HETA 97-0242-2725
Delphi Chassis Systems
Dayton, Ohio

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PREFACE

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

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Health Hazard Evaluation Report 97-0242-2725
Delphi Chassis Systems
Dayton, Ohio
February 1999

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SUMMARY

On June 6, 1997, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from employee and management representatives of Delphi Chassis Systems in Dayton, Ohio. The request stated that employees in departments 2, 12, 37, and 40 of this automotive brake parts manufacturing facility were experiencing a high frequency of upper respiratory irritation and colds. Processes involved heat ejection molding and curing brake pads, and electrostatic application of powder paint. An initial site visit was conducted on October 15, 1997, with additional visits occurring in November 1997, and in March through May 1998.

Full-shift personal breathing-zone (PBZ) air samples collected in departments 2 and 37 revealed time-weighted average (TWA) formaldehyde concentrations ranging from 0.02 - 0.03 parts per million (ppm). Results from area air sampling in department 40 were similar. These concentrations were below the Occupational Safety and Health Administration's (OSHA) permissible exposure limit (PEL) of 0.75 ppm and the American Conference of Governmental Industrial Hygienists' (ACGIH) ceiling limit of 0.30 ppm. However, these concentrations were above the NIOSH recommended exposure limit (REL). NIOSH has identified formaldehyde as a suspected human carcinogen and recommends that exposures be reduced to the lowest feasible concentrations. Air sampling on the six workers also revealed hexamethyltetramine (HMTA) TWA concentrations that ranged from 0.002 - 0.009 ppm. There are no occupational exposure criteria established for HMTA by NIOSH, OSHA, or ACGIH. Area air samples collected for phenol revealed only trace concentrations.

Evaluation and inspection of the exhaust ventilation systems found department 2 to be under negative pressure, which could adversely affect the performance of local exhaust ventilation serving the work area. In departments 2 and 37 some exhaust hoods at unloader bins were either clogged, disconnected, or showed little or no air movement.

Medical interviews were conducted with self-selected employees from the departments of concern. Most reports of work-related health symptoms involved either the paint lines and rotary heat ejection integral molding (HEIM) machines in department 2 or the assembly area in department 40. The most prevalent health symptoms reported among department 2 employees working with the paint lines involved the upper and lower respiratory tract. The most prevalent symptoms reported among department 2 employees working with the rotary HEIMs also involved the upper and lower respiratory tract. In the assembly area of department 40 most reported work-related symptoms involved the upper respiratory tract.

NIOSH investigators concluded that workers in departments 2 and 37 were exposed to formaldehyde concentrations below the range commonly associated with acute health symptoms, but quantifiable concentrations were measured. NIOSH recognizes formaldehyde as a potential occupational carcinogen and recommends that levels be reduced to the lowest feasible concentration, while ACGIH recommends that "worker exposure by all routes should be carefully controlled to levels as low as possible." Based on a review of previous air sampling results performed by the company, employees were also exposed to brake dust and epoxy powder paint. Symptoms reported in the medical interviews were consistent with effects that might occur with exposures to the epoxy powder paint and brake dust. Exhaust ventilation deficiencies found in departments 2 and 37 may contribute to these air contaminants generated in work areas. Recommendations are made in this report to improve engineering controls, use appropriate personal protective equipment, encourage good hygiene practices, and emphasize employee education and surveillance.

Keywords: SIC 3714 (Motor Vehicle Parts and Accessories), formaldehyde, hexamethylenetetramine, HMTA phenol, epoxy resins, powder paint, electrostatic application, metallic disk brake lining compound, brake dust, automotive brakes, brake pads, glass beads, lower respiratory irritation, upper respiratory irritation, respiratory sensitization, skin irritation, skin sensitization.

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INTRODUCTION

On June 6, 1997, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from employee and management representatives of Delphi Chassis Systems in Dayton, Ohio. The request stated that employees in departments 2, 12, 37, and 40 of this automotive brake parts manufacturing facility were experiencing a high frequency of upper respiratory irritation and colds. A prior HHE request (HETA 96-0199) involving the same concerns had been received on June 10, 1996. In response to that first request, an initial walk-through survey was conducted on August 30, 1996, at which time several brake pads were collected for analysis. That HHE was postponed by management and union representatives due to ongoing contract negotiations.

