI uses a number of different plastic resins for their products. The primary plastic resins used are polypropylene (PP) and high–density polyethylene (HDPE). Various color additives are used on a limited basis. WI has three shifts per day period with five to six people per shift. The week starts Sunday night at 11:00 p.m. and ends on Friday night at 11:00 p.m.

The injection–molding process starts with the suctioning of plastic resin material into a feed chamber of the injection–molder. The different resins are held in large cardboard boxes with the suction hose inserted into the box. Additives (regrind or color additives) can be inserted into the original resin box with mixing equipment in the warehouse section of the facility. The injection–molding machines have a horizontal heating chamber where the resin is inserted and melted. The molten resin is forced into the mold where the material cools. The mold pressure is decreased thereby releasing the newly formed plastic part. The mold is then closed and the process repeats itself. Workers stand by their machines and collect and stack the plastic parts prior to packaging and shipping. Other than break/lunch times, workers stand for the entire work period.

Plastics that are over–heated during the injection–molding process can release various thermal decomposition products. The products formed are potentially many and depend upon the polymer constituents and the process temperature. For polypropylene and polyethylene, the thermal decomposition products include CO and formaldehyde.[1]

METHODS

Five real–time, data–logged, area samples were collected for analysis of CO using a Toxi Ultra® Single Sensor Gas Detector (Middletown, Connecticut). The Toxi Ultra is a diffusion monitor that is used for continuous reading. The monitor measures the atmosphere around the instrument and filters the air through a dust and water resistant filter. The monitor can be set–up with a number of different sensors. The CO sensor was used during this site visit. The monitors were calibrated before use by checking their accuracy against a known concentration of CO calibration gas.

Five area air samples were collected for formaldehyde and acetaldehyde. Samples were collected on silica gel sorbent tubes (containing a cartridge coated with 2,4–dinitrophenylhydrazine, with another cartridge in line as a back up), at a calibrated flow rate of 1.0 liter per minute (lpm). The tubes were analyzed by high pressure liquid chromatography (HPLC) with an ultraviolet (UV) detector according to NIOSH Method 2016.[2] The analytical limit of detection (LOD) was 0.2 micrograms per sample (µg/sample) for formaldehyde, which is equivalent to a minimum detectable concentration (MDC) of 0.0003 parts per million (ppm), assuming a sample volume of 489 liters. The limit of quantitation (LOQ) was 0.66 µg/sample for formaldehyde, which is equivalent to a minimum quantifiable concentration (MQC) of 0.0011 ppm, assuming a sample volume of 489 liters. The LOD was 0.2 µg/sample for acetaldehyde, which is equivalent to a MDC of 0.0002 ppm, assuming a sample volume of 489 liters. The LOQ was 0.79 µg/sample for acetaldehyde, which is equivalent to a MQC of 0.0009 ppm, assuming a sample volume of 489 liters.

Eight thermal desorption tube area air samples were collected for qualitative analysis of volatile organic compounds (VOCs) in accordance with NIOSH Method 2549.[2] Samples were collected on three beds of sorbent material enclosed in a stainless steel tube using personal sampling pumps at a calibrated flow rate of 0.05 lpm. The thermal desorption tubes were purged with helium to remove any water and then analyzed using gas chromatography/mass spectrometry (GC/MS).

