CDC Workplace Safety and Health

NIOSH HEALTH HAZARD EVALUATION REPORT

HETA #2006-0059-3009
DaimlerChrysler Jefferson North Assembly Plant
Detroit, Michigan

July 2006

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DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

NIOSH

PREFACE

The Respiratory Disease Hazard Evaluations and Technical Assistance Program (RDHETAP) 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 (OSH) Act of 1970, 29 U.S.C. 669(a)(6), or Section 501(a)(11) of the Federal Mine Safety and Health Act of 1977, 30 U.S.C. 951(a)(11), which authorizes the Secretary of Health and Human Services, following a written request from any employers or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

RDHETAP 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 Richard Kanwal, MD, MPH, and Randy J. Boylstein, MS, REHS, of the RDHETAP, Division of Respiratory Disease Studies (DRDS). Desktop publishing was performed by Amber Harton.

Copies of this report have been sent to employee and management representatives at DaimlerChrylser and the OSHA Regional Office. This report is not copyrighted and may be freely reproduced. The report may be viewed and printed from the following internet address: http://www.cdc.gov/niosh/hhe. Copies may be purchased from the National Technical Information Service (NTIS) at 5825 Port Royal Road, Springfield, Virginia 22161.

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Highlights of the NIOSH Health Hazard Evaluation of DaimlerChrysler Jefferson North Assembly Plant, Detroit, Michigan

As part of the response to a request from workers for an evaluation of respiratory disease risk from welding-related exposures, NIOSH staff visited the plant from February 8-10, 2006. This final report summarizes the findings of this evaluation, provides recommendations to minimize occupational respiratory disease risk, and serves to close out this evaluation.

What NIOSH Did

- Interviewed several workers and reviewed some medical records.
- Performed limited air sampling at several plant locations.
- Reviewed DiamlerChysler and MIOSHA air sampling data.
- Reviewed company material safety data sheets (MSDSs).

What NIOSH Found

- Seven workers in the body shop had evidence of new-onset asthma or worsening of pre-existing asthma.
- Some robotic welding areas did not have process ventilation.
- Some chemicals in adhesives used in the body shop were also found in the air of the plant.
- Several substances used in the plant have the potential to cause respiratory irritation, possibly contributing to problems with asthma, bronchitis, or sinusitis.

What DaimlerChrysler Managers Can Do

- Implement process ventilation for all robotic welding areas, and local exhaust ventilation for all repair welding.
- Address exposure issues in the fluid-fill deck and medical surveillance in XK doors as recommended in this report.
- Accommodate workers who have medical evidence of respiratory problems that are possibly work-related by decreasing their exposures or assigning them to low-exposure work areas.

What DaimlerChrysler Employees Can Do

- See your physician regularly for any persistent respiratory symptoms or problems.
- Inform the plant medical and health and safety departments of any respiratory problems that you and your physician feel are work-related.

CDC Workplace Safety and Health

What To Do For More Information:
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report # 2006-0059-3009

NIOSH

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SUMMARY

On November 15, 2005, The National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from workers at DaimlerChrysler's Jefferson North Assembly Plant (JNAP) in Detroit, Michigan. The request stated that workers were experiencing respiratory problems (asthma, chronic bronchitis, chronic obstructive pulmonary disease (COPD)) and deaths in the setting of inadequate control of welding-related exposures. Several workers reported that they were aware of coworkers who had developed respiratory disease (COPD, cancer) after they started working at the plant and had died at relatively young ages (mid 40s to early 60s). A young worker with preexisting asthma had died of asthma in October 2005 several hours after getting off work. Findings indicating that asthma was the cause of death were noted on the autopsy report. Most of the welding at JNAP is resistance (spot) welding performed by robots. Some of the welding areas have plastic sheeting and exhaust fans (process ventilation) to decrease contamination of the plant air. Some repair welding is performed by workers utilizing gas metal arc welding (also known as metal inert gas (MIG) welding) and flux-cored arc welding. Among the concerns reported by workers was the potential for increased welding-related exposures when less outside air is brought into the plant by the ventilation system during cold weather. Workers reported that repair welding was often performed with no local exhaust ventilation. Workers were also concerned about the potential for health effects from exposures to chemicals resulting from welding on metal parts that have had adhesives applied in the production process. Some workers on the fluid-fill deck reported recurrent problems with asthma, bronchitis, and sinusitis that they felt were related to exposures to engine fluids (radiator, brake, power steering) and air-conditioning refrigerant. NIOSH staff visited JNAP from February 8-10, 2006 to obtain additional information regarding potential worker exposures and health effects.

NIOSH staff performed a walkthrough of the entire facility and performed qualitative and semi-quantitative air sampling for particulate and volatile organic compounds (VOCs) at several locations. The highest particle counts were for particles less than one micrometer in diameter. Some of the VOCs detected in the plant air were also detected in the headspace of adhesive bulk samples. NIOSH staff reviewed air sampling data and material safety data sheets provided by the company, and two reports prepared by the Michigan Occupational Safety and Health Administration (MIOSHA) which detailed the findings of their evaluations of welding-related exposures at JNAP in October 2005 and January 2006. None of the air sampling results exceeded existing MIOSHA permissible exposure limits or NIOSH recommended exposure limits. The potential for eye, skin, or respiratory tract irritation from exposures to adhesives and other substances used in the plant was documented in material safety data sheets. Twenty-

one employees discussed their health concerns with NIOSH staff. Four of these employees permitted review of their medical records. Information on the 31 year-old employee, who died after completing his work shift, was obtained from an autopsy report, his next of kin, and coworkers. Seven employees in the body shop reported symptoms consistent with new-onset asthma or exacerbation of pre-existing asthma (including the 31 year-old employee who died after completing his work shift). Three of these seven employees had medical evaluation results (including the above-mentioned autopsy report) that were consistent with new-onset asthma or exacerbation of pre-existing asthma. Four employees reported asthma and/or recurrent bronchitis while working on the fluid-fill deck. One of these four employees provided medical records which showed reversible airways obstruction consistent with asthma on lung function tests.

JNAP employees can be exposed to many agents with potential to induce or aggravate respiratory illness. Some employees may be affected by the combined effects of exposure to several irritants in the form of dusts, fumes, and gases. This will be more likely when ventilation is decreased due to mechanical breakdowns or in an attempt to decrease heating costs during winter months. Regulatory compliance with exposure limits does not ensure that all workers are protected. The potential for exposures in automotive assembly plants to cause occupational respiratory problems has not yet been adequately assessed. Symptoms and illnesses in employees suggest that additional medical monitoring and control of exposures at JNAP should be implemented and detailed studies to assess occupational health risk conducted. JNAP management should implement the recommendations provided in this report to minimize the potential risk to employees from welding-related and other exposure sources in the plant.

Keywords: NAICS 336111 (Automobile Manufacturing)

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INTRODUCTION

In November 2005, The National Institute for Occupational Safety and Health (NIOSH) received a confidential request for a Health Hazard Evaluation from workers at DaimlerChrysler's Jefferson North Assembly Plant in Detroit, Michigan. The request stated that workers were experiencing respiratory problems (asthma, chronic bronchitis, COPD) and deaths in the setting of inadequate control of welding-related exposures.

BACKGROUND

The Jefferson North Assembly Plant (JNAP) was completed and began production in 1991. Currently the facility produces approximately 950 Jeep vehicles per day (mostly Grand Cherokee and Commander models), five days a week. The facility includes a body shop where galvanized steel body parts are welded together, a paint shop, and an assembly area where all mechanical and interior components of the vehicles are installed. Most of the welding is resistance (spot) welding performed by robots. Some repair welding is performed by workers utilizing gas metal arc welding (also known as metal inert gas (MIG) welding) and flux-cored arc welding. Much of the welding carried out by the robots and by workers is performed on metal that is coated with an epoxy adhesive. The total workforce at the plant is approximately 2100 workers over two eight-hour work shifts (day shift and afternoon shift): ~120 workers per shift in the body shop; ~120 workers per shift in the paint shop; ~700 workers per shift in the assembly area; ~130 workers per shift in skilled trades (e.g., maintenance workers or electricians who work in some or all areas of the plant). There are an additional 85 skilled trades workers on the "midnight" shift.

From November 2005 through January 2006, a physician from NIOSH's Division of Respiratory Disease Studies had telephone conversations with several JNAP workers. Among the concerns reported by workers was the potential for increased welding-related exposures when less outside air is brought into the plant by the ventilation system during cold weather. Workers reported that repair welding was often performed with no local exhaust ventilation. Workers were also concerned about the potential for health effects from exposures caused by welding through adhesives. They noted that they had reviewed the material safety data sheet (MSDS) for one of the adhesives and were concerned about the risk of cancer and respiratory problems, and indicated they thought that the adhesive was not being used appropriately according to the manufacturer's recommendations. We contacted the manufacturer, Henkel Surface Technologies (Madison Heights, Michigan); a company representative informed us that the adhesive in question is intended to decrease the number of welds necessary, and is not intended for use during MIG welding. Several workers reported that they were aware of coworkers who had developed respiratory disease (COPD, cancer) after they started working at the plant and had died at relatively young ages (mid 40s to early 60s). A young worker with preexisting asthma died of asthma in October 2005, several hours after getting off work. Findings indicating that asthma was the cause of death were noted on the autopsy report.

Another area of concern to workers was the fluid-fill deck. Workers reported recurrent problems with asthma, bronchitis, and sinusitis that they felt were related to exposures to engine fluids (radiator, brake, power steering) and air-conditioning refrigerant. Workers reported that spilled fluids accumulate in pans under floor grates which are infrequently cleaned out, and that the accumulated fluids lead to respiratory irritation and bad smells.