After receiving the recent HHE request, a site visit was conducted on October 15, 1997, at which time a worksite tour was conducted, and air sampling and record reviews were performed. A follow-up site visit to perform further air sampling was made by the NIOSH industrial hygienists on November 25, 1997. Interviews of potentially affected employees were performed by the NIOSH medical officer on three separate occasions, between March and May 1998.

BACKGROUND

The Delphi Chassis Systems plant in Dayton is a 1.4 million-square-foot facility that manufactures an array of friction brake systems for the automotive industry. There were four departments of concern during the investigation: departments 2, 12, 37, and 40. Approximately 280 workers (assemblers, machine operators, and quality operators) are employed in these departments over three shifts.

The brake manufacturing process begins in the mixing room where large vats are filled with a metallic disk brake lining compound (brake dust) to create pad stock. The brake dust contains a blend of steel wool, resins, coke, rubber, colloids, barytes, synthetic graphite, magnesia, and fiberglass. After mixing, vats containing pad stock are transported via forklift trucks and conveyor transports to heat ejection integral molding (HEIM) machines located in departments 2 (rotary HEIMs) and 37 (square HEIMs). Pad stock is transferred into dies of HEIM machines where brake pads are formed by mechanical pressure, then initially cured at temperatures ranging from 290-455 degrees Fahrenheit (°F). Each HEIM machine is equipped with local exhaust ventilation exhausting to dust collector hoppers. After brake pads are formed and initially cured, they are deposited into unloader bins to cool and for temporary storage. Local exhaust ventilation is also provided at each unloader bin. Brake pads go through a grinding process and a final cure in department 40. The curing ovens in department 40 are located adjacent to department 2, and are served by a direct exhaust ventilation system.

Insulator parts and brake shoes for brake pads are cut and formed by a steel press. Adhesive is applied to brake shoes with rollcoating machines (department 40), and the brake shoes are attached to the brake pads. The brake pads are transported to paint lines in departments 2 and 12, where they undergo abrasive blasting (with glass beads) and an electrostatic application of epoxy powder paint. The pads enter a paint cure oven (380-420 °F), have an insulator applied, and are then transported to an insulator cure oven to complete the paint line process. The assembly process (department 40) involves attaching wear sensors onto brake pads.

Several other processes occur in the departments of concern. Dye wash areas are located in departments 2 and 37, where the molds used in the HEIM machines are cleaned in alkali baths equipped with local ventilation. Additionally, a cold-mold machine, also used to produce brake pads, is located in department 37 adjacent to department 2.

METHODS

Industrial Hygiene

During a previous site visit to the Delphi Chassis facility (HETA 96-0199), several uncured brake pads were collected and analyzed at a NIOSH laboratory for degradation emission products. Under laboratory conditions, the curing process was simulated by heating portions of the brake dust in a glass tube at 290°F and 455°F for a period of 2 to 3 hours. Headspace analysis was made for volatile organic compounds using a gas chromatograph-mass spectrophotometer (GC-MS). Based on qualitative analysis, the two major compounds detected were hexamethylenetetramine (HMTA) and phenol. Bulk samples of the brake dust were also collected and submitted for microscopic analysis to determine the structure of fibrous and non-fibrous particles.

On October 15, 1997, an industrial hygiene evaluation was conducted that included area air sampling to determine general workplace concentrations for HMTA, phenol, and formaldehyde in departments 2, 12, 37, and 40. Formaldehyde air samples were collected for two reasons: (1) according to material safety data sheets (MSDS), formaldehyde is present in the resin used for brake pad production, and (2) HMTA is known to liberate formaldehyde when heated. Other activities during the site visit included an evaluation of engineering controls, observation of employee work practices, and review of MSDSs and industrial hygiene reports from previous evaluations conducted at Delphi.

Based on the area air sampling results, which revealed trace concentrations of HMTA, phenol, and formaldehyde, additional air sampling was conducted on November 25, 1997, to further assess worker exposures to these substances. This additional air sampling was performed in specific areas where trace levels had been found and volunteers agreed to wear the sampling pumps. Six personal breathing-zone (PBZ) air samples for HMTA and formaldehyde were collected on HEIM operators in departments 2 and 37 (four samples), a quality operator in department 37 (one sample), and a forktruck operator (one sample). A total of five area air samples for phenol, HMTA, and formaldehyde were collected at curing ovens in department 40 and paint lines in department 2. These air samples were collected from a location approximately one foot above the access door of curing ovens and approximately one foot from the exit-end of the paint lines. Area air samples were collected in these locations due to a lack of volunteers to wear personal sampling pumps.

