NIOSH HEALTH HAZARD EVALUATION REPORT

HETA #2005-0243-3016
ACH Foam Technologies
Fond du Lac, Wisconsin

September 2006

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 Manuel Rodriguez and Chandran Achutan of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Analytical support was provided by Ardith Grote, Division of Applied Research and Technology and DataChem Laboratories, Inc. Desktop publishing was performed by Robin Smith. 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

NIOSH received a confidential employee health hazard evaluation (HHE) request expressing concerns about potential long-term health effects from chemicals released while manufacturing and hot wire cutting expandable polystyrene (EPS) products at ACH Foam Technologies in Fond du Lac, Wisconsin. The requestors were also concerned about the material safety data sheets (MSDS) book not being available. NIOSH investigators conducted an evaluation in August 2005.

What NIOSH Did

- We took personal and area air samples for styrene, pentane, volatile organic compounds, and respirable and total dust.
- We measured carbon monoxide in the air in the Custom Mold, Roofing, and Packaging departments.
- We observed EPS production processes.

What NIOSH Found

- Employees were not exposed to any of the chemicals sampled over applicable occupational exposure limits.
- The ACH Foam Technologies Safety Manager stated the MSDS book was being updated and had been returned to the cafeteria.

What ACH Foam Technologies Managers Can Do

- Use local exhaust ventilation to capture and remove chemicals released during hot wire cutting.
- Repair the overhead pneumatic duct in the Recycling department to prevent the release of polystyrene beads.
- Maintain open communication channels with employees.

What the ACH Foam Technologies Employees Can Do

- Tell management about health and safety concerns.
- Look at the MSDS book to learn more about the chemicals you are handling.
- See your doctor if you think something at work is making you ill.

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 #2005-0243-3016

Health Hazard Evaluation Report 2005-0243-3016
ACH Foam Technologies
Fond du Lac, Wisconsin
September 2006

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SUMMARY

On May 17, 2005, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from three employees at ACH Foam Technologies in Fond du Lac, Wisconsin. The requestors expressed concerns about potential long-term effects from exposure to smoke and chemicals generated while manufacturing polystyrene and cutting polyethylene sheeting and expandable polystyrene (EPS) foam.

On August 31, 2005, NIOSH investigators sampled for chemical byproducts from the EPS processes at the ACH facility. Personal breathing zone (PBZ) and area air samples were collected for pentane, styrene, volatile organic compounds (VOCs), and respirable and total dust. Air samples collected on thermal desorption tubes identified pentane, styrene, acetophenone, ethylbenzene, and xylene as predominant chemicals. The charcoal tubes used to sample for VOCs were submitted for laboratory analysis for acetophenone, ethylbenzene, and xylene. Area concentrations of carbon monoxide, a potential byproduct from the EPS processes, were measured in several departments with a direct reading instrument. All sample results were below applicable occupational exposure limits.

NIOSH investigators conclude that a health hazard did not exist on the day of this evaluation. Employees were not exposed over applicable occupational exposure limits to carbon monoxide, pentane, styrene, acetophenone, ethylbenzene, xylene, respirable dust, or total dust while molding and cutting EPS products. Recommendations in this report include providing local exhaust ventilation in the hot wire cutting area, repairing damaged duct work in the Recycling department, and improving communication between supervisors and employees.

Keywords: NAICS 326140 Polystyrene Foam Product Manufacturing. Expandable polystyrene, EPS, CO, acetophenone, ethylbenzene, xylene, pentane, styrene, respirable dust, total dust, VOCs.

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INTRODUCTION

On May 17, 2005, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request for a health hazard evaluation (HHE) from three employees at ACH Foam Technologies in Fond du Lac, Wisconsin. The requestors expressed concerns about potential long-term effects from exposure to smoke and chemicals generated while manufacturing polystyrene and cutting polyethylene sheeting and polystyrene foam. The requestors were also concerned that the book containing material safety data sheets (MSDS) had been removed from the cafeteria.