After an earlier request for a NIOSH Health Hazard Evaluation made by JNAP workers in 2003, a NIOSH physician and industrial hygienist contacted plant management and several workers to obtain additional information. The request mentioned concerns regarding exposures from welding through adhesives, but respiratory symptoms or illnesses were not specifically mentioned by the workers with whom NIOSH staff spoke at that time. NIOSH staff did not make a site visit; they provided recommendations in a closeout letter to management and the requestors. (See Appendix, June 2004 letter to Robert Moon, Industrial Hygienist at DaimlerChrysler)

NIOSH staff visited JNAP from February 8-10, 2006 to obtain additional information regarding potential worker exposures and health effects.

METHODS

The NIOSH site visit team consisted of a physician and two industrial hygienists from the Division of Respiratory Disease Studies (DRDS), an occupational medicine resident physician from West Virginia University in Morgantown, West Virginia (on rotation at DRDS), and a physician from the Centers for Disease Control and Prevention's Epidemic Intelligence Service (EIS) who was based in the Michigan Department of Community Health. Our goals for the site visit were to:

1. obtain detailed information about the production process and areas / sources of potential exposures to particulates and volatile organic compounds (VOCs);
2. obtain detailed information on potential health effects of occupational exposures;
3. perform qualitative exposure assessment in welding areas and in areas where exposures to adhesives and engine fluids might occur.

We conducted the following activities during the site visit:

1. held opening and closing meetings with DaimlerChrysler management and labor representatives from UAW (The International Union, United Automobile, Aerospace and Agricultural Implement Workers of America);
2. performed a walkthrough of all areas of the plant while accompanied by management and labor representatives;
3. conducted voluntary confidential interviews of employees;
4. met with the plant physician;
5. obtained copies of material safety data sheets for all adhesives or other substances used in the production process;
6. reviewed company air sampling data;
7. performed air sampling as described below;
8. obtained bulk samples of adhesives for laboratory analysis.

Industrial Hygiene Sampling

Limited air sampling was conducted at locations throughout the plant including the weld repair shop, fluid-fill deck, beta-foam booth (where methylene diphenyl diisocyanate (MDI) foam is injected into several spaces in the car body), paint shop, at a location between columns EE 38 and EE 39 next to a robotic welding area that was in operation, rolls-test area (where engine testing occurs), and outside (control sample). Ventilation and air-flow patterns were assessed in the weld repair shop using smoke tubes (Air Current Kit, Draeger Safety, Inc., Pittsburgh, PA).

Seven air samples were collected using semi-quantitative sampling methods to assess the types of VOCs present in air. The samples were collected on thermal desorption tubes at a flow rate of 0.05 liters per minute (lpm) and were analyzed by gas chromatography with a mass selective detector (TD-GC-MS) according to NIOSH Method 2549. Three samples were taken during welding operations in the repair shop, and one sample was taken in each of the following areas: the fluid-fill deck, beta-foam area, a location between columns EE 38 and EE 39 (robotic welding), and outside as a control. The air sampling conducted in the repair shop during welding operations involved holding the thermal desorption tubes directly in the plume of smoke generated during the welding process. Three welds were performed. The average time per weld was three minutes.

We also used six-liter silonite-coated vacuum canisters (Entech Instruments, Inc., Simi Valley, CA) model 29-10622G with model CS1200E passive samplers to collect a total of six air samples for VOCs at various locations throughout the plant. Three of the canisters were used to collect instantaneous samples directly in the plume of smoke generated during manual repair welding; one was used for a one-hour sample during intermittent welding in the repair shop; one was used to collect an air sample for approximately eight hours at a location between columns EE 38 and EE 39 while robotic welding was taking place; and one was used to collect an instantaneous air sample at the rolls-test area during normal operations.

The analysis system for the six-liter canister samples consisted of an Entech Model 7100 preconcentrator and Agilent Technologies Model 5890 gas chromatograph with a Model 5972 mass selective detector. The system was programmed with the U.S. Environmental Protection Agency (EPA) Toxic Organic 15 (TO-15) analysis method.

We used Grimm optical particle counters (OPC) (Grimm Technologies, Inc., Douglasville, GA) to measure real-time airborne particle concentrations during welding operations in the repair shop, at a location between columns EE 38 and EE 39 (robotic welding), and in the paint shop.

Bulk samples of four adhesives used at the plant were obtained and analyzed semi-quantitatively for VOC emissions. Ambient headspace samples over each adhesive were collected using a thermal desorption tube, then analyzed by gas chromatography and mass spectrometry (TD-GC-MS). Also, a small portion of each adhesive sample was placed in a quartz tube and heated directly in the thermal desorber system at 300°C for 10 minutes and then analyzed by GC-MS.

Real-time carbon monoxide (CO) levels were measured in the rolls-test area using a Q-Trak™ indoor air quality monitor (Model 8554, TSI Incorporated, St. Paul, MN).

Additional information

JNAP employees posted notices at several locations in the plant to let co-workers know that a team from NIOSH would visit the plant from February 8-10, 2006 and that physicians on the team would be available to meet with them privately at the UAW Local 7 Union Hall located across the street from the plant. In addition to these face-to-face interviews, we also obtained information from employees who contacted us via telephone. We reviewed the medical records of four JNAP employees. We also reviewed two Michigan Occupational Safety and Health Administration (MIOSHA) reports which described findings from investigations of welding-related exposures at JNAP. One investigation took place in August and September 2005 and evaluated exposures related to MIG welding. The other investigation occurred in January 2006 and evaluated welding-related and other potential exposures at several locations throughout the plant.

RESULTS

Reports of Symptoms and Illness in 22 JNAP Employees

We interviewed 10 employees in person at the UAW Local 7 Union Hall and 11 others were interviewed via telephone. Information on the employee who died of asthma in October 2005 was provided by other JNAP employees and by his next of kin. Of these 22 employees,

- 15 employees who worked some or all of the time in the body shop reported respiratory symptoms or problems (one of these employees no longer worked in the body shop; another died of asthma in October 2005).
  - Five reported symptoms (work-related shortness of breath and/or cough) consistent with new-onset asthma. Two of these five provided medical records which showed reversible airways obstruction consistent with asthma on lung function tests.
  - Two reported symptoms consistent with exacerbation of pre-existing asthma. One of these two was the employee who died in October 2005. Findings consistent with asthma as the cause of death were noted on autopsy.
  - Two reported symptoms that could be due to asthma (heaviness in chest while in the body shop; awakening due to shortness of breath).
  - One reported shortness of breath on exertion.

    - One reported a diagnosis of chronic bronchitis.
    - Four reported upper respiratory symptoms or problems such as persistent sinusitis; two of the employees with chest illnesses or symptoms noted above also reported upper respiratory symptoms or problems.
- Four employees reported physician-diagnosed new-onset asthma and/or recurrent bronchitis while working on the fluid-fill deck. One of these four also reported persistent sinusitis. One of these four employees provided medical records which showed reversible airways obstruction consistent with asthma on lung function tests.
- Two employees reported respiratory problems while working in the assembly area:
    - One reported recurrent sinusitis.
    - Another employee provided medical records documenting airways obstruction combined with interstitial lung disease.
- One employee reported episodes of skin, eye, and upper respiratory irritation while working in the paint shop.

Plant Walkthrough

The body shop is a large, open space with several areas where robotic welding occurs. Galvanized steel parts are welded together in stages as the partially-completed automobile bodies move through the various welding areas on a conveyor. The welding areas have metal fencing to prevent individuals from entering the areas for safety reasons. Some of the welding areas have plastic sheeting and exhaust fans (process ventilation) to decrease contamination of the plant air. Adhesives are hydraulically pumped from large metal drums to the robots for application to the metal parts prior to welding. General dilution ventilation in the body shop is supplied by 12 "air houses" located on the roof. Air returns are located at ceiling level. The volume of added makeup air varies from 15% to 100% (as low as 15% during colder months of the year to reduce heating costs). Air temperature is raised or lowered as needed by hot or cold water circulated through coils. Air is supplied from the roof-top "air houses" to the plant through ductwork, with air diffusers located at approximately mid-height between the floor and roof. Additional exhaust fans are located at various locations on the roof.

Several employees in the body shop reported that some of the exhaust fans that were in operation during our walkthrough were usually kept turned off during the winter months. In one welding area where an anti-spatter compound is used during the robotic welding process, employees reported respiratory irritation and insufficient ventilation to the area. They said that a roof-top exhaust fan over this area that was in operation during our walkthrough was usually kept turned off. Employees also reported that ventilation from some of the air houses was sometimes shut off or was inoperable due to mechanical problems. They also said that when breakdowns of process ventilation occur, welding-related contaminants accumulate in the plant air and are re-circulated by the air houses, as production is not halted when process ventilation fails. Management said that it turned on roof-top exhaust fans whenever there was a problem with process ventilation and that it felt that this approach adequately controlled the welding fumes such that halting production was not necessary.

The employee who died of asthma in October 2005 had occasionally worked near an area of the body shop where stamping and robotic assembly of car doors is performed ("XK doors"). Adhesives are hydraulically pumped from large metal drums to the robots for application to the metal door panels as part of this process. The metal barrels containing these adhesives were isolated with plastic sheeting; the area within the plastic sheeting had local exhaust ventilation. Employees used rags to wipe excess adhesive off of finished doors. (The employee who died did not perform this task.) Doors that have defects requiring repair are placed in a metal rack which is later moved with a forklift to a nearby repair area. There was a noticeable chemical-like smell when the rack was moved.

