HETA 99-0311-2790
DaimlerChrysler Transmission Plant
Kokomo, Indiana

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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 Douglas Trout, MD, MHS, Joshua M. Harney, MS, and Robert E. McCleery, MSPH, of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS) and Patricia Sullivan, ScD and Hector Ortega, MD, ScD, of the Division of Respiratory Disease Studies. Field assistance was provided by Kevin Roegner and Lisa Delaney, DSHEFS. Analytical support was provided by the Division of Physical Science and Engineering. Desktop publishing was performed by Elaine Moore. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of DaimlerChrysler Transmission Plant, Department 8700 - Kokomo, Indiana

NIOSH representatives evaluated the DaimlerChrysler transmission plant in Kokomo, Indiana. We looked into the health problems reported by employees from Department 8700 beginning around June 3, 1999.

What NIOSH Did

We walked through Department 8700 and watched employees work.

We reviewed air sampling tests done by the union and management.

We took air and bulk samples for metalworking fluids.

We reviewed medical records of Department 8700 employees who went to the lung specialist in the summer of 1999.

We handed out a symptoms questionnaire to workers in Departments 8700, 7700, and 7500.

What NIOSH Found

We did not find a clear reason for the health problems reported among employees of Department 8700.

Management and union representatives did a lot of testing to find a cause for the symptoms of workers in Department 8700 in the summer of 1999.

High levels of bacteria in the metalworking fluid of Department 8700 suggest that better maintenance of that metalworking fluid is needed.

All but four metalworking fluid air samples had concentrations below the NIOSH recommendation.

Medical records showed several new cases of asthma among workers in Department 8700.

What DaimlerChrysler Can Do to Address the Problem

Keep track of reported health effects in a way that helps identify possible problems with certain jobs, machines, or work materials like metalworking fluids.

What Department 8700 Employees Can Do to Address the Problem

Make sure your supervisors and union representatives know about health and safety concerns you have related to work.

What DaimlerChrysler and Employees Can Do to Improve the Metalworking Fluid Health and Safety Program

Improve the maintenance of the metalworking fluids in the central system of Department 8700.

Perform more sampling for metalworking fluids in several specific areas (listed in the report), to see if more controls are needed.

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NIOSH National Institute for Occupational Safety and Health

Health Hazard Evaluation Report 99-0311-2790
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May 2000

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SUMMARY

On August 9, 1999, NIOSH received a joint management/union (International Union, United Automobile, Aerospace, and Agricultural Implement Workers of America) health hazard evaluation (HHE) request concerning respiratory symptoms occurring among employees of Department 8700 at the DaimlerChrysler transmission plant in Kokomo, Indiana. NIOSH representatives made site visits to the Kokomo plant in August and September 1999. The concerns which were the basis for the HHE request began when a number of employees reported respiratory symptoms on June 3, 1999, and continued to the time of the HHE request with intermittent "outbreaks" of reported symptoms among Department 8700 employees.

During the NIOSH site visits, NIOSH representatives observed work and manufacturing processes, reviewed recent industrial hygiene sampling results and interventions performed by management and the local union, performed bulk material and air sampling in Department 8700 and Department 7700 (another machining area using the same metalworking fluid [MWF]), reviewed medical records of Department 8700 workers, and administered a symptom questionnaire to workers in Departments 8700, 7500, and 7700.

The levels of Gram-negative bacteria in bulk MWF samples ranged from 10^5 - 10^8 colony-forming units per milliliter (cfu/mL). The endotoxin concentrations were generally around 10^5 endotoxin units (EU)/mL. The results of the area air samples taken during the August 1999 site visit revealed trace amounts of volatile organic contaminants, none of which were judged likely to be primarily related to the reported health effects. Among the 70 personal breathing zone (PBZ) samples collected for MWF aerosol during the September 1999 site visit, the concentrations in four samples equaled or exceeded the NIOSH Recommended Exposure Limit (REL) of 0.4 milligrams per cubic meter; one of these samples was from Department 8700, three were from Department 7700.

Medical records were reviewed for 71 Department 8700 workers. The most prevalent symptoms were asthma-like symptoms, with 72% of these 71 workers reporting cough, 45% reporting shortness of breath, 39% reporting chest tightness, and 13% reporting wheezing. The medical records revealed two persons with new-onset asthma associated with a work-related pattern of symptoms, two persons with exacerbations of pre-existing asthma, and six other workers with asthma-like conditions. Overall, 229 (50%) of 462 employees in the three departments surveyed participated in the questionnaire survey (by department: 7500 -

68/80[85%]; 7700 - 95/135[70%]; 8700 - 66/247[27%]). A variety of symptoms, both respiratory and non-respiratory, were reported by employees of the three machining departments. Persistent cough was the symptom most commonly reported among participants from Department 8700 (reported by 62% of participants).

The medical record review confirmed several cases of asthma (both new-onset and aggravation of pre-existing asthma), as well as respiratory symptoms, occurring among employees of Department 8700. No single aspect of the Department 8700 manufacturing process, however, was determined to be clearly related to the cluster of illnesses which were first reported in June 1999. Our air sampling indicates that exposure to MWF aerosol alone in Department 8700 is not likely the cause for the observed increase in reported symptoms. The bulk sampling indicates that microbial contamination is a continuing problem in the MWF of Department 8700. To address the symptoms which were the basis for this HHE request, a recommendation is made concerning continued systematic monitoring of reported health problems. This report also provides recommendations concerning maintenance and cleaning of central MWF systems, machine sumps, and flumes and further air sampling as components of the MWF safety and health program at Kokomo.

KEYWORDS: SIC 3714 (Motor vehicle parts and accessories), Metalworking fluids, asthma, endotoxin, bacteria, thoracic particulate.

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INTRODUCTION

On August 9, 1999, NIOSH received a joint management/union (International Union, United Automobile, Aerospace, and Agricultural Implement Workers of America) health hazard evaluation (HHE) request concerning respiratory symptoms occurring among employees of Department 8700 at the DaimlerChrysler transmission plant in Kokomo, Indiana. On August 16, NIOSH representatives made an initial site visit to the Kokomo plant; the activities that took place on that day were summarized in a letter dated August 18, 1999. During the week of September 20-24, NIOSH representatives conducted a return site visit; the activities of that site visit were summarized in a letter of October 7, 1999. This report is a compilation of the results of those surveys, which have previously been presented to management and union representatives in letters dated December 3, 1999, and February 16, 2000.

BACKGROUND

The concerns which were the basis for the HHE request were reported to have begun on June 3, 1999, when 15 persons from Department 8700 reported respiratory symptoms to management. Department 8700 includes approximately 250 employees who perform a variety of machining operations; the department includes laser-welding operations which are unique to that department. The machining and welding operations in Department 8700 include many enclosed machines, most of which are equipped with mist collectors that exhaust to the outside. Since the initial reports, employees in Department 8700 have continued to report symptoms to management and union representatives. The reports of these symptoms have occurred both sporadically and in clusters that have been described as "outbreaks." The requesters reported that, as of the date of the HHE request, 93 employees from Department 8700 had been to the plant medical department with a variety of symptoms, primarily respiratory. Employees requiring further evaluation for respiratory concerns were referred by the plant medical department to consulting pulmonologists. As a part of this HHE, NIOSH representatives reviewed the medical records concerning the acute symptoms of employees from Department 8700 seen by the plant medical department and/or the pulmonologists.