Air samples for HMTA and formaldehyde were collected in tandem on Occupational Safety and Health Administration versatile sampler (OVS) tubes (13 millimeter quartz filters followed by XAD-2 sorbent beds) and 2,4-dinitrophenyl-hydrazine (DNPH) -treated silica gel cartridges, respectively. Sampling trains for HMTA and formaldehyde consisted of an OVS tube and a silica gel cartridge in series, connected to an air sampling pump pre- and post-calibrated at a flowrate of 1 liters per minute. Air samples for formaldehyde were analyzed in accordance with the NIOSH analytical method 2016,[1] and air samples for HMTA were analyzed by GC-MS. Air samples for phenol were collected on solid sorbent tubes (XAD-7) air sampling pump pre- and post-calibrated at a flowrate of 1 Lpm and analyzed, in accordance with NIOSH analytical method 2546.[1]

During the site visits a general inspection of the departments of concern was done to identify obvious health and safety hazards. In addition, a ventilation evaluation was made using ventilation smoke tubes to qualitatively assess local exhaust airflow at unloader bins as well as airflow patterns throughout the plant (particularly at entrance and exit points in the plant).

Medical

During the October site visit, the Occupational Safety and Health Administration Log and Summary of Occupational Injuries and Illnesses, Form 200 (OSHA 200 log), was reviewed for January 1997 to October 1997. Medical logs from the plant medical

department were also reviewed for the same time period.

Confidential medical interviews were conducted with employees to ascertain the types of health symptoms being reported by employees, as well as the types of exposures that were potentially related to those health symptoms. Employees in departments 2, 12, 37, and 40 were informed of the voluntary interview process during scheduled union meetings; a list of employees who wished to be interviewed was compiled by the union prior to beginning the interview process. Interviews were conducted on three different days (during each of the three shifts) during the period of March - May 1998. During the interview process several additional employees, not on the original lists, came forward to be interviewed.

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. (DOL), OSHA Permissible Exposure Limits (PELs).[4] NIOSH encourages employers to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion. The OSHA PELs reflect the feasibility of controlling exposures in various industries where the agents are used, whereas NIOSH RELs are based primarily on concerns relating to the prevention of occupational disease. It should be noted when reviewing this report that employers are legally required to meet those levels specified by an OSHA standard.

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

Epoxy Powder Paint

The composition of epoxy powders is complex, generally consisting of high-molecular-weight epoxide resins or acrylates, latent curing agents, accelerators, hardeners, pigments, and other chemicals. Several of these chemicals can induce allergic dermatitis, irritant dermatitis, skin photosensitivity, or bronchial asthma. Sensitization may occur to more than one compound within an epoxy powder. Once a worker has become sensitized to epoxy compounds, even a minimal exposure is sufficient to cause symptoms. Avoidance of contact with epoxy powders is the best course for preventing sensitization.[5,6] There are no established occupational health exposure criteria for epoxy powders.

Metallic Disk Brake Lining Compound

The metallic disk brake lining compound (brake dust) consists of multiple components, some of which have no established exposure limit. The MSDS states that overexposure to the brake dust may result in adverse pulmonary effects, including respiratory irritation. Some components listed in the MSDS have NIOSH RELs as low as 2.5 milligrams per cubic meter (mg/m^3) and 3.5 mg/m^3 (natural graphite and carbon black, respectively). As with the epoxy powder paint, there is no established occupational health exposure criterion for the brake dust.

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, respiratory tract, and skin sensitization.