Employees on the fluid-fill deck in the assembly area pointed out puddles of engine fluids in collection pans located beneath floor grates along the production line. They also reported concerns regarding air conditioning refrigerant that they said routinely escaped into the air in two ways: (1) when a connector ("stem") between the refrigerant supply hose and the vehicle's air-conditioner breaks (which reportedly occurs several times per day); (2) from a device that is intended to capture refrigerant from calibration test bottles. Management reported that it was not aware of these concerns or that any significant amounts of refrigerant were being released into the plant air. Management stated that, because of regulatory requirements, it has to document the fate of all amounts of refrigerant that it brings in to the plant (i.e., such that there is minimal discrepancy between the amount that comes in to the plant and the amount that is contained in finished vehicles or other receptacles), and that it was not aware of any discrepancies that would indicate excessive escape of refrigerant into the plant air.

In the beta-foam booth, workers inject an MDI-containing liquid and a liquid resin-polyol foam deadener base into several cavities in the vehicle body. These substances react to produce a solid foam material within the cavities. Injection of these substances is accomplished through the use of a gun to which hoses supply the liquid substances. The beta-foam booth has downdraft ventilation. We noted small amounts of smoke rising from vehicle areas where injection had just been performed. Management reported that the company's medical surveillance program for beta-foam booth workers had not detected any evidence that workers were at risk for respiratory problems from MDI exposures. Some workers that we spoke with did report occasional irritant symptoms.

Other areas of the plant where employees expressed concern regarding potential exposures included an area near the E-coat oven in the paint shop and the area where windshields are installed in the assembly area. Employees in these areas reported eye and/or upper-respiratory irritation. Employees in the paint shop thought their symptoms were due to exposures from the E-coat oven. Employees in the windshield installation area reported irritation from the alcohol wipes used to wipe the windshields.

Testing of vehicle and engine operation occurs in the rolls-test area. The engine of a finished vehicle is initially started approximately 100 feet outside the rolls-test area and the vehicle is then driven into this area by an employee. The vehicle is held in a stationary position on metal rolls while the engine is operated to achieve a wheel speed up to 60 miles per hour. Down draft ventilation is used to capture engine exhaust during testing. There was a noticeable odor of engine exhaust during vehicle engine operation in this area despite visible capture of the vehicle's exhaust by the downdraft ventilation. Employees were concerned that vehicle testing was not halted when this area had ventilation problems. Management reported that the downdraft ventilation was interlocked with the testing machinery such that vehicle testing would not occur if the downdraft ventilation was not operating; dilution ventilation to this area is not interlocked with testing.

NIOSH Air Sampling and Laboratory Analyses

TD-GC-MS results from air sampling at different locations in the plant and from air sampling in the head space of adhesive bulk samples: Reconstructed total ion chromatograms from the TD-GC-MS analyses are presented in Figures 1A-H (samples obtained in the plant) and Figures 2A-D (headspace air samples from four bulk adhesive samples; the results of sampling at room temperature and after heating each bulk sample to 300°C are shown on the same figure for each adhesive). Each numbered peak in the chromatograms corresponds to a specific chemical; the height of the peak corresponds to its relative abundance in the vapor phase. The chemical identity for each number, and the chemicals detected in each sample, are shown in Table 1. Sampling volumes were low for the samples collected during repair welding in the repair shop because only three welds were performed and the average time per weld was only three minutes.

Many dozens of different chemicals were detected in the air samples taken at various locations in the plant and from the headspace of the adhesive bulk samples. Many more chemicals were detected in the headspace after heating the adhesive bulk samples compared to the results from the unheated bulk samples. This may reflect increased volatilization of chemicals originally present in the samples, or formation of additional chemicals due to the heating of the samples. Methyl methacrylate, acetic acid, and phthalic anhydride, chemicals which have been classified as asthmagens (agents that can cause occupational asthma) by the Association of Occupational and Environmental Clinics (AOEC), were found in the headspace of some of the adhesive bulk samples. Formaldehyde (detected in the air sample from the fluid-fill deck) and styrene (detected in the air samples from the fluid-fill deck, near robotic welding, and from repair welding) are also classified as asthmagens by AOEC. There may be other as yet unidentified asthmagens among the chemicals found in the air samples.

Results of air sampling using vacuum canisters: Tables 2 and 3 list the compounds detected in the air samples collected using six-liter vacuum canisters at different locations in the plant, using the EPA TO-15 analysis method. Compounds present in the standard curve are listed in Table 2. The compounds listed in Table 3 are TIC's (tentatively identified compounds) and are identified based on their ion spectra when compared to compounds in the National Institute of Standards and Technology (NIST) library. The concentrations are estimates based on the ratio of the TIC response to that of the closest internal standard (a known concentration added to the sample for calculation of relative response). All values are presented in parts per million (ppm) levels.

Real-time carbon monoxide air sampling: Real-time CO measurements were less than 10 ppm in the rolls-test area while vehicles were being tested. Visible vehicle exhaust during testing appeared to be adequately captured by the downdraft ventilation, but a noticeable exhaust smell during the vehicle testing process indicated that not all vehicle exhaust was captured by this ventilation system.

GRIMM real-time particle monitoring: Figure 3 shows a graph of particle counts in the repair welding area. During the sampling interval, one employee made 3 repair welds on car bodies and doors lasting approximately three minutes each. The highest counts were for particles less than 1 micrometer (µm) in diameter. Five sharp spikes in the particle counts occurred during the two-hour sampling time period, at approximately 2:09, 2:27, 2:55, 3:12, and 3:28 pm. Three of the spikes corresponded to the manual welding events, one spike corresponded to testing of air movement utilizing smoke tubes, and one spike corresponded to use of a portable grinding wheel and movement of materials with a forklift.

Figure 4 shows a graph of particle counts in the T-2 area near column PBB 13 in the paint shop and while walking away from this area. Sampling was conducted at a desk near the PBB 13 column for approximately 10 minutes. During this time the highest counts were for particles smaller than 1 µm in diameter. Particle counts dropped by approximately two-thirds and remained steady when we moved the particle counter away from this area while continuing to sample.

Figure 5 shows a graph of particle counts in the robotic welding area between columns EE 38 and EE 39 over a sampling period of approximately seven hours. The highest counts were for particles smaller than 1 µm in diameter. Several particle count spikes occurred in the afternoon at approximately 2:37, 3:30, 3:52, and 4:07 pm. These particle count spikes were nearly six-fold higher than particle counts measured during the early part of the sampling period and could reflect smoking by nearby workers during a work break.

Assessment of air movements with smoke tubes: Testing in the repair welding shop near the welder's work zone showed the large wall-mounted exhaust fan to be inadequate for removing welding fume. The local electrostatic exhaust system used by the welder appeared to effectively remove welding fume. In the area of the body shop where stamping and robotic assembly of car doors is performed (XK doors), the local exhaust ventilation inside the plastic sheeting used to isolate metal barrels of adhesives was functioning, but a chemical smell was still noticeable outside the plastic sheeting.

MIOSHA Reports

The October 2005 MIOSHA report described findings and provided recommendations related to MIG repair welding. The measured exposures to welding fume, toluene, 1,3 butadiene, and acrylonitrile were all well below MIOSHA permissible exposure limits (PELs). Welding was performed with local exhaust ventilation in place. Among the recommendations made in the report were the following: (1) "Ensure that employees are trained how to properly start-up, adjust and position local exhaust ventilation at their workstation for optimal effect." (2) "Provide a dust/smog hog [local exhaust ventilation] to the employee performing welding operations in the SMS area." (3) "As weld containments [repair welds performed on many vehicles simultaneously on the production line] are set up along the line, ensure that proper exhaust ventilation is available and used at these operations. If possible, perform weld containments in the old welding tunnel where there is sufficient exhaust ventilation and airline-supplied respirators are available." The results of air sampling performed on August 30, 2005 and September 8, 2005 are summarized below:

- Welding fume exposure: 0.13 milligrams per cubic meter of air (mg/m^3)(8-hour time-weighted average PEL: 5.0 mg/m^3)
- Toluene: below the limit of detection (0.8-1.0 mg/m^3)(8-hour time-weighted average PEL: 375 mg/m^3)
- Acrylonitrile: below the limit of detection (1.0 mg/m^3)(short-term exposure limit: 21.7 mg/m^3)
- 1,3 Butadiene: below the limit of detection (1.0 mg/m^3)(short-term exposure limit: 11.1 mg/m^3)

The March 2006 report described the results of air sampling in several areas of the plant for carbon monoxide (rolls-test and alignment areas), formaldehyde (entry to E-coat oven in paint shop) isopropyl alcohol (assembly area, aperture line, paint line, floor pan line), welding fume and metal fume/dust (zinc, lead, cadmium, cobalt, nickel, iron, chromium, manganese, beryllium, copper, aluminum, molybdenum) (underbody and aperture lines), total dust (assembly area, paint shop), methylene bisphenyl isocyanate (MDI) (aperture and roof lines), 2,4 toluene diisocyanate and 2,6 toluene diisocyanate (2,4 TDI, 2,6 TDI) (aperture and roof lines), and nitrogen dioxide and nitric oxide (rolls-test area). All results were below MIOSHA PELs. Specific air sampling results are listed below:

- Welding fumes exposure: 0.38 and 0.22 mg/m^3 (8-hour time-weighted average PEL: 5 mg/m^3)
- Iron oxide fume exposure: 0.16 mg/m^3 (8-hour time-weighted average PEL: 10 mg/m^3)
- Zinc oxide fume exposure: 0.01 and 0.016 mg/m^3 (8-hour time-weighted average PEL: 5 mg/m^3)
- No metals were detected except for zinc and iron
- MDI exposure: below the limit of detection (0.0002-0.003 mg/m^3)(ceiling PEL: 0.2 mg/m^3)
- 2,4 TDI exposure: below the limit of detection (0.004-0.02 mg/m^3)(8-hour time-weighted average PEL: 0.04 mg/m^3)
- 2,6 TDI exposure: below the limit of detection (0.0007-0.003 mg/m^3)(no established PELs)

DaimlerChrysler Air Sampling Data

Management provided results from air sampling performed in various areas of the plant in the years 2001 through 2005. Results for metals (iron, zinc, chromium, copper, manganese) as welding fume in 2001 (personal sampling during MIG welding) and in 2004 (area sampling) were all below NIOSH recommended exposure limits and OSHA PELs. All personal sampling results for MDI for beta-foam booth workers in 2004 were reported as “none detected”; the limit of detection for the samples was not indicated.