At the end of May 1999, the 80,000-gallon central metalworking fluid (MWF) system for Department 8700 (CCS-35) was shut down so that the drag chain could be repaired. The drag chain had been broken for approximately one week. To make the repairs, CCS-35 had to be drained of fluid. When completely drained, 15,000 gallons of MWF (GR-1000, a semi-synthetic MWF) were salvaged from the system. The central holding tank and flume system for CCS-35 were not cleaned of debris at that time. When the repairs were completed, the salvaged 15,000 gallons of GR-1000 were placed back into the system, along with virgin GR-1000 (5½ % concentration) and water. CCS-35 was then put back into use on June 1, 1999, after a holiday weekend. On June 1, and again on June 2, a machine operator in Department 8700 reported respiratory irritation to union and management representatives. On June 3, 15 employees reported respiratory symptoms to the medical department. The employees reporting the symptoms on June 1-3 worked near the area of the #220228 Broach machine. During that time period, the #220228 Broach was using MWF from its own sump (not CCS-35) and several MWFs were being used in trials on that machine, including:(1) on June 1 - TK-145 (soluble oil MWF); (2) on June 2 - C-225; and (3) on June 3 - GR-1000 (same MWF being used in CCS-35 supplying most of the rest of Department 8700). On the evening of June 3, the GR-1000 was pumped out of CCS-35 to a holding tank; CCS-35 was re-filled with C-100 (a soluble oil MWF). In early July the coolant system was thoroughly cleaned, and CCS-35 was re-filled with another

soluble oil MWF (TK-145), which has been used subsequently.

Continuing from June through the time of the HHE request, symptoms recurred in a sporadic manner among Department 8700 employees, sometimes affecting groups of employees. Subsequent to the June 1-3 reports of symptoms, employees in Department 8700 reporting symptoms were not localized to the area around the #220228 Broach. To investigate the reported symptoms, management and union representatives reviewed the manufacturing processes in Department 8700 and performed extensive industrial hygiene evaluations. A number of changes were made throughout the summer; these included modifications and cleaning of the heating, ventilating, and air-conditioning (HVAC) system, cleaning the central MWF system and the flume system, changing the MWF and wash fluids, and modifying the way that outside vendors supplied parts to Department 8700.

To investigate possible causes of the symptoms, industrial hygiene and environmental testing was performed by management with union collaboration. Bulk sampling of MWF in Department 8700 was performed in July by a consulting firm; the results were summarized in a report dated August 30, 1999. Of 19 bulk samples, 11 (58%) had levels of bacteria of 10^7 colony forming units per milliliter (cfu/mL) or greater (maximum 4.2×10^8 cfu/mL). Endotoxin concentrations in the samples ranged from <1 to 640 nanograms per mL (ng/mL).

Because GR-1000 contains a triazine biocide (triazine biocides are thought to act as biocidal agents by releasing formaldehyde), bulk and air sampling was conducted for formaldehyde. Concentrations of formaldehyde in the bulk samples were as follows:

Virgin GR-1000 - 8 milligrams per liter (mg/l); GR-1000 in use in CCS-21 (another central system) - 3.7 mg/l; GR-1000 from CCS-35 (had been pumped to storage tank) - 128 mg/l;CCS-35 sludge - 56 mg/l. To learn more about potential formaldehyde concentrations in the air secondary to the fluid from CCS-35, management performed air sampling in the head space of five-gallon buckets which contained several of the fluids mentioned above, including buckets with two gallons of the used GR-1000 from CCS-35 (resulting formaldehyde concentration: 1.5 parts per million [ppm]) or virgin GR-1000 (5%, with water) (resulting formaldehyde concentration: 2.5 ppm). Area workplace air sampling for formaldehyde (using Drager colorimetric indicator tubes and a Drager air pump) in Department 8700 revealed no detectable amounts; this sampling was done after the GR-1000 had been replaced by C-100 in CCS-35.

Many other potential exposures possibly associated with the reported symptoms were evaluated with industrial hygiene sampling by management. Between June 9 and August 2, 1999, a total of 39 personal and area samples were collected and 141 measurements with direct-reading instruments were made. Substances evaluated included oil mist, total particulate, toluene, total hydrocarbons, various metals, total aldehydes, amines, phosphine, several acids (including acetic acid), nitrogen oxides, triethylamine, sulfur dioxide, and ozone. Results of this sampling did not provide any clear evidence for specific agent(s) as the cause of the symptoms among employees in Department 8700.

METHODS

Industrial Hygiene

During the initial site visit on August 16, 1999, bulk process samples of the MWF in Department 8700 were collected in sterile 150-milliliter (mL) specimen vials. The vials were shipped overnight in ice-filled containers to a NIOSH contract laboratory for the enumeration and speciation of culturable bacteria and fungi. Separately, additional bulk samples were collected in sterile 50 mL specimen vials and shipped overnight in

ice-filled containers to a NIOSH laboratory for endotoxin analysis. During the same site visit, NIOSH industrial hygienists collected several area air samples in Department 8700 to qualitatively screen for both particulate and vapor contaminants in areas identified by union and management representatives as work locations of employees who had reported symptoms. Two air samples were collected on 25-mm Millipore filters for particle identification and characterization by scanning electron microscopy (SEM). One SEM sample was collected on the front of the cage of laser welder #220157, near Broach #220228, and the other was collected on laser welder #220451. Thermal desorption tube (TDT) samples to identify volatile organic compounds were collected according to NIOSH Method #2549 in conjunction with the SEM samples.[1] In addition to the locations where SEM samples were collected, TDT samples were taken atop the control panel of Broach #220228, and above the #014323 weld-checker nearest laser welder #220157.

Based on: (1) the results of the August 1999 air sampling, (2) a review of the industrial hygiene sampling done by management to evaluate symptoms among Department 8700 employees, (3) a review of the processes in Department 8700, and (4) the symptoms being reported to the medical department and to NIOSH investigators in informal interviews during the August walk-through, it did not appear to NIOSH investigators that further industrial hygiene sampling for specific chemical agents in Department 8700 would be helpful in determining the etiology of symptoms that had occurred in June 1999. It was evident, however, that personal MWF exposures had not been well characterized recently among the machinists. Therefore, to determine if MWF particulate levels could be playing a role in the ongoing symptoms among Department 8700 employees, NIOSH conducted an industrial hygiene evaluation in Departments 8700 and 7700 during a September site visit. Department 7700 was chosen as a comparison department because it primarily uses the same MWF as is used in Department 8700, and because "outbreaks" of respiratory symptoms had not been reported. Personal breathing zone (PBZ) samples for thoracic particulate mass (the portion of the MWF aerosol that penetrates beyond the larynx) were collected for representative workers in these departments during first shift operations on September 21 and 22, and during second shift on September 23. Side-by-side area air samples for both total particulate and thoracic particulate were collected in both departments. Video exposure monitoring (VEM) was also performed to improve the understanding of how the worker's individual tasks affect personal exposure to air contaminants in Departments 8700 and 7700.[2]

PBZ samples were collected on a 37-mm closed-face cassette containing a tared 2-micrometer (μm) pore-size polytetrafluoroethylene (PTFE) filter connected to either the right or the left lapel area of the worker. A thoracic cylcone was attached to the sampling cassette so that only the thoracic fraction of the aerosol would be collected.[3] Tygon® tubing connecting the sampler and a personal sampling pump drew air through the sampling train at a flow rate of 1.6 liters per minute (Lpm).[4] Area samples were collected with co-located thoracic fraction samplers, described above, and traditional total particulate samplers. The total particulate samplers consisted of a 37-mm closed-face cassette with 2-μm pore-size PTFE filters, Tygon tubing, and a personal sampling pump calibrated at 2 Lpm according to NIOSH Methods #0500.[5] The analyses of both PBZ and area samples were conducted in the same manner. The cassettes containing the filters and back-up pads for each sample were placed in a dessicator containing calcium sulfate for at least 16 hours for equilibration. The samples were then allowed to equilibrate to balance room conditions for at least two hours prior to weighing for particulate mass.

The particulate mass for each PBZ sample was determined by measuring the gross weight of each filter on an electrobalance and subtracting the previously determined tare weight of the filter.

This mass is referred to as 'thoracic particulate mass' in the tables of this report. The instrumental precision of the microbalance is 0.001 milligrams (mg). Due to the physical integrity of some PTFE filters, the limit of detection (LOD) and limit of quantitation (LOQ) are effectively the same: 0.01 mg/sample.[6] Based on a sample volume of 650L, the minimum quantifiable concentration (MQC) is 0.01 mg per cubic meter of air (mg/m^3).