Seven area air samples were collected for hydrocarbons in accordance with NIOSH Method 1501.[2] Samples were collected on a solid sorbent tube containing coconut shell charcoal [100 milligrams (mg)/50 mg], at a calibrated flow rate of 0.05 lpm. The tubes were analyzed by gas chromatography (GC) with a flame ionization detector (FID), and used a combination of conditions from NIOSH Method 1501, 1550[2], and 1552[2] with modifications. These conditions were necessary to analyze the samples for specific compounds identified as major peaks in the qualitative thermal desorption tube analysis explained above. These compounds (toluene, total xylenes, limonene, and total hydrocarbons from $C_{10} – C_{16}$) were identified as major peaks and analyzed by the methods above. Two of the above compounds, total xylenes and limonene, were detected in the collected samples. The LOD was 0.0004 mg/sample for total xylenes, which is equivalent to a MDC of 0.004 ppm, assuming a sample volume of 24.1 liters. The LOQ was 0.001 mg/sample for total xylenes, which is equivalent to a MQC of 0.01 ppm, assuming a sample volume of 24.1 liters. The LOD was 0.0008 mg/sample for limonene, which is equivalent to a MDC of 0.006 ppm, assuming a sample volume of 24.1 liters. The LOQ was 0.003 mg/sample for limonene, which is equivalent to a MQC of 0.02 ppm, assuming a sample volume of 24.1 liters.

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),[3] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[4] and (3) the U.S. Department of Labor, Occupational Safety and Health (OSHA) Permissible Exposure Limits (PELs).[5] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever is 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 95–596, 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.

Carbon Monoxide (CO)

Carbon monoxide (CO) is a colorless, odorless, tasteless gas produced by incomplete burning of carbon–containing materials. The initial symptoms of CO poisoning may include headache, dizziness, drowsiness, and nausea. These initial symptoms may advance to vomiting, loss of consciousness, and collapse if prolonged or high exposures are encountered. Coma or death may occur if high exposures continue.[6,7,8,9,10,11]

The NIOSH REL for CO is 35 ppm for an 8–hour TWA exposure, with a ceiling limit of 200 ppm which should not been exceeded.[3] The NIOSH REL of 35 ppm is designed to protect workers from health effects associated with carboxyhemoglobin (COHb) levels in excess of 5%.[6] ACGIH recommends an 8–hour TWA TLV of 25 ppm.[4] The OSHA PEL for CO is 50 ppm for an 8–hour TWA exposure.[5] In addition to these standards, the National Research Council has developed a CO exposure standard of 15 ppm, based on a 24 hours per day, 90–day TWA exposure.[12]

Formaldehyde

Formaldehyde is a colorless gas with a strong odor. Exposure can occur through inhalation and skin absorption. The acute effects associated with formaldehyde are irritation of the eyes and respiratory tract and sensitization of the skin. The first symptoms associated with formaldehyde exposure, at concentrations ranging from 0.1 to 5 ppm, are burning of the eyes, tearing, and general irritation of the upper respiratory tract. There is variation among individuals, in terms of their tolerance and susceptibility to acute exposures of the compound.[13]

In two separate studies, formaldehyde has induced a rare form of nasal cancer in rodents. Formaldehyde exposure has been identified as a possible causative factor in cancer of the upper respiratory tract in a proportionate mortality study of workers in the garment industry.[14] NIOSH has identified formaldehyde as a suspected human carcinogen and recommends that exposures be reduced to the lowest feasible concentration. The OSHA PEL is 0.75 ppm as an 8–hour TWA and 2.0 ppm as a STEL.[15] ACGIH has designated formaldehyde to be a suspected human carcinogen and therefore, recommends that worker exposure by all routes should be carefully controlled to levels "as low as reasonably achievable" below the TLV.[4] ACGIH has set a ceiling limit of 0.3 ppm.

Note: NIOSH testimony to DOL on May 5, 1986, stated the following: "Since NIOSH is not aware of any data that describe a safe exposure concentration to a carcinogen NIOSH recommends that occupational exposure to formaldehyde be controlled to the lowest feasible concentration; 0.1 ppm in air by collection of an air sample for any 15–minute period as described in NIOSH analytical method 3500 which is the lowest reliably quantifiable concentration at the present time." NIOSH also lists a REL for formaldehyde of 0.016 ppm for up to a 10–hour TWA exposure (again using NIOSH analytical method 3500 and indicating that this is the lowest reliably quantifiable concentration at the present time). Investigators should be aware that formaldehyde levels can currently be measured below 0.016 ppm. It may be appropriate to refrain from using numerical limits and instead state that concentrations should be the lowest feasible (in some situations, this may be limited by the ambient background concentration.)