DaimlerChrysler Material Safety Data Sheets (MSDSs)

Several adhesives were noted on their MSDSs to have potential irritant effects (inhalational, eye, and skin). These included Terokal EPA-2040.4 (used on metal undergoing robotic welding in many areas), Versilok 262, Versilok 254, and Terostat SA-4510. These last three adhesives are used in the stamping and assembly of door panels. (The employee who died of asthma in October 2005 attached hinges to these doors.) According to the MSDSs, both Terokal EPA-2040.4 and Terostat SA-4510 contain azodiformamide. (This chemical has been associated with occupational asthma.[1] At an azodiformamide plant where workers were found to have developed occupational asthma, azodiformamide dust “levels [were] in the range 2-5 mg/m^3”.[2]) Terokal EPA-2040.4 was also noted to contain caprolactam, a known respiratory irritant.[3] The MSDS for the anti-spatter agent Parco AWS-100 indicated potential for respiratory, eye, and skin irritation; this agent contains ethyl acrylate, a known irritant with an OSHA PEL of 25 parts per million (ppm). The MSDS for the antifreeze used on the fluid-fill deck noted the potential for irritation to eyes, nose, and throat.

DISCUSSION

Several employees at JNAP indicated concern regarding the possible work-relatedness of respiratory problems that they and/or other workers have experienced while working at the plant. Most of these employees worked in the body shop and were concerned about exposures related to robotic and manual welding through adhesives. Four employees reported problems they felt were related to work on the fluid-fill deck. Three of the employees in the body shop had medical evidence of asthma (including autopsy findings in one employee). Several employees noted the onset or worsening of their respiratory symptoms when working in the body shop. These reports indicate that some JNAP employees may be at risk for respiratory problems due to current exposures in the plant. The material safety data sheets (MSDSs) for a number of adhesives and other agents used by or near employees in the plant document their potential to cause respiratory irritation. Our qualitative air sampling showed the presence of several asthmagens in air samples from the plant and/or in the headspace of adhesive bulk samples. Regulatory or recommended exposure limits for such chemicals are often based on acute irritant effects and not on their potential to cause occupational asthma. Their presence at levels below regulatory or recommended limits could still contribute to occupational asthma in some workers, especially when many such chemicals are present in the air of the workplace at the same time.

Whether or not any JNAP employees have developed allergic-type asthma from exposures in the plant is unknown. Exposures to irritants, however, may be a factor in the development or worsening of respiratory problems for some employees. While information on the potential respiratory health risks from exposures in this plant and other automotive assembly plants is limited, there is substantial information in the scientific literature on the potential respiratory health risks from welding and particulate exposures in general. This information indicates that steps should be taken now to minimize risk to employees at JNAP, and suggests future actions should be taken to further characterize the potential risk to employees.

Review of the Scientific Literature

Respiratory disease in welders: The potential for respiratory symptoms and illnesses from welding-related exposures depends on the type of welding being performed, the characteristics of the metal being welded on and of any coatings present on the metal, the makeup of any consumable electrode in use, and the intensity and duration of the exposures. Certain welding situations are well recognized for their potential to cause acute respiratory problems (e.g., inadequately-controlled exposures while welding on metals such as zinc can cause metal fume fever, a flu-like illness).[4,5] Chronic respiratory problems have also been associated with welding.[4,5] A study of arc welders documented higher rates of chronic bronchitis symptoms and decreased lung function related to years of welding.[6] Decreased lung function and increased rates of chronic bronchitis symptoms have been found in welders exposed to higher fume concentrations due to work in confined, poorly ventilated spaces (e.g., shipyard welders).[7] Studies have also noted cross-shift declines in lung function in arc welders. In a recent study, this effect was related more to welding on stainless steel as compared to mild steel, and to manual metal arc welding as compared to MIG welding.[8] Some studies have suggested that welding-related exposures may cause asthma.[9,10] Most studies are limited by a lack of information on the types, durations, and intensities of workers' exposures.[4,5] In many studies the effects of welding exposure could not be differentiated from the potential effects of cigarette smoking and asbestos exposure.[4,5] In a recent study at an automobile assembly plant, respiratory symptoms were significantly elevated in body shop workers compared to paint shop and assembly area workers, but self-reported respiratory diagnoses were not increased in body shop workers.[11] How the exposures of workers at this plant compare to those of workers at JNAP is unknown.

The review of the relevant scientific literature conducted by NIOSH for its 1988 criteria document for welding indicated that "…collectively these studies demonstrate an elevated risk of *lung cancer* among welders that is not completely accounted for by smoking or asbestos exposure, and that appears to increase with the latent period from onset of first exposure and duration of employment."[4] Some subsequent studies have also demonstrated an elevated risk for lung cancer in welders; two studies estimated an increased risk of approximately 35%.[5] A study that analyzed data on causes of death in 198,245 automotive industry workers from 1973 through 1995 revealed lung cancer deaths to be approximately 11% higher than expected (compared to U.S. general population data) in "vehicle assembly workers".[12] As has been the case with most studies of respiratory health in welders, this study lacked data on specific exposures of the workers.

Work-related respiratory illness development or exacerbation: Asthma is a form of lung disease in which airways develop inflammation and bronchospasm (reversible airways obstruction) in response to a variety of specific and non-specific triggering agents.[13] The prevalence of asthma in the U.S. is approximately 5%. Work-related asthma (WRA) includes physician-diagnosed new-onset asthma due to an agent (irritant or allergen) encountered in the workplace, as well as exacerbation of stable pre-existing asthma from exposure to irritants in the workplace.[13] WRA has been estimated to make up 15% of all asthma among adults.[14] In some workers, mild WRA can progress to severe persistent asthma if exposures are not controlled or eliminated. New-onset asthma due to a workplace allergen typically requires complete exposure elimination to prevent disease progression. In workers with exacerbation of asthma due to irritants, decreased exposure levels combined with close medical monitoring and management may result in clinical improvement and may allow the worker to remain safely at the same job.[13]

Inflammation can affect the upper respiratory tract as well as the lungs. Like asthma, rhinitis (inflammation of the nasal mucosa) can result from irritants or allergens found in the workplace.[14,15] An estimated 20% of the population has allergic rhinitis and an additional 5% has non-allergic rhinitis.[14] Asthma and rhinitis often coexist. The swelling of nasal tissues that occurs with rhinitis can obstruct the openings that allow normal drainage of fluids from sinuses, leading to secondary infections (sinusitis).[14,15]

Exposure measurements and lung disease risk: While the available data on welding-related exposures at JNAP were all below applicable regulatory limits, it is still possible that a subset of workers with preexisting respiratory disease or personal susceptibility to develop disease might be adversely affected by current conditions in the plant. Regulatory limits for welding-related particulate exposures are based on the amount of particulate in the air (mass) without regard to particle size distribution. Studies of the effects of air pollution on respiratory health have shown consistent relationships between the amount of fine particulate in the air (i.e., particles with an aerodynamic diameter less than 2.5 micrometers) and deaths and hospitalizations due to respiratory disease.[16] Ultrafine particles (aerodynamic diameter less than 0.1 micrometers) may also be an important factor in respiratory disease development or exacerbation.[17-20] Both fine and ultrafine particles can be present in high number concentration and yet contribute little to measured particulate mass. Research on the composition of welding fume has shown that it is largely composed of fine and ultrafine particles.[21-23]

CONCLUSIONS

JNAP employees can be exposed to many agents with potential to induce or aggravate respiratory illness. Some employees may be affected by the combined effects of exposure to several irritants in the form of dusts, fumes, and gases. This will be more likely when ventilation is decreased due to mechanical breakdowns or in an attempt to decrease heating costs during winter months. Regulatory compliance with exposure limits does not ensure that all workers are protected. The potential for exposures in automotive assembly plants to cause occupational respiratory problems has not yet been adequately assessed. Symptoms and illnesses in employees suggest that additional medical monitoring and control of exposures at JNAP should be implemented and detailed studies to assess occupational health risk conducted.

RECOMMENDATIONS

- Minimize welding-related exposures:
  - Implement process ventilation for all robotic welding areas. Assure performance of comprehensive preventive maintenance for all ventilation systems on a regular schedule in order to minimize breakdowns.
  - Implement mandatory use of local exhaust ventilation during all manual repair welding activities. Assure that each worker who performs repair welds is able to utilize local exhaust ventilation (either from a portable device or permanently mounted flexible duct system) at any location where welding is to be performed. Also assure that the worker can adequately position the duct to capture all welding fumes. A fume extraction gun is an alternative method for exhausting fume during welding that may be considered.
- Minimize exposures on the fluid-fill deck:
  - Identify ways to minimize fluid spills.
  - Implement regularly scheduled cleanout of fluid collection pans under floor grates.
  - Assess the potential for air conditioning refrigerant leaks to occur during charging of air conditioners and collection of refrigerant from calibration test bottles.
- Implement medical monitoring with an asthma symptom questionnaire for workers in the XK doors and hinge-to-door work areas. Refer workers with asthma symptoms for medical evaluation to rule out occupational asthma. Identify ways to minimize exposure potential if medical evaluations indicate likely occupational asthma. The Michigan Public Health Code requires employers and physicians to report cases of occupational illness such as asthma to the Michigan Department of Labor and Economic Growth. The Michigan State University (MSU) Department of Occupational and Environmental Medicine conducts follow-up of cases of occupational asthma for the State through the Sentinel Event Notification System for Occupational Risks (SENSOR) program. Details on this

program and on how to report cases can be found at the MSU Occupational and Environmental Medicine internet website (http://oem.msu.edu/reportform.asp).