Medical

NIOSH representatives reviewed the medical records from the plant medical department and from consultants for all employees in Department 8700 who reported symptoms to the medical department around June 3, 1999, and during the following months. Records of 71 workers were reviewed. A number of these records were collected during the site visits; additional records were forwarded to NIOSH in an ongoing manner as they became available.

During the September site visit, a questionnaire was administered to employees of Departments 7500, 7700, and 8700 to better characterize reported symptoms. Departments 7500 and 7700 are also machining departments and were chosen as comparisons because they primarily used the same MWF (TK 145) as was being used in Department 8700. All three departments have large central systems supplying MWF to the machinery, and all machine primarily steel or cast iron. The questionnaire addressed work history and symptoms or illnesses experienced at the time of the survey and in the preceding 6-12 months. A "work-related" symptom was defined in this analysis as: (1) a symptom reported by the participant to have occurred in repeated episodes or every workday for a month or more; and (2) a "positive" or "unsure" response to the question: "does [the symptom] improve during time away from work?" Questionnaire responses were analyzed by categorizing participants as working in Department 8700 versus working in Departments 7500/7700. Data analyses were done using EpiInfo Version 6.

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),[7] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[3] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[8] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are 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.

Metalworking Fluids

NIOSH recommends that occupational exposures to MWF aerosols be limited to 0.4 mg/m^3 of thoracic particulate mass as a TWA concentration for up to a 10 hr/day during a 40-hr work week, measured according to NIOSH Method 0500.[5] The 0.4 mg/m^3 concentration of thoracic particulate mass approximately corresponds to 0.5 mg/m^3 for total particulate mass. This REL is intended to reduce respiratory disorders associated with MWF exposures in the workplace.[9]

Microorganisms in MWF

Historically, microbial contamination of MWF has been a problem primarily because of the microbial growth effects on fluid quality and performance. Fluid degredation from microorganisms may result in changes in fluid viscosity, and the acid products of fermentation may lower the pH of the fluids, causing corrosion of machined parts. Anaerobic bacteria, specifically the sulfate reducers, may produce hydrogen sulfide and other toxic gases. Excessive microbial growth may result in clogged filters and ports and may interfere with the machining operations. Currently, there is evidence that allergic or hypersensitivity reactions are associated with microbially contaminated MWF, even with relatively low air concentration of allergens.

Water-based MWFs are excellent nutritional sources for many kinds of bacteria and fungi. The predominant species routinely recovered from MWFs are virtually identical to those routinely recovered from natural water systems. Many species that grow in MWFs secrete waste products that serve as a nutritional substrate for organisms that have more restrictive nutritional needs. Although some pathogenic organisms have been identified in oil emulsion MWFs in the past,[10,11] most pathogens do not persist well in MWFs.[12,13,14,15] Some researchers have suggested that well-maintained MWFs should have bacterial concentrations below 10^6 CFU/mL of fluid.[16] There are insufficient data to determine acceptable levels of microbial contamination in the air. Bacterial endotoxin is a heat-stable, lipopolysaccharide compound from the outer cell wall of Gram–negative bacteria, which normally occur abundantly in MWFs. Exposure to airborne endotoxin can cause adverse respiratory effects. Occupational exposure limits for endotoxin have not been established by either NIOSH, OSHA, or the ACGIH. Although in some individual workplaces the air concentration of endotoxin has been reported to be correlated with the amount of endotoxin detected in the MWF,[17,18] in general, potential inhalation exposure to endotoxin may be difficult to determine based on bulk sampling results.[17] Bulk sample concentrations of endotoxin are primarily useful as another indicator (along with other measures, such as culturable bacteria levels) of whether adequate maintenance procedures are in place for the MWF system.

RESULTS

Industrial Hygiene

The microbial counts and endotoxin concentrations for the six bulk samples collected are listed in Tables 1 and 2, respectively. Samples 1-3 were collected from machines connected to CCS-35. Samples numbered 4 were collected from the ultrasonic-bath fluid used in a weld-checker. Samples 5 and 6 are from the Landis grinders with stand-alone sumps. The levels of Gram-negative bacteria in these samples ranged from 10^5 - 10^8 cfu/mL; the endotoxin concentrations were generally around 10^5 EU/mL, except in fluid from one weld-checker which had a lower concentration.

The results of the area air samples taken during the August 1999 site visit revealed only trace amounts of particulate found on the SEM filter samples, which was not enough for identification or characterization. The results for TDT samples collected near laser welders primarily showed C9-C14 aliphatic hydrocarbons, C14-C20 saturated and unsaturated aliphatic hydrocarbons, and dichlorofluoroethane. The TDT samples collected near the weld checker, laser welder #220157 near Broach #220228, and Broach #220228 detected ethylene glycol in addition to these compounds. While these contaminants were distinguishable from substances found on the field blanks, none of them (at the apparently low levels in the samples) were judged likely to be primarily related to the concerns being evaluated in the HHE request.

PBZ sampling results for thoracic particulate can be found in Tables 3-8. Tables 3 and 4 present results of samples taken on September 21 in Departments 7700 and 8700, respectively. Tables 5-8 present results of samples taken on September 22-23. For all tables, the thoracic particulate measurements are reported as the average air concentration for the time sampled. Four of the 70 PBZ samples had MWF concentrations that equaled or exceeded the NIOSH REL. On September 21, the median air concentration of thoracic particulate among the samples from Department 7700 was 0.22 mg/m^3 (number of samples = 15, range 0.12 - 0.51 mg/m^3), while the median air concentration among the samples from Department 8700 was 0.13 mg/m^3 (number of samples = 14, range 0.07 - 0.74 mg/m^3). On September 22, the median concentration among samples from Department 7700 was 0.28 mg/m^3 (number of samples = 10, range = 0.08 - 0.52 mg/m^3), while the median concentration for the samples from Department 8700 was 0.16 mg/m^3 (number of samples = 11, range = 0.05 - 0.25 mg/m^3). On September 23, the median concentration for samples collected in Department 7700 was 0.18 mg/m^3 (number of samples = 9, range 0.1 - 0.29 mg/m^3), while that in Department 8700 was 0.06 mg/m^3 (number of samples = 11, range = 0.04 - 0.14 mg/m^3). Four (11%) of the 36 PBZ air samples collected from Department 8700, and 19 (56%) of the 34 PBZ samples from Department 7700, had MWF concentrations greater than one-half of the NIOSH REL.

The results of the side-by-side area air samples for total particulate and thoracic particulate, and of the video exposure monitoring (VEM) are presented in Appendices 1 and 2, respectively. The thoracic fraction of an aerosol is a subset of the "total" fraction. Therefore, it was expected that the thoracic particulate concentration would be less than that of the corresponding total sample for each sample pair. However, in 8 of the 17 paired samples, the thoracic concentration exceeded the "total" concentration; there is no clear explanation for those findings at this time. The VEM results presented demonstrate that VEM can serve as an effective tool in selected instances to discern from which specific task a worker receives the majority of his exposure.

Medical

Questionnaire

Overall, 229 of 462 (50%) employees in the three departments participated in the questionnaire

survey (by department: 7500 - 68/80[85%]; 7700 - 95/135[70%]; 8700 - 66/247[27%]). Characteristics of the participants are reported in Table 9A. Relative to the other departments, participants from Department 8700 had a lower percentage of men and a lower percentage reporting work with, or near, MWF. The prevalence rates of some of the symptoms (focusing on respiratory symptoms) reported in the survey are presented in Tables 9B-9D. Table 9B reveals that persistent cough was the symptom most commonly reported among participants from Department 8700 (reported by 62% of participants). Among participants from Departments 7500/7700, the prevalence of reported respiratory and upper respiratory symptoms ranged from 24-48%. Comparison of the data in Tables 9B and 9C shows that the five selected symptoms were reported approximately one-half as commonly among participants on the day of the survey (Table 9C) versus 'during the last six months' (Table 9B). Table 9D reports the prevalence of selected 'work-related' symptoms (see Methods for case definition). Among respondents in Department 8700, persistent cough and unusual shortness of breath were the two most commonly reported work-related symptoms.