During August 30-31, 2005, NIOSH investigators conducted a site visit to evaluate potential chemical exposures while processing expandable polystyrene (EPS) foam. On August 30, 2005, NIOSH investigators held an opening conference with management officials and an employee representative. Following the opening conference, NIOSH investigators toured the facility. On August 31, 2005, NIOSH investigators conducted air monitoring for styrene, pentane, respirable dust, total dust, volatile organic compounds (VOCs), and carbon monoxide (CO).

BACKGROUND

ACH Foam Technologies

ACH Foam Technologies has 400 employees at nine facilities in the U.S. and one facility in Mexico. This company was formed as a result of a merger of three EPS manufacturers: Advanced Foam Plastics, Contour Products, and Heartland EPS. The company manufactures EPS for insulated concrete forms, wall insulation, sight and sound barriers along highways, custom molding packaging products, coolers, custom molded parts, casting molds, architectural shapes, and structures such as building columns or signs.

This evaluation was conducted at the ACH facility, formerly known as Heartland EPS, Inc. located in Fond du Lac Wisconsin. This facility has 82 employees (54 in the production department, 3 drivers, and 25 in management and administrative support); none are represented by a union. EPS processes are conducted in six departments: Expanding, Custom Molding, Custom Molding Assembly, Packaging, Roofing, and Recycling. Two employees are assigned to the Recycling department where EPS waste is ground for reuse. The only personal protective equipment employees use is safety glasses.

On August 2, 2005, a consultant hired by ACH collected personal breathing zone (PBZ) air samples for total dust on two employees, one in the Recycling department and the other in the Custom Mold Assembly department. Both sample results were at least 10 times below the Occupational Safety and Health Administration (OSHA) 8-hour Permissible Exposure Limit-Time Weighted Average (PEL-TWA). PBZ samples were also collected for benzene and styrene on two employees in the Packaging department who were operating a down cutter (hot wire cutter). All sample results were well below applicable occupational exposure limits.

The EPS Process

EPS is manufactured by the polymerization of a styrene monomer resin followed by impregnation of the polymerized polystyrene bead with a blowing agent, usually pentane or butane, which causes the bead to grow in diameter. At this point the beads, which contain 4%-7% of the blowing agent, are very small (0.2-3 millimeters in diameter). The beads are then dried, sorted by size, and specially packaged because the blowing agent is a volatile hydrocarbon that is gradually released from the beads. After packaging, the beads are shipped to manufacturers to make EPS shipping containers, coolers, wall insulation, meat trays, food containers, and many other products. The beads require expanding prior to being used for making EPS. The polymerization process is not performed at ACH. Instead, the company receives the beads ready for expansion and EPS production.

Expanding

One employee per shift is assigned to the Expanding department. The facility receives raw polystyrene beads containing pentane as a blowing agent. The beads are stored in a hopper until an EPS order is received. To produce an EPS product, the beads are transferred by an auger from the hopper to an expander. In the expander, steam is added to remove the pentane in the beads and replace it with air. This process causes the beads to grow up to 40 times the original volume. The beads are then transferred to a dryer. The entire expanding process is enclosed (meaning that the beads are transferred through metal ducts by a vacuum). After drying, the beads are stored in large bags until the pentane concentration drops to a desired level, and are then injected into a steam heated mold to fuse the beads into a block. The block is then cured in either a large heated room or at ambient room temperature, depending on the final use application. While the worker's primary exposure is pentane, some hot wire cutting of the EPS foam is occasionally performed, resulting in potential exposure to decomposition products such as VOCs, carbon dioxide, styrene, CO, and soot. Additionally some dust is generated by handling the EPS beads.