- Accommodate JNAP workers with physician-diagnosed work-related asthma (i.e., new-onset asthma or exacerbation of stable preexisting asthma that is progressive or persists despite treatment). This may require removal of the worker from further exposure if additional exposure control is not feasible (or if the suspect agent is a sensitizer). A NIOSH-certified N95 filtering facepiece respirator may provide sufficient protection if a worker's asthma is due to an irritant response to airborne particulate. JNAP management should make a selection of NIOSH-certified N95 respirators available for such workers and provide instruction on how to wear them correctly.

DaimlerChrysler and UAW should consider conducting a joint health study to assess the potential for welding- and adhesive-related exposures in automobile assembly plants to affect the respiratory health of workers. Such a study should be well designed and executed in order to assure that the data collected is representative of actual exposures and worker health. Important in the design and performance of such a study are methods to encourage high participation by workers, and identification of a suitable comparison group. Serial health and exposure surveys at several plants over time may be required in order to obtain sufficient data for analyses to provide interpretable results. Health assessments should include a questionnaire to determine rates of respiratory symptoms and physician-diagnosed respiratory disease, and spirometry (pre- and post-bronchodilator administration) to objectively determine the prevalence of airways obstruction and whether or not the obstruction is reversible. Assistance with the design and performance of such a study can be obtained from NIOSH and / or a university-based occupational health department.

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TABLES AND FIGURES

Table 1. Summary of results of TD-GC-MS analysis of air and bulk adhesive samples (pages 13, 14, 15, and 16).

	Air Samples								Bulk adhesive samples							
	Manual weld test 1 (adhesive 1)	Manual weld test 2 (adhesive 4)	Manual weld test 3 (no adhesive)	Robotic welding area	Fluid-fill deck	Beta-foam area	Outside control	Field blanks	Adhesive 1 - room temp	Adhesive 1 - 300° temp	Adhesive 2 - room temp	Adhesive 2 - 300° temp	Adhesive 3 - room temp	Adhesive 3 - 300° temp	Adhesive 4 - room temp	Adhesive 4 - 300° temp
1) Air	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2) Nitric oxide?	X				X	X										
3) CO2		X	X	X	X		X	X								
4) Formaldehyde					X											
5) Acetaldehyde					X											
6) Methanol	X								X							
7) Ethanol	X		X				X									
8) Acetone	X	X		X	X							X	X			
9) Isopentane	X	X	X	X	X	X	X	X								
10) Isopropanol	X	X	X	X	X		X									
11) C5H10 aliphatics				X	X											
12) Pentane	X	X	X	X	X	X	X	X								
13) Methylene chloride								X								
14) C5H8 aliphatics		X		X												
15) t-Butanol					X						X	X				
16) 1,1,2-Trichloro-1,2,2- trifluoroethane					X	X	X									
17) Methacrolein							X									
18) C6 aliphatic hydrocarbons		X		X	X	X	X									
19) Butanal							X									
20) Methyl ethyl ketone					X								X		X	
21) Hexane	X	X	X	X	X	X	X	X								
22) Isobutanol				X			X						X	X		
23) Methylcyclopentane				X	X	X										
24) Butanol							X									
25) Benzene	X	X	X	X	X	X	X	X				X	X	X		
26) 1-Methoxy-2-propoxypropanol				X			X									
27) Cyclohexene																
28) Dihydropyran?				X												
29) Carbon tetrachloride					X											
30) Cyclohexane				X	X											
31) C7 aliphatic hydrocarbons/ heptane			X		X	X	X	X								
32) Ethylene glycol					X											
33) Trichloroethylene	X	X	X	X		X		X								
34) Isooctane				X		X										
35) Methyl methacrylate				X											X	X
36) Methyl isobutyl ketone				X			X						X			
37) Methylcyclohexane			X	X	X	X										
38) 2-Methyl-1-butanol							X									
39) Ethylene glycol formate					X											
40) Amyl alcohol							X									
41) Toluene	X	X	X	X	X	X	X		X	X	X	X	X	X		
42) C8 aliphatic hydrocarbons	X	X			X											
43) 2-Propoxyethanol					X											

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	Manual weld test 1 (adhesive 1)	Manual weld test 2 (adhesive 4)	Manual weld test 3 (no adhesive)	Robotic welding area	Fluid-fill deck	Beta-foam area	Outside control	Field blanks	Adhesive 1 - room temp	Adhesive 1 - 300° temp	Adhesive 2 - room temp	Adhesive 2 - 300° temp	Adhesive 3 - room temp	Adhesive 3 - 300° temp	Adhesive 4 - room temp	Adhesive 4 - 300° temp
44) Butyl acetate	X			X			X									
45) Octane					X											
46) 4-Vinylcyclohexene				X							X		X	X	X	X
47) Hexamethylcyclotrisiloxane			X		X	X										
48) C9 aliphatic hydrocarbons					X		X									
49) 1-Propoxy-2-propanol					X		X									
50) Ethyl benzene/xylene isomers	X	X		X	X	X	X		X				X			
51) Phenyl acetylene		X														
52) Isoamyl acetate							X									
53) Styrene		X		X	X											
54) Butyl cellosolve					X		X									
55) Amyl acetate				X			X									
56) Nonane					X											
57) Benzaldehyde	X	X		X	X		X				X		X	X	X	X
58) C9H12 alkyl benzenes (trimethylbenzenes) etc.	X	X	X	X	X	X										
59) Phenol	X	X												X		
60) Hexyl acetate							X									
61) Allyl benzene?							X									
62) C10H14 alkyl benzenes (tetramethylbenzene)				X			X					X				
63) C10H16 terpene					X											
64) Octamethylcyclotetrasiloxane	X	X			X											
65) Indene		X										X				
66) Decane					X											
67) p-Dichlorobenzene					X											
68) 2-Ethyl-1-hexanol					X							X	X	X		
69) Limonene				X	X											
70) Acetophenone					X									X		
71) Aliphatic hydrocarbons					X											
72) alpha, alpha-Dimethylbenzenemethanol					X			X								
73) C9-C10 Aliphatic aldehydes	X				X	X		X								
74) Undecane				X	X											
75) Decamethylcyclopentasiloxane					X											
76) 2-(2-Butoxyethoxy)ethanol					X											
77) Naphthalene/decanal	X	X		X	X											
78) Dodecane					X											
79) Methyl naphthalene		X														
80) Benzothiazole					X											
81) Propylene glycol oligomer?					X											
82) Dimethylphthalate	X	X	X	X	X	X	X	X					X			
83) 2-[2-(2-utoxyethoxy)ethoxy] ethanol					X											
84) Diethylphthalate	X	X	X	X	X	X	X	X								
85) Cyclohexylmethacrylate				X							X		X		X	X
86) Tetrahydrofurfuryl ester(methacrylate)				X									X		X	X
87) Chlorobutene isomer									X							
88) Methyl hexadiene									X							
89) Cyclopentanone									X	X						
90) C10-C12 aliphatics, unsat. hydrocarbs, alkenes									X							
91) Methacrylate esters?									X							X
92) Unknown									X							

Table 1. Summary of results of TD-GC-MS analysis of air and bulk adhesive samples (pages 13, 14, 15, and 16).

	Air Samples								Bulk adhesive samples							
	Manual weld test 1 (adhesive 1)	Manual weld test 2 (adhesive 4)	Manual weld test 3 (no adhesive)	Robotic welding area	Fluid-fill deck	Beta-foam area	Outside control	Field blanks	Adhesive 1 - room temp	Adhesive 1 - 300° temp	Adhesive 2 - room temp	Adhesive 2 - 300° temp	Adhesive 3 - room temp	Adhesive 3 - 300° temp	Adhesive 4 - room temp	Adhesive 4 - 300° temp
93) Dimethylamine										X	X					
94) Trimethylamine										X						
95) Unknowns, possible N compounds										X						X
96) Acetol										X				X		X
97) Formamide										X		X				
98) Pyridine										X						
99) Dimethylaminoacetone?										X						
100) 2-Methyl pyridine										X						
101) 3-Methyl pyridine										X						
102) Pyridine diols?										X						
103) Dimethyl pyrazine										X						
104) Unknown, aliphatic compound?												X				
105) Aniline										X						X
106) Trimethyl pyrazine										X						
107) Benzyl chloride										X						
108) Acetyl pyrrole?																
109) Methyl benzenamine																
110) Aliphatic, oxy compounds									X	X		X		X		
111) Caprolactam										X						
112) Butylated hydroxytoluene (BHT)										X						
113) Laurolactam?										X						
114) Methyl palmitate										X						
115) Methyl linoleate										X						
116) Methyl oleate										X						
117) Methyl stearate										X						
118) Methyl ricinoleate										X						
119) (Hydroxyethyl)alkyl amide?										X						
120) Diacetyl											X					
121) Acetic acid											X	X				X
122) Phenyl isocyanate												X	X			
123) Benzofuran																
124) Cyclohexenyl cyanide											X		X	X	X	
125) Acetamide												X				
126) Dichloropropanol isomers												X				
127) Phenol												X				
128) Dimethyl urea?																
129) Indan												X				
130) Chloroalkane												X				
131) t-Butylphenyl ether												X				
132) Octanethiol?												X				
133) Methyl benzofurans												X				
134) Benzoic acid											X	X	X	X		
135) Phenoxy-2-propanone												X				
136) Isopropyl phenol												X				
137) Phthalic anhydride												X				
138) 3,4-Dihydro-2H-1-benzopyran-3-ol?												X				
139) Dibromophenol												X				
140) Phthalimide												X				
141) 1-Chloro-3-phenoxy-2- propanol												X				