Medical Record Review

The medical records reviewed dated from May 20, 1999, through August 3, 1999. The records were from 71 workers, all of whom were assigned to Department 8700 or worked in 8700 in jobs such as maintenance or inspection. Most medical visits to the plant medical department occurred June 3-4 (33 visits) and June 14-17 (29 visits). Many of the plant medical records were accompanied by reports from a consulting pulmonologist. Information provided from the pulmonologist supported the information contained in the plant medical records. Information on symptoms reported by workers is summarized in Table 10. The symptoms presented in Table 10 are presented by general category, such as mucosal irritation and upper respiratory, lower respiratory, etc. The most prevalent symptoms were asthma-like symptoms, with 72 % of these 71 workers reporting cough, 45% reporting shortness of breath, 39% reporting chest tightness, and 13% reporting wheezing. Among the other lower respiratory symptoms, 23% reported phlegm production. Symptoms of mucosal irritation were also prevalent, with 59% reporting throat irritation and 23% reporting eye irritation. Other work-related symptoms commonly reported in the records were headache (39%), dizziness (23%), fatigue (17%), an unusual taste in the mouth (16%), and nausea (10%).

The 71 medical records revealed two cases of new-onset asthma associated with these work-related symptoms. Another two workers with a history of early childhood asthma, but with no previous history of adult asthma attacks, experienced exacerbation of asthma symptoms. There were six additional workers with asthma-like conditions. The medical record of one of these six workers included a physician diagnosis of asthma, but the date of onset was not clear. Another of the six was diagnosed with "atypical asthma;" that person had no prior history of asthma. Among the remaining four workers, there was no definitive diagnosis of asthma, but the record suggested symptoms compatible with asthma, obstructive disease on pulmonary function test, and/or report of "positive" methacholine challenge test.

DISCUSSION

Due to the low participation rate (27%) in Department 8700, it is difficult to draw any conclusions from the questionnaire regarding symptoms among Department 8700 employees. We cannot exclude the possibility that symptomatic employees from Department 8700 chose to participate, while asymptomatic employees chose not to. Thus, the results for Department 8700 may not accurately reflect the health status of all employees in that department. Because of this concern, we did not do a formal statistical analysis of the data. The reason(s) for

the low participation rate among Department 8700 employees, given the good participation in Departments 7500/7700, are unclear at this time.

During our site visits, NIOSH representatives conducted informal interviews with several employees in Department 8700. In those interviews, several employees reported that they had experienced respiratory symptoms prior to the first reported "outbreak" on June 3, 1999. The occurrence of symptoms among at least a few employees from Department 8700 in the latter part of May was confirmed by the medical records. The relationship between the symptoms experienced by some employees in May and the large increase in reported symptoms in early June is not clear.

The results of the medical record review confirm that the most commonly reported symptoms among employees of Department 8700 over the several months for which medical records were reviewed were respiratory in nature; a smaller number of other, non-respiratory, symptoms were also reported. Cases of new-onset asthma and aggravation of pre-existing asthma were documented among the records reviewed. We have not been able to determine potential cause(s) for the symptoms (or cases of asthma) reported among employees of Department 8700. The facts that: (1) MWF PBZ air concentrations during the time of our site visit were generally higher in Department 7700 than in 8700; and (2) increased numbers of employees from Department 8700 reported symptoms to the medical department during June 1999, may indicate that exposure to MWF alone in Department 8700 is not likely the cause of the increase in reported symptoms. Medical records for employees in Department 7700 were not reviewed, so we cannot comment on physician-diagnosed asthma among those employees.

Exposure to MWF is known to be associated with an increased prevalence of respiratory symptoms, decreases in airflow over a work shift, and the occurrence of occupational asthma and hypersensitivity pneumonitis.[9] A discussion of an occupational safety and health program pertaining to MWF, including medical monitoring, fluid maintenance, engineering controls, and environmental surveillance, is contained in the NIOSH Criteria Document "Occupational Exposure to Metalworking Fluids."[9] It was evident during our site visits that Department 8700 is, to a great extent, employing engineering controls (such as enclosures and local exhaust ventilation) as recommended in the NIOSH document.

The endotoxin and bacteria levels found in our bulk sampling were higher than those observed in some other recent NIOSH HHEs;[19,20] however, levels comparable to those found in our sampling in Department 8700 have been reported in other published investigations.[21,22] The endotoxin concentrations found in our sampling were higher than those found by the consultant's sampling in July; the bacteria levels from our sampling were comparable to the bacteria levels found by the consultant. Despite the recent cleaning of CCS-35, as well as the change of MWF, these results suggest that microbial contamination is a continuing problem in the MWF of Department 8700.

Except for one PBZ sample from Department 8700 and three from Department 7700, MWF concentrations were below the NIOSH REL for the sampling period. The NIOSH REL is intended to reduce respiratory disorders associated with MWF exposure. Because workers in other MWF environments have developed adverse health effects from exposures below the REL, lower exposures are desirable whenever possible.[9]

Many factors related to processes in Department 8700 which may have contributed to the reported symptoms were also investigated by management and union representatives. One of these factors was the deionizer (which removes minerals from the community water as it enters the plant), which stopped working prior to the onset of reported symptoms in June. The deionizer supplies treated

water to many areas of the plant, but none of the other areas had increased reporting of respiratory symptoms. In addition, the deionizer had not been working for most of the summer, while the clusters of reported symptoms in Department 8700 have recurred intermittently. Finally, it is not apparent how community water, deionized or not, would have caused the respiratory conditions found among Department 8700 employees.

Many of the reported symptoms in Department 8700 first occurred very soon after CCS-35 was placed back in use after approximately one week of repair. This suggests that the MWF in CCS-35 may have undergone some change during the time of the repair or the start-up of the central system and that this was related to the symptoms. The only "abnormality" that was identified in the evaluation performed by management and union representatives concerned formaldehyde levels in the MWF. Levels of formaldehyde in the MWF (GR-1000) in use in CCS-35 on June 3 were substantially higher than those found in comparable MWF from an area where an increase in respiratory symptoms was not reported. The source of this formaldehyde is not known with certainty, but is most likely related to the biocide in the MWF used at the time (a formaldehyde-releaser). Acute effects of exposure to formaldehyde include eye and upper respiratory tract irritation at low ambient air concentrations; inhalation of higher concentrations can lead to lower respiratory tract irritation which may cause symptoms such as cough and chest tightness.[23] Concentrations of formaldehyde in the air at the time the symptoms were reported on June 3 are not known. The MWF with elevated formaldehyde concentration was in use in CCS-35 at the time the initial cluster of symptoms was reported (June 3); therefore, airborne formaldehyde could have contributed to the occurrence of some symptoms at that time.

CONCLUSIONS

NIOSH investigators have not been able to determine any single aspect of the Department 8700 manufacturing process to be clearly related to the reported symptoms which were primarily first reported in June 1999. A variety of symptoms, both respiratory and non-respiratory, have been reported by employees of the three machining departments evaluated in the questionnaire survey. Many of the reported symptoms in all three departments evaluated meet a definition of "work-related" as used in this analysis. At this time, we cannot reliably determine from our survey whether employees of Department 8700, as a whole, have experienced, or are continuing to experience, more symptoms than employees of other departments with apparently similar workplace exposures. Our air sampling indicates that exposure to MWF aerosol alone in Department 8700 is not likely the cause for the "outbreaks" of respiratory symptoms.

Concentrations of culturable bacteria (sampling done by management consultants and separately by NIOSH) and endotoxin (sampling done by NIOSH) from the MWF in CCS-35 supplying Department 8700 were at levels that suggest suboptimal maintenance of the MWF.