Packaging and Roofing

Eleven employees work in the Roofing department and eight work in Packaging. Employees in the Roofing department cut flat panels from polystyrene blocks using hot wire cutters. The panels are used on roofs and other structures. In the Packaging department the workers use hot wire cutters to cut the blocks to a specified size and shape according to customer requirements. The hot wires can be computer-controlled for specific shape cutting, straight cuts may be made with the aid of a conveyor belt system, or a combination of the two. Once the block has been cut down, it is packaged and prepared for shipment. Cut off sections are used elsewhere or ground for recycling. Potential worker exposures include pentane, styrene, CO, and VOCs.

Custom Molding and Custom Molding Assembly

Twenty-four employees are assigned to the Custom Molding and Custom Molding Assembly departments. The Custom Molding department receives raw polystyrene beads that undergo a similar expanding process. Custom patterns are press molded using aluminum tools that have specific shapes cut into them. The beads are forced into the mold cavity of the tool, placed under a vacuum, and then steam is injected into the mold to fuse the beads together. The molds are then cured at room temperature or in a heated room. Once cured, the custom mold is prepared for shipment, or if it is part of a larger assembly, is sent to Custom Molding Assembly where the parts are joined with hot glue. Potential worker exposures include pentane and styrene.

Pressure Sensitive Adhesive (PSA)

One employee per shift works in this area spraying an adhesive called Instant-Lok® 34-6101 on the EPS panels, then applying 2.5 millimeter blue high-density polyethylene sheeting on top of the panels. This allows the customer to remove the sheeting and stick the panel to a surface. If smaller panels are required, they are cut with a hot wire cutter called a down cutter. The polyethylene sheeting covering the panel is also cut during the process. Potential worker exposures include styrene, pentane, and decomposition products from EPS foam and the polyethylene sheeting. The adhesive contains a white mineral oil.

METHODS

Pentane and Styrene

PBZ air samples for pentane and styrene were collected simultaneously on four employees working in the Roofing, Custom Molding, and Custom Assembly departments. A pentane sample was also collected on an employee working in the Expanding department. Three area air samples for pentane and styrene were

collected in the Roofing, Packaging, and Custom Molding departments. Samples for pentane and styrene were collected using charcoal tubes at a flow rate of 20 milliliters per minute (mL/min). The samples for pentane were analyzed by NIOSH Manual of Analytical Methods (NMAM) Method 1500[1] and for styrene by NMAM Method 1501[2].

Direct reading measurements of pentane and styrene were taken in the Roofing, Expanding, Custom Mold Assembly, Packaging, and Custom Mold departments, using colorimetric detector tubes (Drager®). One end of the tube was placed inside a hand-held air pump, and the other end was exposed to the atmosphere. Air was drawn through the tube by squeezing the hand pump 10 times for the pentane tube and 20 times for the styrene tube, as specified by the manufacturer. The airborne concentrations of pentane and styrene were determined by the length of stain of the reactive material inside the tube.[3]

Volatile Organic Compounds

PBZ air samples for VOCs were collected on two employees in the Packaging department, two employees in the Custom Assembly department, one in the Roofing department, and one in the PSA department. Side-by-side area air samples for VOCs were collected in the Packaging and Roofing departments using thermal desorption tubes for qualitative analysis and charcoal tubes for quantitative analysis. Samples were collected in areas where EPS panels were being cut with hot wires. Thermal desorption tube samples were collected at a flow rate of 50 mL/min and analyzed per NIOSH Method 2549[4] using thermal desorption (TD), gas chromatography, and mass spectrometry to characterize the VOC mixtures. Besides pentane and styrene, the major compounds identified on the TD tubes were ethyl benzene, xylene, and acetophenone. The charcoal tubes were submitted for laboratory analysis by NIOSH Method 1501[2] with modifications. Sampling for VOCs with charcoal tubes was performed at a flow rate of 20 mL/min.