The first symptoms associated with formaldehyde exposure, at concentrations ranging from 0.1 to 5 parts per million (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 to this compound.[7]

The International Agency for Research on Cancer (IARC) has classified formaldehyde as "probably carcinogenic to humans" (Group 2A).[8] 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.[9] NIOSH has identified formaldehyde as a suspected human carcinogen and recommends that exposures be reduced to the lowest feasible concentration or the lowest detectable concentration. NIOSH has identified formaldehyde as a suspected human carinogen and recommends that exposures be reduced to the lowest feasible concentration. This is based on the analytical capability at that time.[10] The OSHA PEL for formaldehyde is 0.75 ppm as an 8-hour TWA and 2 ppm as a STEL.[11] The ACGIH recommends a ceiling limit of 0.30 ppm for formaldehyde.

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 to 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 reliable quantifiable concentration at the present time." NIOSH also lists a REL for formaldehyde of 0.016 for up to a 10-hour TWA exposure (again using NIOSH analytical method 3500) and indicating that this is the lowest reliable 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).

Hexamethylenetetramine (HMTA)

Hexamethylenetetramine (HMTA) is a white, crystalline solid with a slight ammonia odor.[12] The principle uses of HMTA include its use in the rubber industry as an accelerator, as a curing agent for thermosetting resins (particularly phenyl-formaldehyde and urea-formaldehyde resins), in foundry mold castings as part of binder resins, and for use in manufacturing of adhesives and coatings.[12]

Primary routes of exposure would be direct skin contact and inhalation. Toxicological studies in humans show that HMTA is a skin sensitizer.[12] Skin rash and inflammation have been seen in exposed

workers, and in severe cases, blisters may develop. After repeated exposure some workers may develop a tolerance to further irritation. Inhalation exposure may cause asthma-like reactions in previously sensitized individuals.[12] Currently, no exposure criteria for HMTA have been established by NIOSH, OSHA, ACGIH, or other recognized organizations.

Phenol

Phenol is a strong irritant, and systemic absorption under unusual exposure conditions can cause convulsions as well as liver and kidney disease.[13] The skin is a primary route of entry for the vapor, liquid, and solid. Symptoms of chronic phenol poisoning may include difficulty in swallowing, diarrhea, vomiting, lack of appetite, headache, fainting, dizziness, mental disturbances, and possibly skin rash.[13] The NIOSH REL, ACGIH TLV, and OSHA PEL for phenol are 5 ppm as a TWA concentration.

Glass Beads

Glass beads, glas shot® or pavement beads, consist of an amorphous fusion of oxides of soda-lime plate glass. The beads do not contain free crystalline silica. This compound is considered a particulate not otherwise classified (p.n.o.c.)/particulate not otherwise regulated (p.n.o.r.). Overexposure may cause temporary eye and respiratory irritation.

RESULTS

Industrial Hygiene

Air Sampling

Air sampling results are presented in Table 1. Full-shift PBZ air samples collected on six workers revealed quantifiable concentrations for formaldehyde that ranged from 0.02 to 0.03 ppm, well below the OSHA PEL of 0.75 ppm (as an 8-hour TWA) and ACGIH ceiling limit of 0.30 ppm. These concentrations, however, were above the NIOSH REL of 0.016 ppm. The six workers were also exposed to HMTA concentrations that ranged from 0.002 ppm to 0.009 ppm. No exposure criterion is currently established for HMTA. For area air samples collected, formaldehyde concentrations ranged from 0.01 to 0.04 ppm, and trace HMTA concentrations were detected in three of the five samples. Area air samples for phenol revealed only trace concentrations of less than 0.005 ppm (based on a sample volume of 480 liters), well below the NIOSH REL of 5 ppm.

Air sampling for brake dust and epoxy powder paint was not performed during the NIOSH evaluation. Review of management's industrial hygiene reports indicated that over the previous three years full-shift air sampling had been performed on workers to determine their total dust exposures to the brake dust and epoxy powder paint. The results revealed total dust concentrations up to 0.55 mg/m^3 for brake dust and 1.03 mg/m^3 for epoxy powder paint. No occupational exposure criteria currently exist for these substances.

Bulk Sample Analysis

The microscopic analysis of the brake dust showed that fibrous particles were found to have relatively smooth sides and constant diameters, which ranged from about 1 micrometer (µm) to greater than 10 µm, with an average of 8 µm. The lengths ranged from about 10 µm to greater than 100 µm, with an average of 60 µm. The non-fibrous particles were found to be very rounded to somewhat angular in shape, and from less than 1 µm to about 60 µm in length (mean = 20 µm).