Acetaldehyde

Acetaldehyde is a colorless liquid that is used in the production of perfumes, polyester resins, and dyes; is used in the synthesis of acetic acid and other compounds; is used as a food preservative; and is used as a flavoring agent.[9] The primary route of exposure to acetaldehyde is through inhalation. One study indicated that there was upper respiratory irritation at 134 ppm for a 30 minute exposure, and mild eye irritation was indicated at 50 ppm for a 15 minute exposure.[16] Tumors were produced in rat and hamster respiratory tracts with chronic exposure to acetaldehyde.[17] The International Agency for Research on Cancer (IARC) has designated acetaldehyde as class 2B, which means that acetaldehyde is possibly carcinogenic with inadequate evidence in humans, but sufficient evidence in animals.

The OSHA PEL for acetaldehyde is 200 ppm. Although NIOSH does not have a numerical REL for acetaldehyde, the NIOSH position on this substance is as follows: exposure to acetaldehyde has produced nasal tumors in rats and laryngeal tumors in hamsters. NIOSH therefore recommends that acetaldehyde be considered a potential occupational carcinogen in conformance with the OSHA carcinogen policy.[3] ACGIH has a ceiling limit of 25 ppm for acetaldehyde. This is a concentration that should not be exceeded at any point during the work period. ACGIH also gives acetaldehyde an A3 designation which means that acetaldehyde is a confirmed animal carcinogen with unknown relevance to humans. Worker exposure by all routes should be controlled to levels as low as possible below the TLV.[4]

RESULTS

Personal Protective Equipment (PPE)

Workers at WI are not required to wear hearing protection while in the injection–molding area of the facility. They are offered 3M® 1100 Foam Ear Plugs. The Noise Reduction Rating (NRR) for these plugs is 29 decibels (dB). There are also 3M 8500 respirators (single strap respirators for nuisance dust) offered. However, these respirators are not NIOSH approved under the current regulation, 42 CFR Part 84.[18,19] NIOSH investigators did not observe any employees wearing any personal protective equipment (PPE) during the site visit.

Ventilation

WI has a heating system for the facility. However, it is rarely operated in the injection–molding area due to the heat generated by the process. During the site visit, the rear overhead door leading to the docking area was open throughout the day as well as the front entrance door. WI does not have local exhaust ventilation (LEV) for the injection–molding machines. A wall exhaust fan was in operation in the southwest corner of the production area. However, employees indicated those exhaust fans are not typically in operation, as they were during the NIOSH site visit.

Environmental

Six injection–molding machines were running at the time of the site visit. Machine #15 did not start until the afternoon of November 18, therefore air samples were not collected in that area.

1. Injection–molding machine #8 – Stokes machine, operating temperature of 390°F (Fahrenheit) to 440°F in the heating chamber, 440°F nozzle temperature, producing white mattress handles from 90% virgin/10% regrind PP resin, at a rate of 3800 parts per hour (parts/hr).

2. Machine #20 – Reed machine, operating temperature of 430°F to 450°F in the heating chamber, 450°F nozzle temperature, producing black pallet legs from 99% virgin/1% regrind PP copolymer resin. This machine is not maned on a permanent basis.

3. Machine #13 – Eckert & Ziegler machine, operating temperature of 370°F to 640°F in the heating chamber, 400°F nozzle temperature, producing 13 gallon, white diaper pales from ethylene – vinyl acetate copolymer resin.

4. Machine #17 – Cincinnati machine, operating temperature of 580°F nozzle temperature, producing white mattress corner guards from HDPE resin.

5. Machine #7 – Cincinnati machine, operating temperature of 450°F to 500°F in the heating chamber, 505°F nozzle temperature, producing white mattress corner guards from 95% virgin/5% regrind HDPE resin.

Carbon Monoxide

Five samples for carbon monoxide were collected on the different injection–molding machines in operation. Table 1 gives the results of the collected samples. CO concentrations ranged from 0–5 ppm. The highest peak CO concentration found was 5 ppm near injection–molding machine #7.