Respirable and Total Dust

PBZ exposure monitoring for respirable dust and total dust was performed on an employee working in the Recycling department, where the highest levels of visible dust were being generated, based on a visual assessment. Two respirable dust and two total dust area air samples were collected in the Expanding and Roofing departments. Respirable and total dust samples were collected on tared 37-millimeter (mm) polyvinyl chloride filters at flow rates of 1.7 and 2.0 liters per minute (Lpm) respectively, and analyzed per NIOSH Methods 0500[5] for respirable dust and 0600[6] for total dust. A Dorr-Oliver cyclone was used as a pre-selector for the respirable dust samples.

Carbon Monoxide

Direct-reading measurements for CO were obtained in the Roofing, Packaging, Custom Mold, and Custom Mold Assembly departments using a TSI Q-Track™ (Model 8554) indoor air quality (IAQ) monitor. This portable instrument uses an electro-chemical sensor to measure CO in the range of 0-500 parts per million (ppm).

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 becomes available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),[7] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[8] and (3) the U.S. Department of Labor, OSHA PELs.[9] 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 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.

Pentane and Styrene

Pentane is a colorless liquid with a gasoline like-odor. It is irritating to the eyes, skin, and nose. Pentane is also highly flammable. During a controlled human exposure study, subjects exposed to 5000 ppm pentane for 10 minutes did not experience irritation or narcosis.[10] NIOSH has an REL-TWA for pentane of 120 ppm and a ceiling limit of 610 ppm (15 minutes). OSHA has established a PEL-TWA for pentane of 1000 ppm. ACGIH has a TLV-TWA for pentane of 600 ppm based on irritative effects and narcosis.

Styrene is an aromatic hydrocarbon widely used in manufacturing polystyrene plastics and synthetic rubber. It can cause eye, skin, and respiratory tract irritation. Occupational exposure occurs mainly via inhalation with about 60% of inhaled styrene retained in the lungs. Styrene is also a defatting agent and a primary skin irritant. Long-term exposure may result in weakness, headaches, fatigue, poor memory, and dizziness.[11] NIOSH has an REL-TWA of 50 ppm and REL-STEL of 100 ppm for styrene. ACGIH recommends that exposures to styrene not exceed a TLV-TWA of 20 ppm or a STEL of 40 ppm. These values are intended to minimize the potential for central and peripheral nervous system effects and for mucous membrane and respiratory tract irritation. The central nervous system effects that have been reported include deficits in color vision and high frequency hearing. Styrene has adequate warning properties and an odor threshold of 0.04-0.32 ppm, which is below applicable occupational exposure limits.[12]

Volatile Organic Compounds

VOCs are a large class of chemicals which are organic (i.e., containing carbon) and have a sufficiently high vapor pressure to allow some of the compound to exist in the gaseous state at room temperature. They are emitted in varying concentrations from numerous indoor sources including, but not limited to, carpeting, fabrics, adhesives, solvents, paints, cleaners, waxes, cigarettes, and combustion sources. The most common route of exposure to VOCs is through inhalation. NIOSH has REL-TWAs for ethyl benzene and xylene of 100 ppm. ACGIH has a TLV-TWA for acetophenone of 10 ppm.

Respirable and Total Dust

OSHA has PEL-TWAs for respirable and total dust (particulates not otherwise regulated) of 5 and 15 milligrams per cubic meter (mg/m^3) respectively. ACGIH has not established TLVs for respirable and inhalable particles because of insufficient evidence of adverse health effects. However, ACGIH believes that all particles, even if they are biologically inert or not soluble, may have adverse health effects and therefore recommends that exposure to respirable particles not exceed 3 mg/m^3, and that inhalable particles exposure not exceed 10 mg/m^3. These recommendations are for particles that do not have a specific TLV, referred to by ACGIH as particles (insoluble or poorly soluble) not otherwise specified.[12]