Ventilation Evaluation

Based on airflow measurements made in departments 2 and 37, these work areas appeared to be under severe negative pressure. Ventilation

smoke tubes showed a strong inward flow of air at two doorways, one of which was difficult to open due to the negative pressure.

Airflow measurements and inspection of exhaust hoods at unloaders discovered deficiencies in hoods serving unloader bins in departments 2 and 37. Some hoods showed little or no air movement; one was backdrafting (giving the potential to discharge air contaminants), one was disconnected from the ventilation system, and another appeared to be clogged.

Other Observations

In department 5 oil puddles were observed on the floor that originated from two automated grinding machines used to make wheel cylinders. These machines discharged a water-based metal-working fluid onto the floor due to lack of adequate splash guarding and presents a slip hazard. Also, for protection against dermal exposure to metal-working fluids, grinder operators at these machines were observed wearing latex rubber gloves, which do not offer adequate protection against water-based metal-working fluids.

Medical

A total of 46 employees (18% of 254) from departments 2, 37, and 40 were interviewed; none from department 12 volunteered to be interviewed.

Nineteen (16% of 116) employees in department 2 were interviewed. Sixteen employees reported work-related health symptoms (defined for this evaluation as health symptoms occurring only at work or being worse at work, with improvement when away from the workplace). There were 13 reports of work-related upper respiratory problems (sore throat, itchy eyes, nasal congestion, nosebleeds, or sinusitis), 9 reports of work-related lower respiratory problems (cough, wheeze, chest tightness, shortness of breath, or bronchitis), 8 reports of work-related headache, and 2 reports of work-related skin rash. Most employees reporting work-related health problems were employees working with the paint lines and/or the rotary HEIM machines.

Twenty (19% of 104) employees in department 40 were interviewed. Thirteen employees reported work-related health problems, including 10 with upper respiratory symptoms, 4 with lower respiratory symptoms, 2 with headaches, and 3 with skin rash. Seven of the employees reporting work-related health symptoms worked in the assembly area, three in the rollcoating area, two in the grinder area, and one in the mix room.

Seven (21% of 34) employees in department 37 were interviewed. Three employees reported work-related health problems, including 3 with upper respiratory symptoms, 1 with lower respiratory symptoms, 1 with headaches, and 2 with skin rash. The three employees worked in separate areas of department 37.

OSHA 200 logs indicated one illness, an unspecified respiratory/lung disease in department 37. Medical department logs indicated two cases of respiratory/lung disease during the same period. One case occurred in department 37, with an unspecified diagnosis. The second case occurred in department 2 and involved wheezing and bronchitis in an employee who had an acute exposure to paint dust while cleaning the paint line. Other recorded cases and medical department reports in the areas of concern involved musculoskeletal disease and soft-tissue injuries.

DISCUSSION

Despite the fact that only a small percentage of department 2, 12, 37, and 40 employees participated in this HHE, and the lack of information available concerning the health status of employees who were not interviewed, the symptoms reported by participating employees are consistent with known effects of substances used in their jobs. The most prevalent health symptoms reported among department 2 employees working with the paint lines involved the upper and lower respiratory tract. The

primary exposures of concern in this area were epoxy powder paint dust, paint fumes, and glass beads. Epoxy resins contained in the epoxy powder paints have been linked to irritant and allergic contact dermatitis as well as asthmatic symptoms.[13] The MSDS for the glass-shot beads indicates that overexposure (>5 mg/m³) to this material may cause temporary respiratory and eye irritation.

The most prevalent symptoms reported among department 2 employees working with the rotary HEIMs also involved the upper and lower respiratory tract. One of the exposures of concern in this area was to formaldehyde. The levels of formaldehyde measured at the paint lines and rotary HEIM would generally not be expected to cause acute health symptoms, although it is possible that some employees could experience health symptoms at the levels detected.[16]

In the assembly area of department 40, most of the reported work-related symptoms involved the upper respiratory tract. An exposure of concern in both departments 2 and 40 concerned the brake dust. The MSDS for the brake dust states that overexposure to the dust may result in respiratory irritation. Company air sampling results for brake dust showed maximum concentrations of 0.55 mg/m³. There is no established exposure criterion for the brake dust, and thus it is difficult to classify an "overexposure." Even in the absence of an "overexposure" it can be expected that in a group of employees, some may experience symptoms when exposed to relatively low concentrations of irritants. Thus, it is possible that some of the reported symptoms may be related to the brake dust. The microscopic analyses of the brake dust, revealing the brake dust particles to have round and relatively smooth sides, suggests that the physical characteristics of the particles may not be the primary cause of irritation caused by that dust.