Formaldehyde

Five area air samples for formaldehyde were collected and are described in Table 2. Sample concentrations ranged from 0.01 to 0.015 ppm. The highest formaldehyde concentration (0.015 ppm) was located on injection–molding machine #7 (white mattress corner guard, HDPE). All air sample results were lower than relevant evaluation criteria.

Acetaldehyde

Five area air samples for acetaldehyde were collected and are described in Table 2. Sample concentrations were 0.003 or 0.004 ppm. The highest acetaldehyde concentration (0.004 ppm) was found on every injection–molding machine sample except #8 (white mattress handles, PP). All air sample results were lower than relevant evaluation criteria.

Volatile Organic Compounds (VOCs)

Eight thermal tube area air samples were collected. One thermal tube was placed in each of the following areas: with each running injection–molding machine, in an office area, outside as a background sample, and one used as a field blank. The major peaks identified on some of the samples included toluene, xylenes, acetonitrile, decane, limonene, dodecane, and tetradecane. Other compounds that were detected in the analysis included benzene, hexane, octane, styrene, butyl cellosolve, propylene glycol methyl acetate, siloxanes, and other aliphatic hydrocarbons. The office area thermal tube contained traces of dimethyl ether, methylene chloride, and trichloroethylene. These three compounds were the only major differences observed between samples collected in the various areas.

Hydrocarbons

Seven area air samples were collected. These samples were analyzed according to the specific compounds identified as major peaks in the qualitative thermal desorption tube analysis. The compounds analyzed for included toluene, total xylenes, limonene, and total hydrocarbons from C_{10} – C_{16}. Two samples indicated trace amounts of some of the above listed compounds. Trace amount means that the substance was detected in the air (and therefore was present above the MDC), but at a concentration below that at which it is reliably quantifiable (the MQC). The injection–molding machine #20 air samples indicated a trace amount, 0.004 ppm, of total xylenes. The office area air samples indicated a trace amount, 0.005 ppm and 0.008 ppm, of total xylenes and limonene, respectively.

DISCUSSION

The highest air sample concentrations in the facility were for formaldehyde in the injection–molding areas. Formaldehyde concentrations were below relevant evaluation criteria. However, all five area samples were approaching the NIOSH REL of 0.016 ppm. Acetaldehyde was found in all the injection–molding areas as well. The concentrations found were below relevant evaluation criteria. For both formaldehyde and acetaldehyde, NIOSH is concerned with the carcinogenic potential of these compounds and recommends that they be kept at the lowest feasible concentration.

All air samples were collected as close to the mold opening of the injection–molding machine as possible. When the mold was opened and the newly formed piece was released, any gaseous compounds formed during the process would be released and subsequently collected by the air samples. Most of the injection–molding machines have a plexiglass door that is closed except when there is required maintenance of the machine.

The air samples collected for VOCs indicated that there are various compounds being generated from the process. However, the concentrations of these compounds are quite low. The air samples for hydrocarbons and the real–time CO measurements were all below relevant evaluation criteria.

CONCLUSIONS

The results from the collected air samples indicate the presence of formaldehyde, acetaldehyde, CO, and various organic compounds associated with the injection–molding process in this facility. All injection–molding machines in operation at the time of the NIOSH site visit indicated the presence of the compounds discussed in this report. All collected air sample concentrations were below relevant evaluation criteria (with exception of formaldehyde and acetaldehyde, which NIOSH recommends that be kept at the lowest feasible concentration).

RECOMMENDATIONS

The following recommendations are based on the findings of this investigation and offered to improve the safety and health of employees working with materials used in the operations discussed in this report.