RECOMMENDATIONS

Pertaining to Symptoms Reported by Department 8700 Employees

1. Employees should be encouraged to continue to report all potential work-related health symptoms to appropriate health care personnel. As part of the safety and health program at the Kokomo plant, DaimlerChrysler should monitor reported health problems in a systematic manner designed to identify particular job duties, work materials (such as particular MWFs), machines, or areas of the plant which may be associated with particular health effects. Individuals with definite or possible occupational illnesses should be protected from exposures to presumed causes or exacerbators of the disease, using engineering (e.g., isolation, and ventilation) and/or

administrative (e.g., work and hygiene practices, and housekeeping) controls if possible, or with personal protective equipment. In some cases, workers may have to be reassigned (also considered an administrative control measure) to areas where exposure is minimized or nonexistent. In such cases, the reassigned worker should retain wages, seniority, and other benefits that might otherwise be lost by such a job transfer.

Components of a Safety and Health Program for Metalworking Fluids

2. Machines, machine sumps, or central systems found to be excessively contaminated with microbes should be appropriately treated and/or cleaned following the MWF manufacturer's recommendations. Appropriate precautions should be taken to protect the health of workers performing the cleaning. This should include personal protective equipment to minimize skin contact with MWF and contaminants. If there is the potential to generate aerosols during the cleaning process, respirators should be worn to minimize inhalation of those aerosols. A P-series (oil-proof) filter certified under 42 CFR Part 84 should be used; the minimally protective filter would be designated P-95. Respirators should only be used within the constraints of a comprehensive respiratory protection program.[24] Users must be trained, fit-tested, and medically cleared for their assigned respirator. Several resources are available which provide recommendations concerning MWF maintenance procedures, including the NIOSH Criteria Document[9] and the Organization Resources Counselors' Management of the Metal Removal Fluid Environment.[*]

3. A small number of PBZ samples for MWF equaled or exceeded the NIOSH REL. These samples were taken from employees working in: (1) Department 7700, OP30, 399 line, machine BT263270; (2) Department 8700, OP30, machines #343 and 168; (3) Department 7700, OP60, machines BT317529, and -30, near bay N34; and (4) Department 7700, OP 40, bay N34, machine BT252725. Additional sampling should be conducted in those areas to better characterize MWF exposures related to those operations. This additional sampling should help determine if additional controls are needed to reduce the exposure to MWF in those areas. If needed, engineering controls (e.g., enclosure and/or local ventilation) or work practice changes should be considered first. If engineering or other controls are not feasible, or prior to the implementation of controls, workers conducting tasks where exposures could exceed the NIOSH REL should utilize respiratory protection.

4. In areas or operations in which the PBZ air sample concentrations of MWF exceeded one-half of the NIOSH REL (which occurred more commonly in Department 7700 than in Department 8700), additional sampling to evaluate worker exposures to MWF should be conducted every 6 months.[9] The sampling strategy should focus on workers who are expected to have the highest exposures (e.g., high-production areas). Area sampling can help augment the personal exposure monitoring. The objectives of an environmental monitoring program are to evaluate the effectiveness of work practices and engineering controls, ensure that exposures are below the REL, and identify areas where further reduction in exposures is possible.

[*]Organization Resources Counselors, Inc. [1999]. http://www.orc-dc.com.

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TABLE 1
Bulk process metalworking fluid microbial results, in colony forming units per milliliter (cfu/mL)

HETA 99-0311-2790
Daimler Chrysler Transmission Plant
Kokomo, Indiana

Sample #	Brass tag number	Bay location	Machine type	Gram negative. bacteria, cfu/mL	Total fungi, cfu/mL
1	220228	NN11	Broach	2.5×10^8	21
2	244342	NN13	lead-off on OP20	1.7×10^7	23
3	102923	PP9	Olofsson	2.9×10^7	18
4	286372	PP10	Rohrer weld-test unit	6.3×10^5	21
5	244329	MM11	Landis grinder	1.7×10^8	8
6	244330	MM11	Landis grinder	2.9×10^7	10

TABLE 2
Bulk process metalworking fluid endotoxin results, in "endotoxin units" per milliliter (EU/mL)
HETA 99-0311-2790
DaimlerChrysler Transmission Plant
Kokomo, Indiana

Sample #	Brass tag number	Bay location	Machine type	EU/mL
endo 1	220228	NN11	Broach	2.9×10^5
endo 2	244342	NN13	lead-off on OP20	2.9×10^5
endo 3	102923	PP9	Olofsson	4.8×10^5
endo 4	286372	PP10	Rohrer weld-test unit	6.6×10^3
endo 5	244329	MM11	Landis grinder	3.3×10^5
endo 6	244330	MM11	Landis Grinder	2.7×10^5

TABLE 3
Thoracic particulate personal breathing zone sampling results for Department 7700, September 21, 1999
[Number of samples = 15, range = 0.12-0.51 mg/m^3, median = 0.22 mg/m^3]
HETA 99-0311-2790
DaimlerChrysler Transmission Plant
Kokomo, Indiana

Job description / location	Sample #	Sample time (minutes)	Thoracic particulate concentration* (mg/m^3)
job setter	77-1	442	0.13
L-30, 297 facer, BT329070	77-2	455	0.22
Float and hub grinder	77-3	451	0.33
N-31, shaft press, BT329017	77-4	453	0.24
Kingsbury drill, float, BT132-775	77-5	449	0.38
Clutch balancer, BT293420	77-6	449	0.13
OP30, 399 line, BT263270	77-7	437	0.51
Leadoff on 030 line (deburr), beyond West wall, BT289030	77-8	437	0.16
K-31, 014 broach, Cincinnati NK8307	77-9	420	0.27
West of K-31, 338 anchors, BT133004	77-10	455	0.26
N-40, shaft heat-treat	77-11	429	0.12
M-33, Olofssons 883, -4, -5	77-12	425	0.22
M-33, OP20, 'the mill', BT244484	77-13	431	0.29
P-34, hand deburr, BT260598	77-14	445	0.19
Shaft grinding, Landis machines, BT252745	77-15	447	0.21
NIOSH REL			***0.4***

**Minimum quantifiable concentration = 0.01 mg/m^3, based on a sample volume of 650L*

TABLE 4
Thoracic particulate personal breathing zone sampling results for Department 8700, September 21, 1999
[Number of samples = 14, range = 0.07-0.74 mg/m^3, median = 0.13 mg/m^3]
HETA 99-0311-2790
DaimlerChrysler Transmission Plant
Kokomo, Indiana

Job description / location	Sample #	Sample time (minutes)	Thoracic particulate concentration* (mg/m^3)
PP-9, OP20, machine #AA012923	87-1	461	0.15
PP-10, OP30, part 618	87-2	464	0.08
OP30, machine #s 343 & 168	87-3	429	0.74
NN-12, OP30 machine #s 303 & 341	87-4	428	0.1
MM-12, 293 welder	87-5	458	0.12
LL-13, contour hardening machine	87-6	472	0.22
OP10, welder station #1	87-7	444	0.07
KK-10, OP40, 450 welder	87-8	447	0.18
LL-14/LL-15, machine# 34346	87-9	464	0.28
Machine#627-20	87-10	437	0.13
NN-12, OP20	87-11	425	0.12
NN-11, 220 broach	87-12	452	0.19
PP-9, 888 & 157 welders	87-13	435	0.13
NN-11, 034 welder, OP10	87-14	440	0.08
NIOSH REL			***0.4***

**Minimum quantifiable concentration = 0.01 mg/m^3, based on a sample volume of 650L*

TABLE 5
Thoracic particulate personal breathing zone sampling results for Department 7700, September 22, 1999
[Number of samples = 10, range = 0.08-0.52 mg/m^3, median = 0.28 mg/m^3]
HETA 99-0311-2790
DaimlerChrysler Transmission Plant
Kokomo, Indiana

Job description / location	Sample #	Sample time (minutes)	Thoracic particulate concentration* (mg/m^3)
M-32 Hobbs	77-16	192	0.38
float	77-17	395	0.1
297 line, #57	77-18	439	0.36
207 washer, and CNCs, BT329014,-5,-6	77-19	417	0.14
olofssons, BT317565, 329150	77-20	452	0.32
J-35, , lathing, BT275792	77-21	447	0.14
N-33/34, 855 line, BT263277, 286380	77-22	453	0.08
OP60 near N-34 grinders, BT317529, -30	77-23	459	0.42
Olofsson, 437 leadoff, BT252729, 252742	77-24	460	0.23
N-34 OP40, BT252725	77-25	463	0.52
NIOSH REL			***0.4***