Brake dust and epoxy powder paint should not be evaluated using exposure limits for p.n.o.r. because these substances may cause health effects such as respiratory irritation or sensitization. Workers may experience health effects when exposed to brake dust and epoxy powder paint concentrations below the OSHA and ACGIH exposure criteria for p.n.o.r./p.n.o.c.

Respirator use, including the use of dust-mist masks was reported by only a few employees. The MSDS for the epoxy powder paint recommends the use of appropriate NIOSH listed respiratory devices for particulates and fumes. The MSDS for the glass beads recommends the use of a NIOSH approved dust respirator. The MSDS for the metallic disk brake lining compound states that respiratory protection is not generally needed, as long as local exhaust and general ventilation maintain acceptable exposure levels. Exposure levels for all these substances should be minimized due to the complex composition of the dust and the uncertain health effects potentially related to it.

Although local exhaust ventilation was provided at the HEIM and paint operations, dust was still being emitted into the work environment, as evidenced by accumulated dust on the floor and working surfaces. It is important to note that while properly designed exhaust ventilation systems will remove toxic contaminants from industrial processes, they should be not be relied upon to draw outside air into the plant. If the amount of replacement air supplied to the plant is lower than the amount of air exhausted, the pressure in the plant will be lower than atmospheric. This condition, called "negative pressure," results in air entering the plant in an uncontrolled manner through windows, doorways, and walls. As a result, too much negative pressure can create high-velocity drafts and backdrafting that may affect the performance of the local exhaust ventilation systems. Too much negative pressure may also lead to difficulty opening or shutting doors and, in some cases, can cause personnel safety hazards when doors open or shut in an uncontrolled fashion. In addition to improving the performance of the existing exhaust ventilation system serving HEIM machines, improvements in the exhaust ventilation for the unloader bins, paint lines, and cure ovens may be helpful in reducing formaldehyde concentration in departments where those operations are located.

Although not a focus of this HHE, workers in department 5 were observed to be wearing inappropriate gloves for protection from skin exposure to metalworking fluids. Skin protection is important where metalworking fluids are used. Several cutaneous disorders have been associated with the use of metalworking fluids, including irritant contact dermatitis, allergic contact dermatitis, and folliculitis.[15]

RECOMMENDATIONS

Engineering Controls

1. Due to the potential health effects associated with exposure to brake dust, epoxy resins, formaldehyde, and HMTA (at unspecified concentrations), exposure to these air contaminants should be minimized to their lowest feasible concentrations. One way to further reduce exposures would be to improve the exhaust ventilation effectiveness by providing an adequate supply of replacement air, thus eliminating excessive negative pressure. In addition, exhaust ventilation systems serving HEIM machines, unloader bins, paint lines, and cure ovens should be further evaluated and modified by a qualified industrial ventilation engineer to assure optimum service and performance.
2. These air contaminants of concern should also be periodically monitored to assure that engineering controls and personal protective equipment use are adequate. Additional monitoring for formaldehyde in the workplace should include a comparison with the outdoor ambient concentration to help determine if such lower levels are feasible. Trace concentrations of formaldehyde are common in ambient outdoor air, especially in urbanized areas, and reducing workplace exposure concentrations that are not substantially elevated above the ambient outdoor concentration may not always be feasible.
3. Splash guards at grinding machines in department 5 should be improved to prevent metalworking fluids from being splashed onto workers, thus reducing the possibility of dermal contact that may cause dermatitis. Better splash guards should also inhibit metal-working fluids from being discharged on the floor to prevent accidental slips and falls.