1. Although no noise level measurements were collected during the site visit, a noise survey of the facility should be conducted to characterize the levels around the injection–molding machines. Noise measurements should be collected whenever there are injection–molding machines added or some other process change. If there are any noise exposures above relevant evaluation criteria, a hearing conservation program should be implemented in the facility according to the OSHA Occupational Noise Exposure Standard.[20]

2. All PPE should be stored in one area that is easily accessible to employees. At the time of the site visit, WI had PPE in many different areas, some of which were easy to find and some which took some time to locate.

3. Although employees do not typically wear respirators, the respirators that are offered to employees should be NIOSH certified with a minimum of a N95 designation (as defined by the current NIOSH certification procedures 42 CFR 84 effective July 10, 1998).[19] The OSHA respiratory protection standard can be referred to for help in choosing the correct respirator and the requirements for a facility respiratory protection program.[21] 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*.[22,23]

4. To facilitate ease of use, the MSDSs should be grouped within their binders based upon the area of the facility in which each material is used. The MSDSs should be labeled with their corresponding plastic product.

5. Appropriate housekeeping and hygiene practices should be continued at WI. A regular cleaning schedule will help keep resin dust and scrap plastic pieces to a minimum. Acceptable hygiene practices may reduce the possibility of exposures by routes other than inhalation, such as ingestion by hand–to–mouth contact.

6. Any exhaust fans in the production area should be in continuous operation. This will enhance the air movement in the production area and assist in the dilution of contaminants generated during the injection–molding process.

7. Due to the heat generated from the injection–molding machines, WI should be aware of the potential for heat stress, especially during the summer months. Additional information on heat stress can be obtained from the OSHA web page, ACGIH TLV booklet, *NIOSH – Working in Hot Environments publication*, and *NIOSH Criteria for a Recommended Standard: Occupational Exposure to Hot Environments* publication.[24,4,25,26]

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Table 1. Results of November 18, 1999, area sampling for carbon monoxide.

Location	Sample Time (military)	Concentrations in parts per million (ppm)			
		Peak	Peak ST	8–hr TWA	Average
Injection–molding machine #8	0732 – 1413	2	1	0	0
Injection–molding machine #20	Instrument malfunction – no data				
Injection–molding machine #13	0721 – 1519	4	1	0	0
Injection–molding machine #17	0739 – 1528	3	2	1	1
Injection–molding machine #7	0753 – 1523	5	3	0	0
Evaluation Criteria	NIOSH REL	35, C 200			
	OSHA PEL	50			
	ACGIH TLV	25			

C = Ceiling concentration – a concentration which should not be exceeded at any time.
ST = Short–term Exposure Limit – a 15 minute exposure limit that should not be exceeded at any time during the day.

Table 2. Results of November 18, 1999, area air sampling for formaldehyde and acetaldehyde.

Location	Sample Time (military)	Sample Volume (liters)	8–hour TWA concentrations in parts per million (ppm)	
			Formaldehyde	Acetaldehyde
Injection–molding machine #8	0730 – 1413	411	0.01	0.003
Injection–molding machine #20	0739 – 1533	480	0.014	0.004
Injection–molding machine #13	0720 – 1510	483	0.011	0.004
Injection–molding machine #17	0737 – 1530	480	0.012	0.004
Injection–molding machine #7	0730 – 1522	489	0.015	0.004
Minimum Detectable Concentration (MDC)			0.0003	0.0002
Minimum Quantifiable Concentration (MQC)			0.0011	0.0009
Evaluation Criteria		NIOSH REL	0.016, C 0.1, LFC	*
		OSHA PEL	0.75, ST 2.0	200
		ACGIH TLV	C 0.3, A2	C 25, A3

C = Ceiling concentration – a concentration which should not be exceeded at any time.
LFC = Lowest Feasible Concentration – see formaldehyde in Evaluation Criteria section.
ST = Short–term Exposure Limit – a 15 minute exposure limit that should not be exceeded at any time during the day.
A2 = suspected human carcinogen.
A3 = confirmed animal carcinogen with unknown relevance to humans
* = see acetaldehyde in Evaluation Criteria section.

For Information on Other
Occupational Safety and Health Concerns

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