**Minimum quantifiable concentration = 0.01 mg/m^3, based on a sample volume of 650L*

TABLE 6
Thoracic particulate personal breathing zone sampling results for department 8700, September 22, 1999
[Number of samples = 11, range = 0.05-0.25 mg/m^3, median = 0.16 mg/m^3]
HETA 99-0311-2790
DaimlerChrysler Transmission Plant
Kokomo, Indiana

Job description / location	Sample #	Sample time (minutes)	Thoracic particulate concentration* (mg/m^3)
NN-12, 293 welder	87-15	463	0.16
NN-12, OP20, BT220304, 244340	87-16	463	0.20
NN-12, OP20	87-17	414	0.19
M-12, OP10 welder, BT220293	87-18	456	0.19
P-9, OP30, part#618	87-19	461	0.25
KK-17, front carrier bldg.	87-20	451	0.05
NN-10, welder, BT220885	87-21	444	0.11
PP-10, 888&157 welders	87-22	445	0.11
PP-9, OP20, machine #AA012923	87-23	451	0.07
NN-9, BT220343	87-24	451	0.10
NN-11, float	87-25	446	0.17
NIOSH REL			***0.4***

**Minimum quantifiable concentration = 0.01 mg/m^3, based on a sample volume of 650L*

TABLE 7
Thoracic particulate personal breathing zone sampling results for department 7700, September 23, 1999
[Number of samples = 9, range = 0.1-0.29 mg/m^3, median = 0.18 mg/m^3]
HETA 99-0311-2790
DaimlerChrysler Transmission Plant
Kokomo, Indiana

Job description / location	Sample #	Sample time (minutes)	Thoracic particulate concentration* (mg/m^3)
855 rear clutch, S.of N-32, BT263277	77-31	124	0.29
P-32, Olofssons	77-32	414	0.22
Olofsson, S. of M-30, BT293361	77-33	406	0.12
Inspector	77-34	440	0.23
N-34, face grinder, BT252743	77-35	449	0.15
Detroit trace, BT252725, -6	77-36	464	0.19
P-32, Olofsson #AAA004206	77-37	442	0.1
Sheffield grinders, BT263301,-2,-3	77-38	449	0.18
P-33 parts washer, BT252918	77-39	450	0.15
NIOSH REL			***0.4***

**Minimum quantifiable concentration = 0.01 mg/m^3, based on a sample volume of 650L*

TABLE 8
Thoracic particulate personal breathing zone sampling results for department 8700, September 23, 1999
[Number of samples = 11, range = 0.04-0.14 mg/m^3, median = 0.06 mg/m^3]
HETA 99-0311-2790
DaimlerChrysler Transmission Plant
Kokomo, Indiana

Job description / location	Sample #	Sample time (minutes)	Thoracic particulate concentration* (mg/m^3)
MM-12, 293 welder	87-33	419	0.09
NN-13, New Brittian, BT220204	87-35	400	0.05
NN-12, #343&168	87-36	441	0.07
LL-17, bearings retainer, BT252798, 220169	87-37	424	0.04
NN-10, welder, BT275885	87-38	395	0.14
NN-11, OP60, BT 252798, 220169	87-39	420	0.05
PP-9, 618 inspection bench	87-40	401	0.11
PP-9, 271 Olofsson	87-42	411	0.06
NN-11, side of BT220228	87-43	400	0.05
MM-15, BT252710, 220149	87-45	427	0.12
NN-13, BT244340, 220304	87-46	404	0.06
NOSH REL			***0.4***

**Minimum quantifiable concentration = 0.01 mg/m^3, based on a sample volume of 650L*

Table 9A
Characteristics of HHE Participants - By Department[1], September 1999
HETA 99-0311-2790
DaimlerChrysler Transmission Plant
Kokomo, Indiana

Department	# (%)[2]	Mean Age	# (%) Male	# (%) Working > 40 Hours/Week	# (%) Reporting MWF Exposure[3]	Race (# [%] White)	# (%) Current Cigarette Smokers	# (%) Participants Who Ever Smoked
7500	68 (85)	43	56 (84)	54 (79)	57 (84)	56 (82)	30 (44)	36 (63)
7700	95 (70)	39	85 (89)	78 (82)	85 (91)	76 (81)	37 (39)	49 (57)
8700	66 (27)	38	41 (63)	55 (86)	45 (69)	49 (75)	29 (45)	34 (58)

[1] Except where noted, percentages are based on the number of participants answering specific questions; this number may differ slightly from the overall number of participants in a given group.
[2] Percentage of participation for each department is based on the number participating and on the following number of potential participants for each department: 7500 - 80; 7700 - 135; 8700 - 247.
[3] Based on response to the question: “Do you work with, or near, machining fluids in your current job?”

TABLE 9B
Reported Symptoms/Illnesses Among Employees - By Department[1], September 1999
HETA 99-0311-2790
DaimlerChrysler Transmission Plant
Kokomo, Indiana

Symptom/Illness occurring in past 6 months (except asthma question)	# in Dept 8700 (% respondents) reporting symptom/illness[1]	# in Dept 7500/7700 (% respondents) reporting symptom/illness[1]
Persistent cough	41 (62)	46 (28)
Sinus problems	39 (59)	78 (48)
Tightness in chest	35 (54)	40 (25)
Unusual shortness of breath	34 (52)	38 (24)
Wheezing or whistling in chest	30 (46)	44(27)
Excessive phlegm	29 (45)	43 (27)
Irritation of eyes	28 (44)	58 (36)
Flu (fever, cough, aches)	18 (29)	53 (33)
Use of inhaled medicines to help breathing	17 (28)	28 (18)
Rash or skin irritation	14 (22)	47 (29)
Ever had asthma	7 (11)	14 (9)

[1] Except where noted, percentages are based on the number of participants answering specific questions; this number may differ slightly from the overall number of participants in a given group.

TABLE 9C
Reported Symptoms/Illnesses Among Employees On Day of Survey - By Department[1], September 1999
HETA 99-0311-2790
DaimlerChrysler Transmission Plant
Kokomo, Indiana

Symptom[2] - Response to question: "Do you have this symptom today?"	# in Dept 8700 (% respondents) reporting symptom/illness[1]	# in Dept 7500/7700 (% respondents) reporting symptom/illness[1]
Persistent cough	20 (30)	26 (16)
Unusual shortness of breath	16 (24)	13 (8)
Irritation of eyes	15 (23)	27 (17)
Tightness in chest	13 (20)	18 (11)
Wheezing or whistling in chest	11 (17)	20 (12)

[1] Except where noted, percentages are based on the number of participants answering specific questions; this number may differ slightly from the overall number of participants in a given group.
[2] Including only five symptoms likely to have acute onset and resolution.

TABLE 9D
Reported Work-Related[1] Symptoms Among Employees - By Department[2], September 1999
HETA 99-0311-2790
DaimlerChrysler Transmission Plant
Kokomo, Indiana

Symptom occurring in past six months	# in Dept 8700 (% respondents) reporting work-related symptom[2]	# in Dept 7500/7700 (% respondents) reporting work-related symptom[2]
Persistent cough	32 (48)	33 (20)
Unusual shortness of breath	28 (42)	22 (14)
Sinus problems	26 (39)	52 (32)
Tightness in chest	24 (36)	27 (17)
Irritation of eyes	22 (33)	50 (31)
Wheezing or whistling in chest	22 (33)	26 (16)
Excessive phlegm	20 (30)	32 (20)
Rash or skin irritation	7 (11)	36 (22)

[1] A "work-related" symptom was defined in this analysis as: (1) a symptom reported by the participant to have occurred in repeated episodes or every workday for a month or more; and (2) a "positive" or "unsure" response to the question: does {the symptom} improve during time away from work?

[2] Except where noted, percentages are based on the number of participants answering specific questions; this number may differ slightly from the overall number of participants in a given group.