Personal Protective Equipment

1. Following exhaust ventilation improvements, use of respirators could be considered for workers who continue to experience respiratory tract irritation. NIOSH/Mine Safety and Health Administration (MSHA) approved respirators for particulates and fumes should be used by employees working with the paint lines. This will provide protection from exposure to the epoxy powder paint dust and fumes and the glass beads. NIOSH/MSHA approved dust/mist masks should be made available for employees who may experience respiratory tract irritation from exposure to the brake dust. All employees using respirators should be included in an appropriate respirator program (written worksite-specific procedures, program evaluation, selection, training, fit testing, inspection and maintenance, medical evaluations, work-area surveillance, approved respirators). *It should be noted that respirators should not be used as the primary means of reducing worker exposures. Instead, respirators should be used only as an interim plan for protection until improved engineering controls are in place, or for use periodically.*

2. Safety glasses should be used in all work areas. Dust-proof goggles are recommended for exposures to the epoxy powder paint dust, particularly when working directly with the paint application apparatus.

3. Employees working with the epoxy powder paint should use protective coveralls, sleeve

protectors, and permeation resistant gloves to minimize contact with skin and personal clothing.

4. Machine operators who work with metalworking fluids should discontinue using latex rubber gloves for skin protection. Instead, gloves made of nitrile rubber material should be used. This material is more effective against permeation by metalworking fluids.

Employee Hygiene

1. Irritants and allergens that have come in contact with exposed skin should be washed off with mild soap and water as soon as possible. Residual soap should be washed off the skin surface. Special attention should be directed toward soaps and skin cleansers since they themselves can serve as irritants. Use of harsh and abrasive cleansers should be minimized. Certain components of the soaps or moisturizers (e.g., lanolin and fragrances) are known allergens and may cause allergic contact dermatitis.

2. Clothing contaminated with known irritants or allergens should be removed and laundered prior to re-use. This is particularly applicable to the epoxy powder paint in those employees not wearing protective gowns or coveralls.

Employee Education

Employees must be educated regarding the possible health effects of agents being used and proper selection and use of personal protective equipment. Employees must be made aware of the availability of MSDS for the agents that they are working with. Training should ensure that employees know what procedures to follow if a potential occupational illness, injury, or health effect occurs.

Evaluation, Reporting, and Surveillance

Workers should be encouraged to report all possible work-related health problems to the appropriate medical or supervisory personnel. These problems should be investigated on an individual basis by the company and consulting health care providers, preferably physicians with experience in occupational health. Individuals with definite or possible occupational health effects should be protected from exposures to presumed causes or exacerbators of the disease.

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Table 1
Air Sampling Results - Delphi Chassis Systems
November 25, 1997

Sample Location	Sampling Duration (minutes)	Sample Volume (liters)	Concentration, parts per million (ppm)	
			Formaldehyde	Hexamethylenetetramine
Personal Breathing-Zone Samples				
HEIM operator, Dept. 37	453	453	0.03	0.009
HEIM operator, Dept. 37	450	450	0.03	0.008
HEIM operator, Dept. 37	430	430	0.02	0.003
Quality operator, Dept. 37	419	419	0.03	0.003
HEIM operator, Dept. 2	414	414	0.02	0.002
Fork truck operator/ curing oven loader	441	441	0.03	0.009
General Area Air Samples				
Area - curing oven #2, Dept. 40	350	350	0.02	trace
Area - adjacent to curing oven #6, Dept. 40	428	428	0.02	trace
Area - curing oven #1, Dept. 40	350	350	0.04	ND
Area - paint line #2, Dept. 2	385	385	0.01	ND
Area - paint line #3, Dept. 2	382	382	0.02	trace
Minimum Detectable Concentration (MDC)†			0.00007	0.0004
Minimum Quantifiable Concentration (MQC)†			0.0002	0.002
Exposure Criteria (expressed in ppm)				
NIOSH Recommended Exposure Limit (REL)			LFC *	NA
OSHA Permissible Exposure Limit (PEL)			0.75	NA
ACGIH Threshold Limit Value (TLV®)			0.30 (C)	NA

ND = none detected, NA = none available or established
C = ceiling limit
* probable carcinogen - lowest feasible concentration recommended (lowest reliably quantifiable concentration is represented here)
† = assuming a 453 liter sample

For Information on Other
Occupational Safety and Health Concerns

Call NIOSH at:
1–800–35–NIOSH (356–4674)
or visit the NIOSH Homepage at:
http://www.cdc.gov/niosh/homepage.html

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