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142) Dodecanol?												X				
143) Chloroalkane (dodecane)												X				
144) Lauric acid												X				
145) Tri-n-butyl phosphate												X				
146) t-Butyl phenylene cyclic carbonate?												X				
147) Nonyl phenol isomers												X				X
148) Palmitic acid												X				
149) Trimethylolpropane trimethyl acrylate												X				
150) 1,3-Diphenoxypropan-2-ol												X				
151) Dioctyl disulfide												X				
152) Stearic acid												X				
153) Docosane												X				
154) Dioctyl adipate												X				
155) Acrolein														X		X
156) Chloroacetaldehyde														X		
157) Glycidol														X		
158) Benzoic acid ester														X		X
159) Biphenyl														X		
160) Isopropenyl phenyl glycidyl ether														X		
161) Phenyl benzoate														X		
162) Diisobutyl phthalate													X	X		
163) Phenolic compound?														X		
164) Vinylcyclobutane																X
165) Methacrylic acid															X	X
166) Propyl methacrylate															X	X
167) Tetrahydrofurfuryl alcohol															X	X
168) Cyanophenol																X
169) 2-Ethylhexyl methacrylate																X
170) Glycidol methacrylate?																X
171) Ethylene dimethacrylate																X
172) Triethylene dimethacrylate																X
173) Carryover peaks from previous analyses									X		X		X	X		X

? – Indicates lower quality match with mass spectral library.

Table 2. Results of GC-MS analysis of air samples collected in vacuum bottles, compounds present in standard curve.

Chemical	Manual weld test 1*	Manual weld test 2*	Manual weld test 3*	Welding repair shop 1 hour	Rolls-test area*	Between EE 38 – EE 39 8–hour
	ppm	ppm	ppm	ppm	ppm	ppm
Propylene	**0.023**	**0.077**	**0.036**	0.00	**0.004**	0.00
Chloromethane	**0.003**	**0.001**	0.00	0.00	0.00	0.00
1,3-Butadiene	**0.007**	**0.023**	0.00	0.00	0.00	0.00
Bromomethane	**0.002**	**0.001**	0.00	0.00	0.00	0.00
Ethanol	0.00	0.00	0.00	**0.002**	0.00	**0.018**
Acetone	0.00	0.00	0.00	**0.003**	0.00	**0.003**
Isopropyl alcohol	0.00	0.00	**0.004**	**0.025**	**0.002**	**0.028**
Methylene chloride	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**
Methyl ethyl ketone	0.00	0.00	0.00	0.00	**0.001**	0.00
Benzene	**0.045**	**0.118**	**0.004**	0.00	**0.001**	**0.001**
Heptane	**0.0002**	0.00	0.00	0.00	0.00	0.00
trans,1 3 Dichloropropene	0.00	0.00	0.00	0.00	0.00	**0.0001**
Toluene	**0.005**	**0.011**	**0.001**	**0.0004**	**0.002**	**0.0004**
Ethyl benzene	**0.001**	**0.002**	**0.001**	**0.0004**	0.00	0.00
m,p Xylene	0.00	0.00	**0.001**	**0.001**	**0.0004**	**0.0004**
Styrene	0.00	**0.005**	0.00	0.00	0.00	0.00
4-Ethyltoluene	0.00	**0.001**	0.00	0.00	0.00	0.00
1,3,5 Trimethylbenzene	0.00	0.00	**0.001**	0.00	0.00	0.00
1,2,4 Trimethylbenzene	0.00	0.00	**0.001**	**0.002**	0.00	0.00

* Instantaneous sample; ppm – parts per million

Table 3. Results of GC-MS analysis of air samples collected in vacuum bottles, tentatively identified compounds.

Chemical	**Manual weld test 1***	**Manual weld test 2***	**Manual weld test 3***	**Welding repair shop 1 hour**	**Rolls-test area***	**Between EE 38 – EE 39 8–hour**
	ppm	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
Allene or Propyne	**0.009**	**0.028**	**0.006**	0.00	0.00	0.00
Acetaldehyde	**0.003**	**0.006**	**0.005**	0.00	0.00	0.00
2-Propenal	0.00	0.00	**0.002**	0.00	0.00	0.00
1 Bromo-propane	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**
4-Methyl-1 pentene	0.00	**0.002**	0.00	0.00	0.00	0.00
2-Methyl-butane	0.00	0.00	0.00	0.00	**0.003**	0.00
2-Methyl-1 butene	**0.001**	0.00	0.00	0.00	0.00	0.00
2-methyl-1 propene	0.00	0.00	**0.015**	0.00	**0.001**	0.00
Acetic acid butyl ester	0.00	**0.002**	**0.002**	**0.002**	0.00	0.00
Benzaldehyde	**0.002**	0.00	**0.001**	0.00	0.00	0.00
3-methylene-heptane	**0.002**	0.00	0.00	0.00	0.00	0.00
Phenylethyne	**0.003**	**0.001**	0.00	0.00	0.00	0.00
1,3-Cyclopentadiene	**0.001**	0.00	0.00	0.00	0.00	0.00
Benzonitrile	**0.002**	0.00	0.00	0.00	0.00	0.00
Indene	**0.001**	0.00	0.00	0.00	0.00	0.00
Naphthalene	**0.006**	0.00	0.00	0.00	0.00	0.00
1-Ethyl-2methylbenzene	0.00	0.00	0.00	**0.001**	0.00	0.00

* Instantaneous sample; ppm – parts per million

Figure 1A. TD-GC-MS chromatogram of an air sample collected in smoke plume during manual weld test 1 (through adhesive number 1).

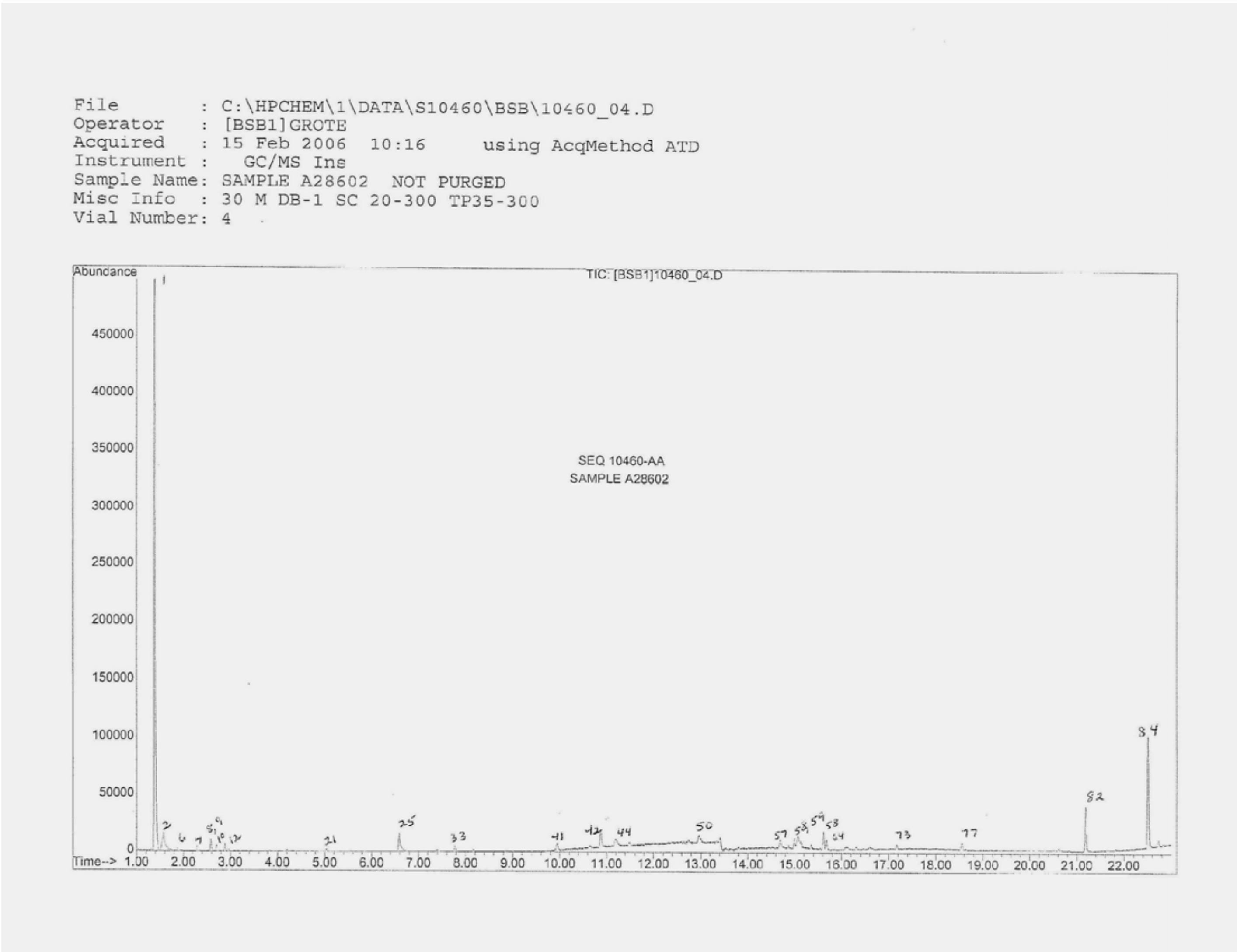


Figure 1B. TD-GC-MS chromatogram of an air sample collected in smoke plume during manual weld test 2 (through adhesive number 4).