TABLE 10
Prevalence of symptoms reported in medical records of 71 workers, September 1999
HETA 99-0311-2790
DaimlerChrysler Transmission Plant
Kokomo, Indiana

SYMPTOM	Percent of Workers Reporting Symptom
Mucosal Irritation and Upper Respiratory	
Throat irritation	59
Eye irritation	23
Runny Nose	17
Sinus problem	7
Nasal irritation	6
Mouth burning	4
Mouth blister	3
Nose sores	1
Lower Respiratory	
Cough	72
Shortness of breath	45
Chest tightness	39
Phlegm	23
Wheezing	13
Chest pain	10
Chest congestion	4
Lungs burning	4

Table 10 Continued
Prevalence of symptoms reported in medical records of 71 workers
Kokomo Transmission Plant
HETA 99-0311-2790
DaimlerChrysler Transmission Plant
Kokomo, Indiana

SYMPTOM	Percent of Workers Reporting Symptom
Systemic Symptoms	
Fatigue	17
Aches	6
Dermatologic complains	6
Flu-like illness	4
Weight loss	3
Chills	3
Concentrated urine (change in color)	3
Fever	1
Night sweats	1
Central Nervous System-related symptoms	
Headache	39
Dizziness	23
Taste (perception changes)	16
Tongue tingling	3
Disorientation	3
Difficulty concentrating	3
Vision blurred	1
Gastrointestinal-related symptoms	
Nausea	10
Vomit	6
Stool (perception changes)	4
Diarrhea	3

APPENDIX 1

Thoracic and Total Particulate Area Sampling Results for Departments 7700 and 8700 September 21-23, 1999

Date collected	Department	Sample Location	Sample Number	Sample Time (minutes)	Particulate Concentration* (mg/m^3)
					Thoracic
					Total
9-21	7700	main coolant reservoir	Pair 1	435	0.84
			Pair 1a		*0.79*
9-22	7700	P-29 Olofsson BT317567	Pair 2	411	0.29
			Pair 2a		*0.18*
9-22	7700	CCS-13	Pair 3	406	0.75
			Pair 3a		*0.64*
9-22	7700	BT263251	Pair 4	390	0.76
			Pair 4a		*0.68*
9-22	7700	P-31, BT329049	Pair 5	406	0.20
			Pair 5a		*0.07*
9-22	8700	8700 coolant reservoir	87-27	406	0.12
			87-32		*0.05*
9-22	8700	NN-12, 293 welder	87-28	353	0.19
			87-30		*0.14*
9-22	8700	NN-12, OP20	87-26	357	0.1
			87-31		*0.1*
9-23	7700	OP60 grinding, BT252835	Pair 7	379	0.4
			Pair 7a		*0.46*

APPENDIX 1 Continued
Thoracic and Total Particulate Area Sampling Results for Departments 7700 and 8700
September 21-23, 1999

9-23	7700	Landis grinder, BT317529	Pair 9	287	0.15
			Pair 9a		*0.34*
9-23	7700	Hobbs, BT116577	Pair 13	392	0.29
			Pair 13a		*0.17*
9-23	7700	CNC machine, BT329014	Pair 14	385	0.3
			Pair 14a		*0.31*
9-23	7700	Dept. 7700 supervisors' office	Pair 15	415	0.07
			Pair 15a		*0.09*
9-23	8700	coolant reservoir	87-41	385	0.06
			87-51		*0.08*
9-23	8700	MM-15, BT220149	87-34	424	0.09
			87-50		*0.13*
9-23	8700	MM-14, BT220229	87-47	420	0.1
			87-48		*0.29*
9-23	8700	NN-11, BT220228	87-43	400	0.05
			87-49		*0.05*

** Minimum quantifiable concentration = 0.01 mg/m^3, based on a sample volume of 650L*

Discussion

The side-by-side area samples were collected with the intent of comparing the thoracic and "total" fraction sampling methods for MWF aerosols. While they are accurate as measures of airborne MWF concentration, the area samples do not necessarily characterize personal exposures (several pairs were collected in areas where no workers work). The areas were chosen primarily to allow measurement across the full range of anticipated MWF concentrations from very low (supervisor's office) to very high (CCS pit).

The thoracic fraction of an aerosol is a subset of the "total" fraction. Therefore, it was expected that the thoracic particulate concentration would be less than that of the corresponding total sample for each sample pair. There is no clear explanation for the samples above which revealed thoracic fractions greater than the corresponding "total" fractions. NIOSH continues to investigate such paired sample data sets from other current MWF field studies.

APPENDIX 2

Results of Video Exposure Monitoring (VEM)

Video Exposure Monitoring (VEM)

Real–time particulate sampling coupled with video recording was performed to evaluate worker exposures to MWFs in several selected operations. Video exposure monitoring (VEM) was conducted in Department 7700 at machines BT 132775 and BT 317566 (Olofsson) on September 22, 1999. Tasks that were monitored were selected based on their potential to produce peak exposures. The goal of VEM is to improve our understanding of how worker's individual tasks affect personal exposure to air contaminants. VEM was also conducted in Department 8700, but equipment failure in the field prevented subsequent data analysis.

Copies of the VEM videotape have been sent to management and union representatives. The VEM shows the worker activities and the correlating relative exposure concentrations. Work practices that contribute to the peak exposure concentrations can be viewed. Modifications to these work practices can then be made in order to minimize exposure as much as possible. The video indicates the exposure concentration in mg/m^3 and time in hours:minutes:seconds (h:m:s). While observing the video, the top center of the screen will indicate the exposure concentration in mg/m^3 per second. The height of concentration scale on the videos is marked at the highest peak detected during that sampling period. The concentration scales on the following figures in this report have been adjusted for simplicity and effective presentation in this format.

Methods

VEM can be used to identify sources of worker exposure to air contaminants and to address questions such as: how does exposure vary among the tasks of a job, how effective is a particular engineering control, and how quickly does the contaminant concentration decay once an operation has stopped? While air concentrations are being measured with the Hand–held Aerosol Monitor (HAM) (PPM Inc., Knoxville, Tennessee), workplace activities are simultaneously recorded on videotape. The analog output from direct reading instruments can be overlaid on a video recording as a moving bar or graph that has a height proportional to the air contaminant concentration. This technique shows how worker exposures are related to work activities, and it permits control recommendations that are focused upon specific exposure sources.

The HAM measures PBZ relative air contaminant concentrations by drawing the aerosol through a sensing chamber. The aerosol scatters the light emitted from the HAM's light emitting diode. The quantity of scattered light is a function of aerosol concentration, particle size, and refractive index. The analog output of this instrument is proportional to the quantity of the scattered light detected by a photomultiplier tube. This output of the HAM is viewed as a measure of *relative* concentration because workplace aerosols may differ from the aerosol used to calibrate the HAM. The analog output of the HAM is recorded by a data logger, and then downloaded to a computer and converted into a spreadsheet for analysis. The HAM was operated on the 0–20 volt scale during monitored activities in both processes in Department 7700.

At Olofsson machine BT 132775 (and machines of this type), the machinist was observed to have two main jobs. Initially, the machinist takes the part and places it onto the rotating working platform of the machine to have that part drilled and machined in various ways. Once a part has rotated through this portion of the process, the machinist takes the part out of this area and places the part on another circular machining area (his/her left, as you ascend the workstation steps).

The second area where VEM was conducted was also in Department 7700, at Olofsson machine BT 317566. The machinist takes a circular metal part and places it into a machining cabinet with closing doors. At the end of a cycle, the cabinet door opens and the machinist takes the part out and sends it to another area for further

processing. At Kokomo, there are six such machines in this specific area with two employees to run those machines.

Results

Samples for total particulate were collected at the exit of the HAM probe (near the workers breathing zone) during metal working operations. One filter was used for both VEM activities in Department 7700 in order to assure that, given the relatively short sampling time and anticipated low airborne concentration of MWF, a detectable concentration of MWF would be collected. The air sample collected at the exhaust of the HAM sampling probe, during MWF activities, indicated a concentration of 0.26 mg/m^3 over the time sampled.