Carbon Monoxide

A colorless, odorless, tasteless gas, CO can be a product of the incomplete combustion of organic compounds. It combines with hemoglobin and interferes with the oxygen-carrying capacity of blood. Symptoms include headache, drowsiness, dizziness, nausea, vomiting, collapse, myocardial ischemia, and death.[13] The NIOSH REL for CO is 35 ppm as a 10-hour TWA. NIOSH also recommends a ceiling limit of 200 ppm, which should not be exceeded at any time during the workday. The OSHA PEL for CO is 50 ppm as an 8-hour TWA. The ACGIH TLV for CO is 25 ppm as an 8-hour TWA. This value is intended to maintain blood carboxyhemoglobin (COHb) levels below 3.5%, to minimize the potential for adverse neurological behavioral changes, and to maintain cardiovascular work and exercise capacities.[14] The time to reach a COHb level of 3.5% at a given CO concentration decreases as the workload increases.[14]

RESULTS

Pentane and Styrene

As shown in Table 1, concentrations of pentane ranged from 5-73 ppm with the highest result of 73 ppm obtained on a worker in the Expanding department. Concentrations in other departments ranged from 5-18 ppm. All sample results were below the NIOSH REL-TWA of 120 ppm for pentane. Styrene was not detected on any of the PBZ or area air samples. Approximately 50 ppm of pentane was detected in the Roofing department and 100 ppm in the adjacent Expanding department using colorimetric indicator tubes. Neither styrene nor pentane were detected in the Custom Molding Assembly department, while approximately 5 ppm of styrene was detected in the Roofing and Expanding departments. Trace amounts of pentane and styrene were detected in the Packaging department, and trace amounts of styrene were detected in the Custom Mold department.

Volatile Organic Compounds

Laboratory analysis of the thermal desorption tubes indicated the presence of 72 chemicals. Compounds exhibiting the highest abundance peaks in the mass spectrum for each sample were pentane, styrene, ethyl benzene, xylene, acetophenone, and benzaldehyde. Other compounds detected include benzene, toluene, various aliphatic hydrocarbons and alkyl benzenes, alpha-methyl styrene, methyl styrenes, limonene, α-dimethylbenzenemethanol, and several aliphatic ketones and alcohols. Charcoal tubes were submitted for laboratory analysis for ethyl benzene, xylene, and acetophenone, which were the most prominent chemicals detected on the desorption tubes after pentane and styrene. Sample results for ethyl benzene, xylene, and acetophenone were below their respective analytical method limits of detection.

Respirable and Total Dust

One PBZ air sample for respirable dust and one for total dust was collected on an employee in the Recycling department, and the results were below the OSHA 8-hour PEL-TWA. Concentrations of respirable and total dust in area air samples collected in the Expanding and Roofing departments were approximately 100 times lower than the OSHA 8-hour PEL-TWA.

Sample results for respirable and total dust are provided in Table 2.

While collecting air samples for dust in the Recycling department, NIOSH investigators observed polystyrene beads falling from a breach in an overhead pneumatic duct used to transport the beads.

Carbon Monoxide

Area concentrations of CO were 6.5 ppm in the Roofing department, 0.2 ppm in Custom Mold Assembly, 0.9 ppm in Packaging, and 2 ppm in the Custom Mold department. All results were below applicable occupational exposure limits.

MSDS Book

The ACH Safety Manager was asked about the location of the MSDS book because the HHE requestors mentioned it had been removed from the cafeteria. The Safety manager stated that the book had been removed for updating and had been returned to the cafeteria.

DISCUSSION AND CONCLUSION

NIOSH air sample results for total and respirable dust for an employee working in the Recycling department were similar to those obtained previously by a consultant hired by ACH, further suggesting that this employee is not routinely exposed to dust over the OSHA PEL-TWAs. While sample results for VOCs and other chemicals are below applicable occupational exposure limits, some chemicals can be irritating at very low levels. People with allergies, asthma, and other respiratory problems may be more sensitive to low levels of chemicals. Many chemicals also have odor thresholds below the exposure limits, contributing to the perception of some people that if they can smell it, it is harmful. While in a production area it may be difficult to eliminate chemical odors, an effort should be made to reduce contaminant sources through engineering controls or product substitution to improve how employees perceive air quality. If odors cannot be eliminated, and it has been documented that the odors are not due to harmful chemical concentrations, then it is important to inform employees that the odors are just a nuisance and will not cause any harm.