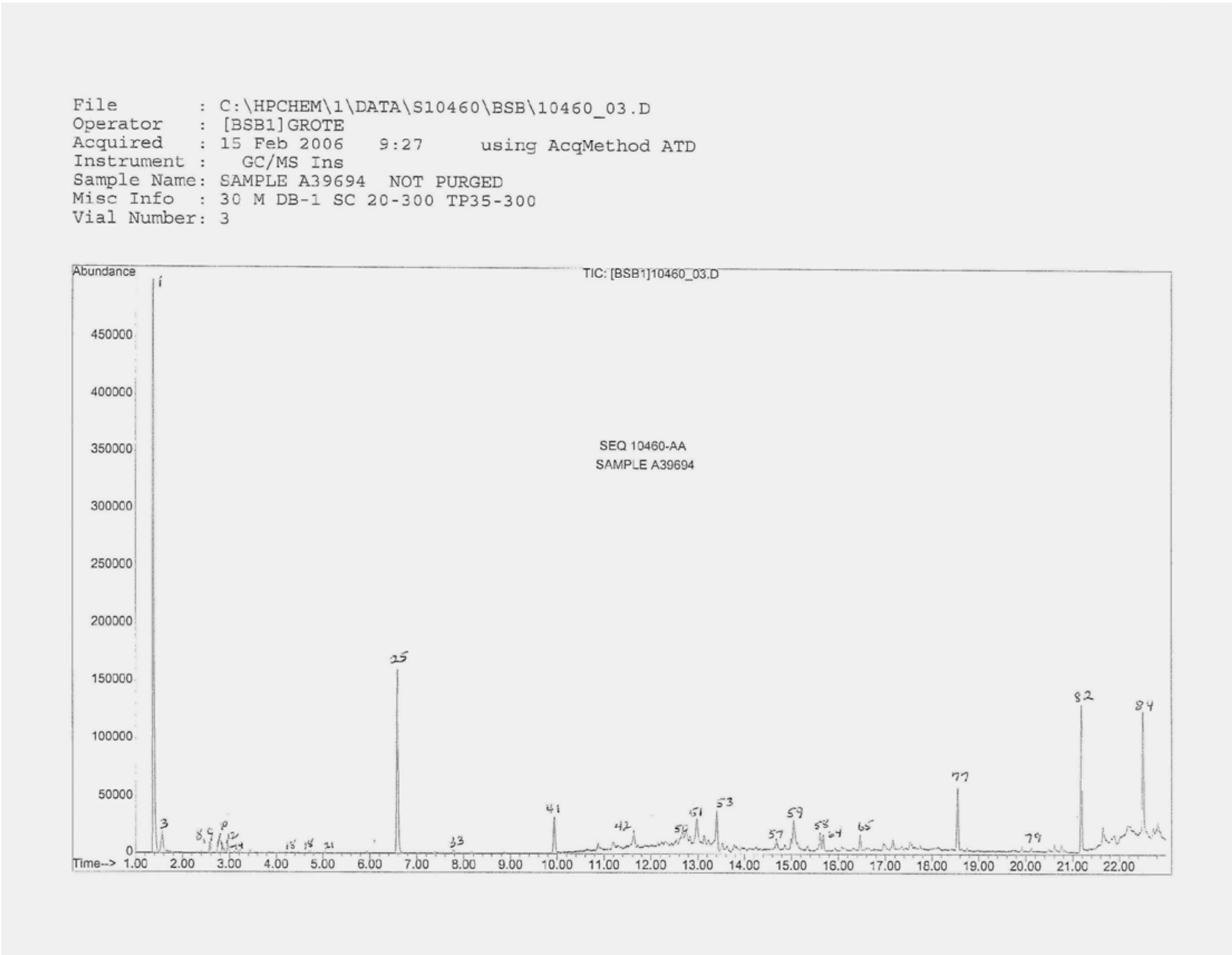


Figure 1C. TD-GC-MS chromatogram of an air sample during manual weld test 3 (no adhesive).

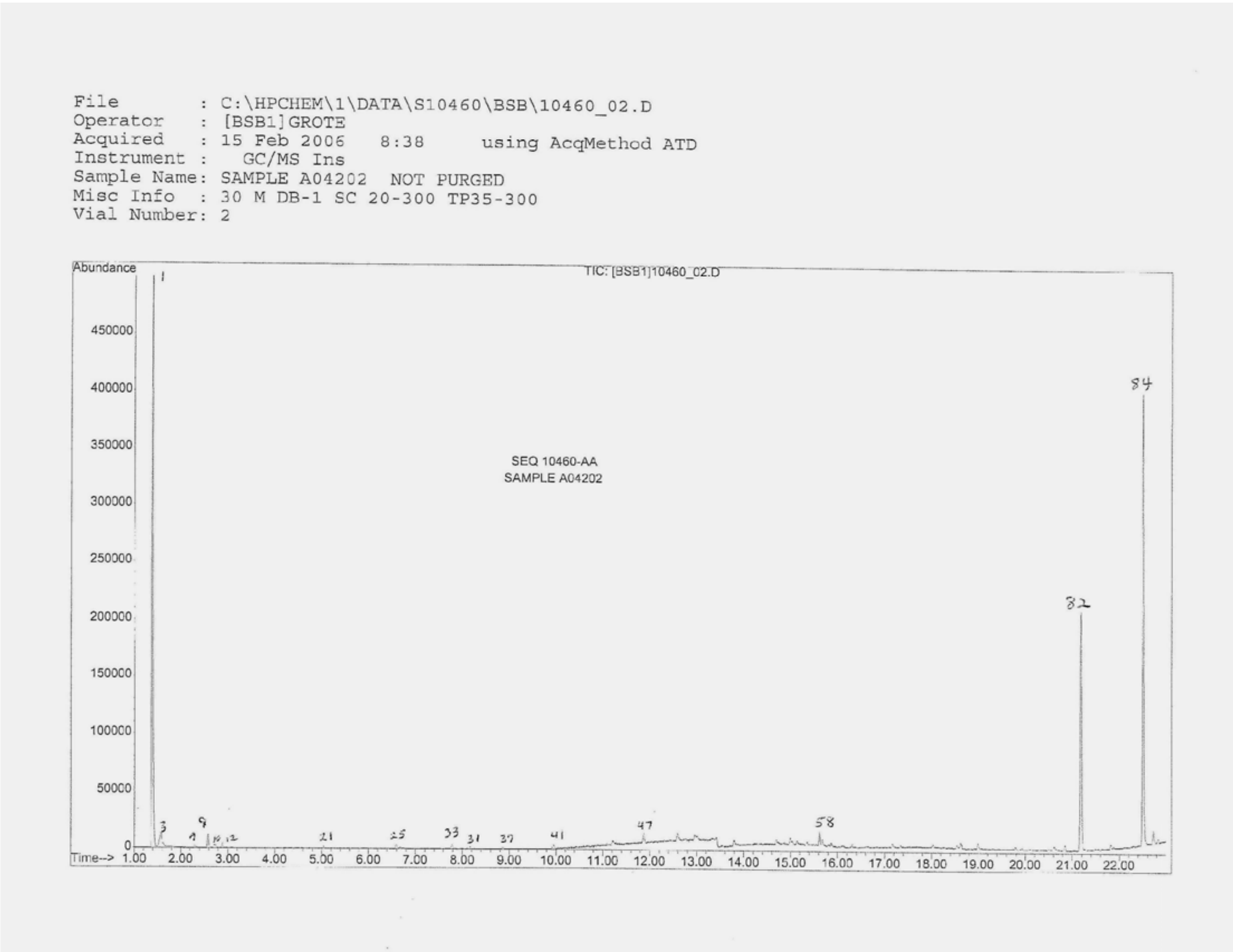


Figure 1D. TD-GC-MS chromatogram of an air sample taken at a location between EE38 and EE39 in the robotic welding area.