During machining activities at BT 132775, the worker is exposed to the highest MWF concentrations when initially placing the metal part onto the rotating machine platform (to the right as you ascend the workstation steps). The MWF concentration was constant (~1 to 2 mg/m^3) when the worker stood at this initial step of the process. The peak estimated particulate exposure measured with the HAM during the machining activities was 2.01 mg/m^3. Figure 1 presents the HAM concentration responses during the machining activities at BT 132775.

The results of sampling at the Olofsson BT 317566 indicated that the worker is exposed to the highest MWF concentrations when standing at the machine when the doors open for the part to be taken out after machining, and when standing in the area of the second worker in the same area. The peak estimated particulate exposure measured with the HAM (2.23 mg/m^3) occurred while the employee was at a workstation when the doors opened. Figure 2 presents the HAM concentration responses during the machining activities at BT 317566.

Discussion

Figures 1 and 2 display the exposure concentrations measured with the HAM during machining activities in Department 7700 at machines BT 132775 and BT 317566 on September 22, 1999. The figures point to peaks in the exposure concentration data, which are indicative of certain activities by the worker. The peaks in Figure 1 are due to the machinist working in closer proximity to the rotating parts platform where there is increased MWF aerosol generation. When the employee stood in this area, the exposures were relatively constant which may indicate lack of opportunity for the aerosol to disperse.

Peaks in Figure 2 represent elevated exposure concentrations when the machinist is standing in close proximity to the Olofsson machine when the cabinet doors open and when the worker is in the area of the second employee, who performed the same tasks. When the booth doors open, there was a small cloud of visible MWF aerosol that escaped through this opening. This increased the potential for exposure to MWF.

Conclusions and Recommendation

This assessment method should not be viewed as a substitute for PBZ monitoring of contaminants. But in a relatively well controlled environment, such as seen at DaimlerChrysler Kokomo, where many of the machines were enclosed or enclosed and directly ventilated, it can serve as an effective tool to discern from which specific task a worker receives the majority of his exposure. The following recommendation is made to minimize exposure to MWF aerosol at the machines surveyed, or at other similar machines:

1. Olofsson machinists could let the doors open, then give the MWF aerosol a moment to disperse before approaching the machine and taking the part out. The VEM showed the worker receiving peak exposures when waiting immediately by the doors before they opened. When the doors opened, and the worker came back to change parts after a moment or two, the relative aerosol concentrations were small.

2. At BT 132775, the machinist could minimize the amount of time spent near the rotating parts platform, to the right of the work station as you ascend the steps. While the machinist must occupy this space to

correctly perform his job duties, by minimizing the *unnecessary* time spent here his MWF exposure could be lowered. For example, if there is idle time between parts changes, he could wait on the left side of the workstation platform.

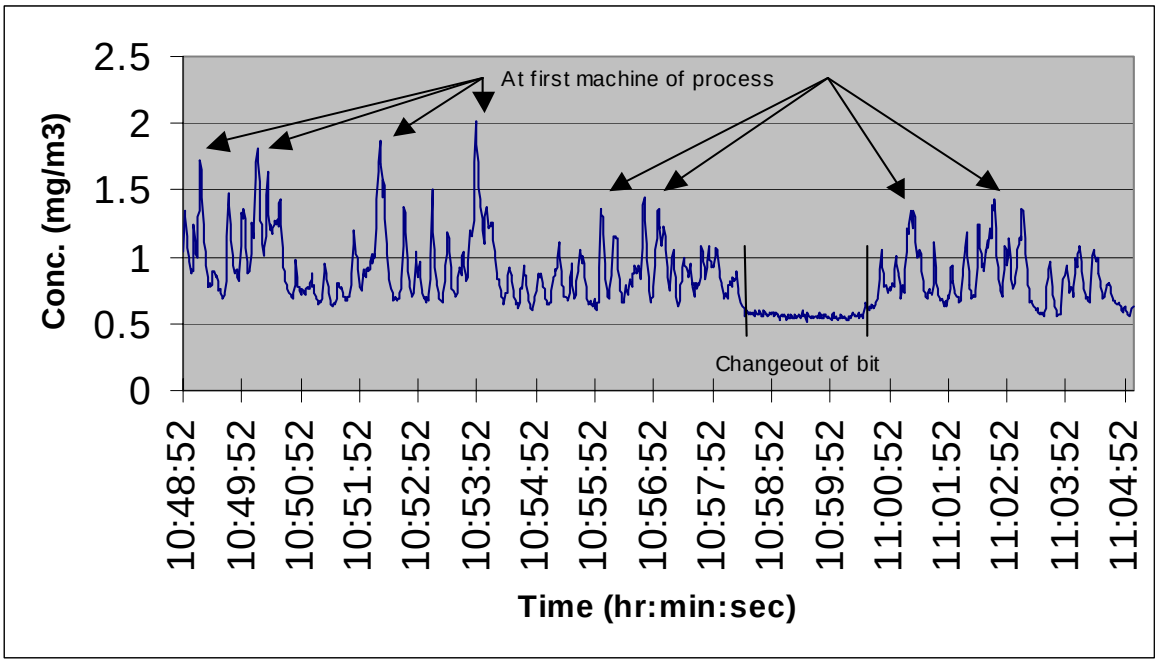

Figure 1. Exposure concentration in Department 7700 at BT 132775 on September 22, 1999.

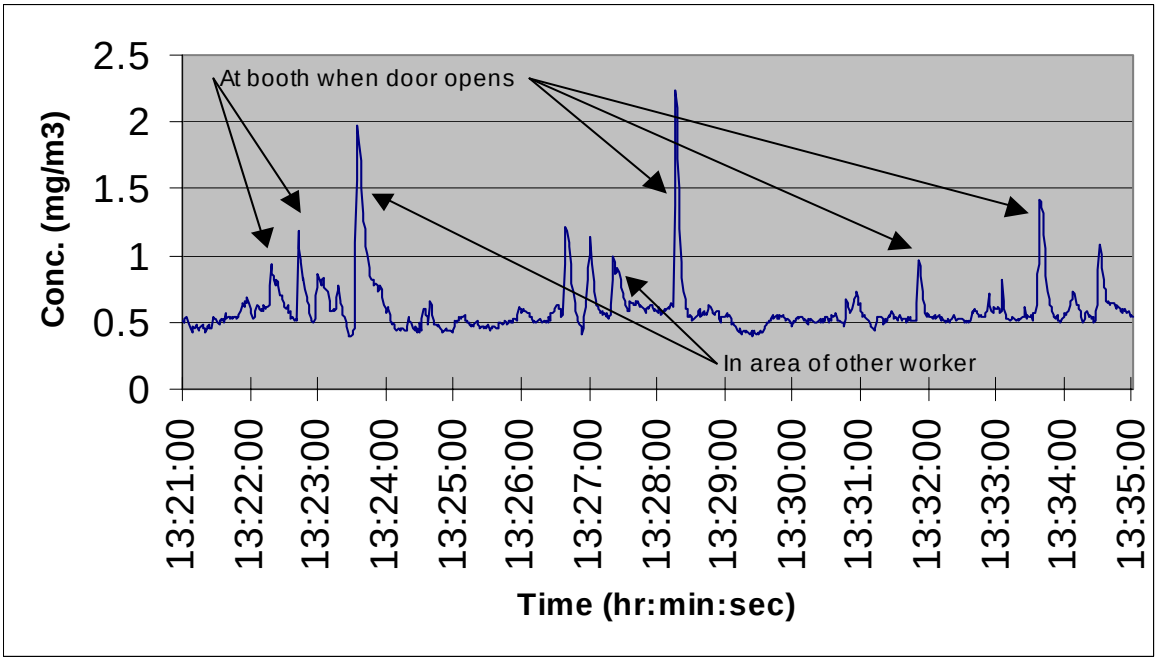

Figure 2. Exposure concentration in Department 7700 at Olosson BT 317556 on September 22, 1999.