In conclusion, ACH Foam Technologies employees at the Fond du Lac, Wisconsin facility were not exposed to respirable or total dust, pentane, styrene, CO, ethyl benzene, xylene, or acetophenone over applicable occupational exposure limits. Based on these sample results NIOSH investigators conclude that employees are not exposed to hazardous chemical byproducts while cutting polystyrene with hot wires or manufacturing EPS products.

RECOMMENDATIONS

1. Provide local exhaust ventilation where hot wire cutters are used to further improve air quality in the production areas. Exhaust fans with moveable flexible exhaust ducts such as used for welding operations may be used to capture smoke and more efficiently exhaust it out of the facility.

2. Repair the overhead pneumatic duct in the Recycling department to prevent poly-styrene beads from escaping.

3. If feasible, cut the EPS panels prior to adhering the polyethylene sheeting so that the cut does not have to go through both pieces.

4. Maintain open channels of communication with employees. Encourage employees to voice their work-related health and safety concerns to their supervisors, through a health and safety committee, suggestion box or other means. Employees should be provided feedback when concerns are raised, to include any pertinent findings and/or actions taken to address their concerns.

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TABLES

Table 1
HETA 2005-0243-3016
ACH Foam Technologies
Pentane Air Sample Results
August 31, 2005

Sample #	Sample Type	Department	Sample Time	Concentration (ppm)
P-PEN-01	PBZ	Roofing	514	10
P-PEN-02	PBZ	Expanding	371	73
P-PEN-03	PBZ	Custom Molding	632	12
P-PEN-04	PBZ	Custom Assembly	475	7
P-PEN-05	PBZ	Custom Molding	644	18
P-PEN-06	PBZ	Custom Molding	639	5
A-PEN-01	Area	Packaging	504	14
A-PEN-02	Area	Custom Molding	492	10
A-PEN-03	Area	Roofing	506	14
NIOSH REL-TWA				**120**
OSHA PEL-TWA				**600**

ppm = parts per million
PBZ = personal breathing zone

Table 2
HETA 2005-0243-3016
ACH Foam Technologies
Dust Sample Results
August 31, 2005

Sample #	Sample Type	Department	Sample Time	Concentration (mg/m^3)	
				Total Dust	RSP Dust
B05-157	PBZ	Recycling	510		0.09
B05-186	PBZ	Recycling	510	1.88	
B05-198	Area	Expanding	501		0.05
B05-166	Area	Expanding	502	0.15	
B05-159	Area	Roofing	504		0.06
B05-164	Area	Roofing	504	0.14	
OSHA PEL-TWA*				**15 mg/m^3**	**5 mg/m^3**
ACGIH TLV				**10 mg/m^3 ****	**3 mg/m^3**

mg/m^3 = milligrams per cubic meter of air
RSP = respirable
PBZ = personal breathing zone
* As particulates not otherwise regulated
** As inhalable particulates not otherwise specified

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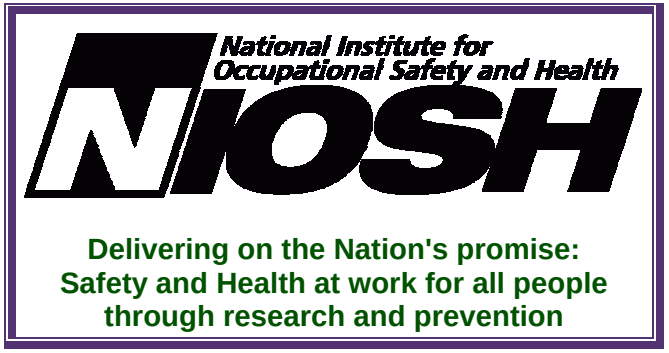

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