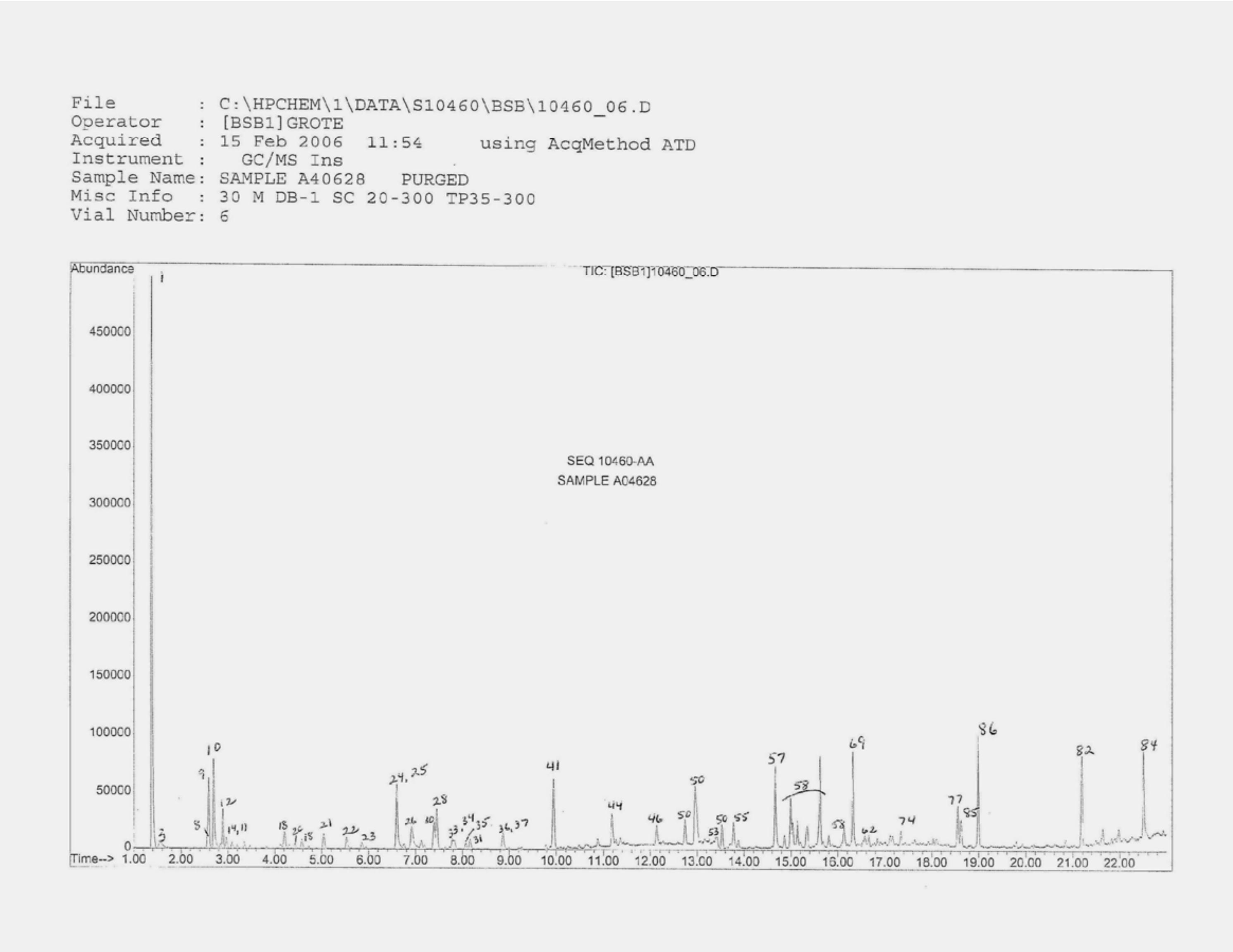


Figure 1E. TD-GC-MS chromatogram of an air sample from the fluid-fill deck.

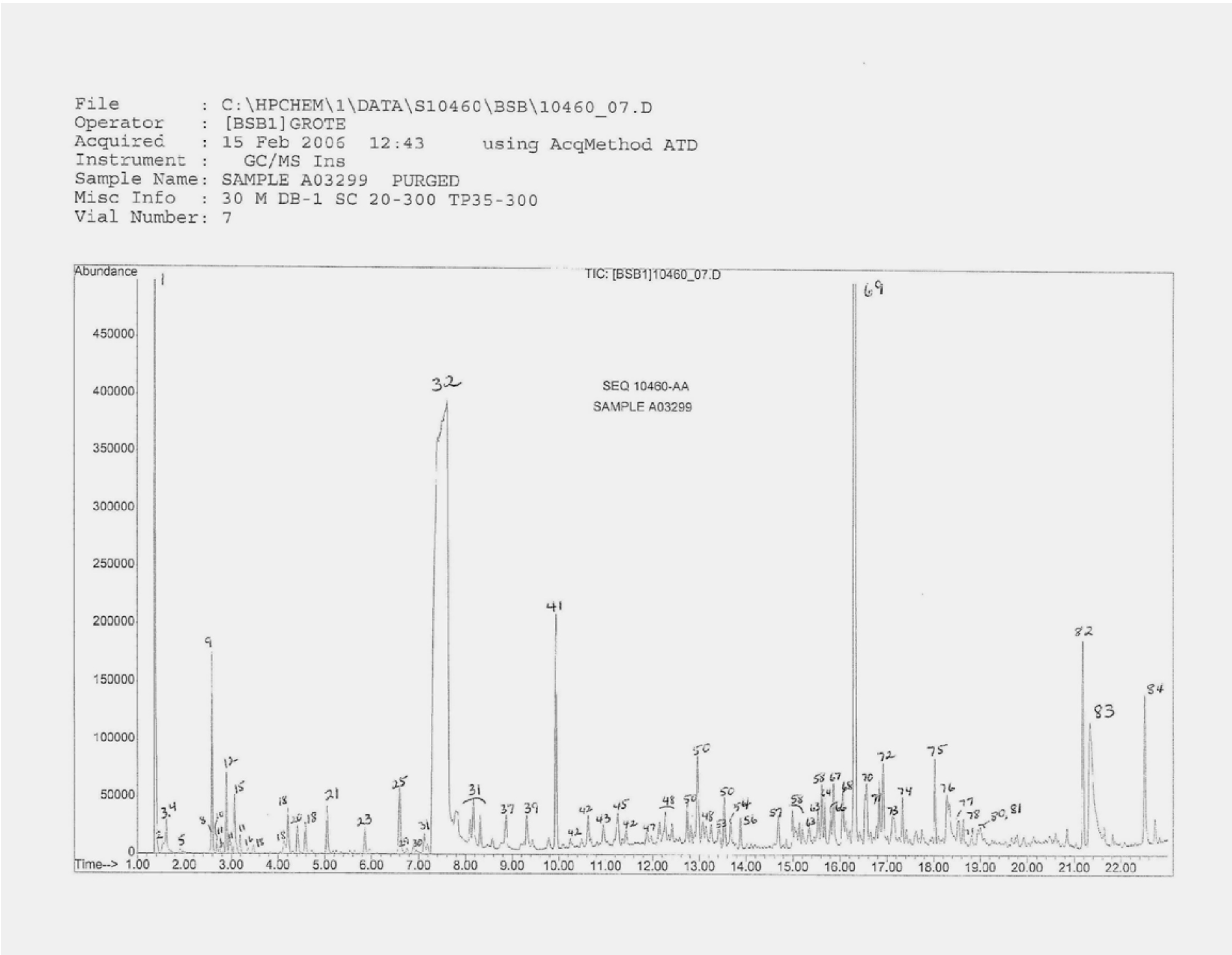


Figure 1F. TD-GC-MS chromatogram of an air sample from the beta-foam area.

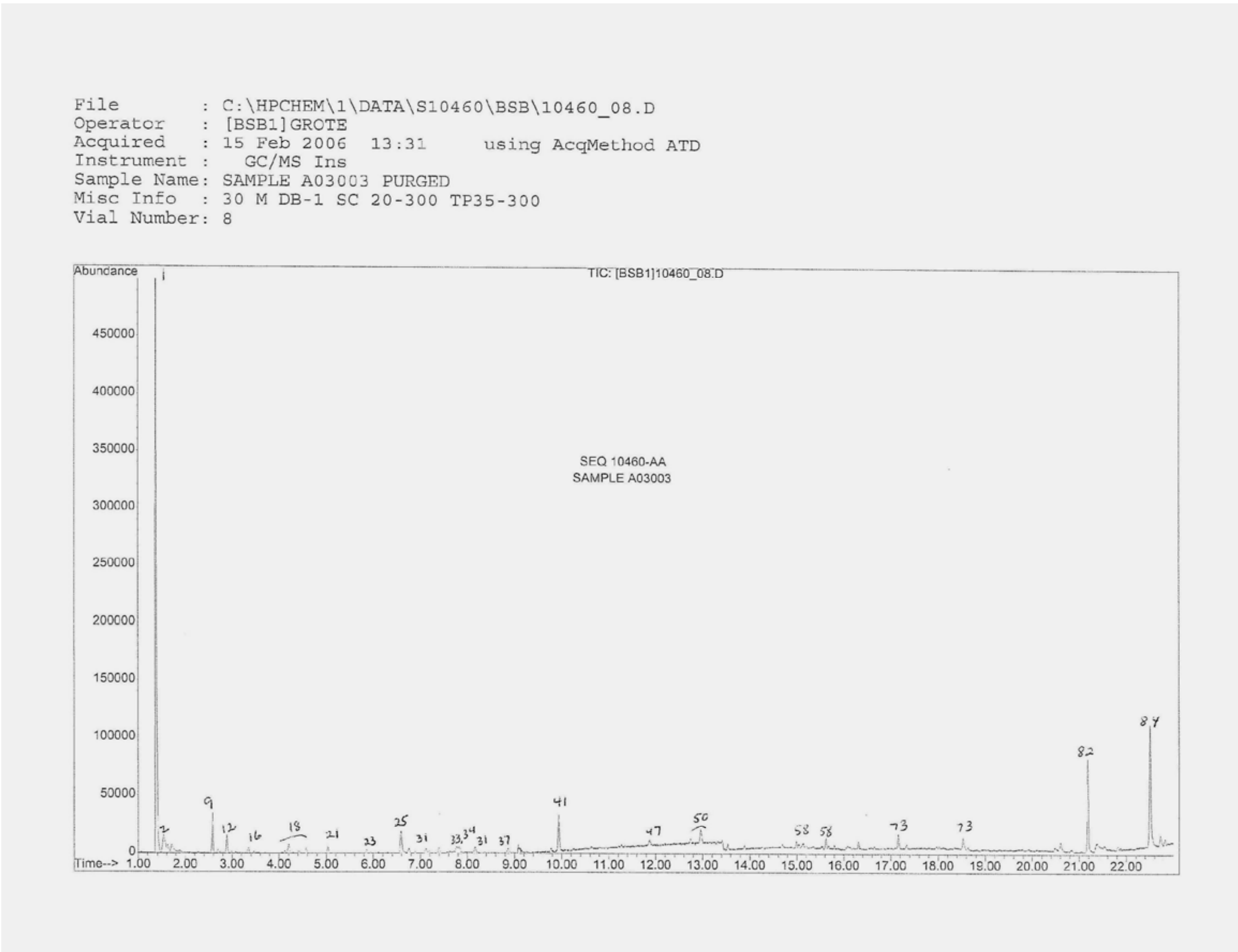


Figure 1G. TD-GC-MS chromatogram of an air sample taken outside as a control.

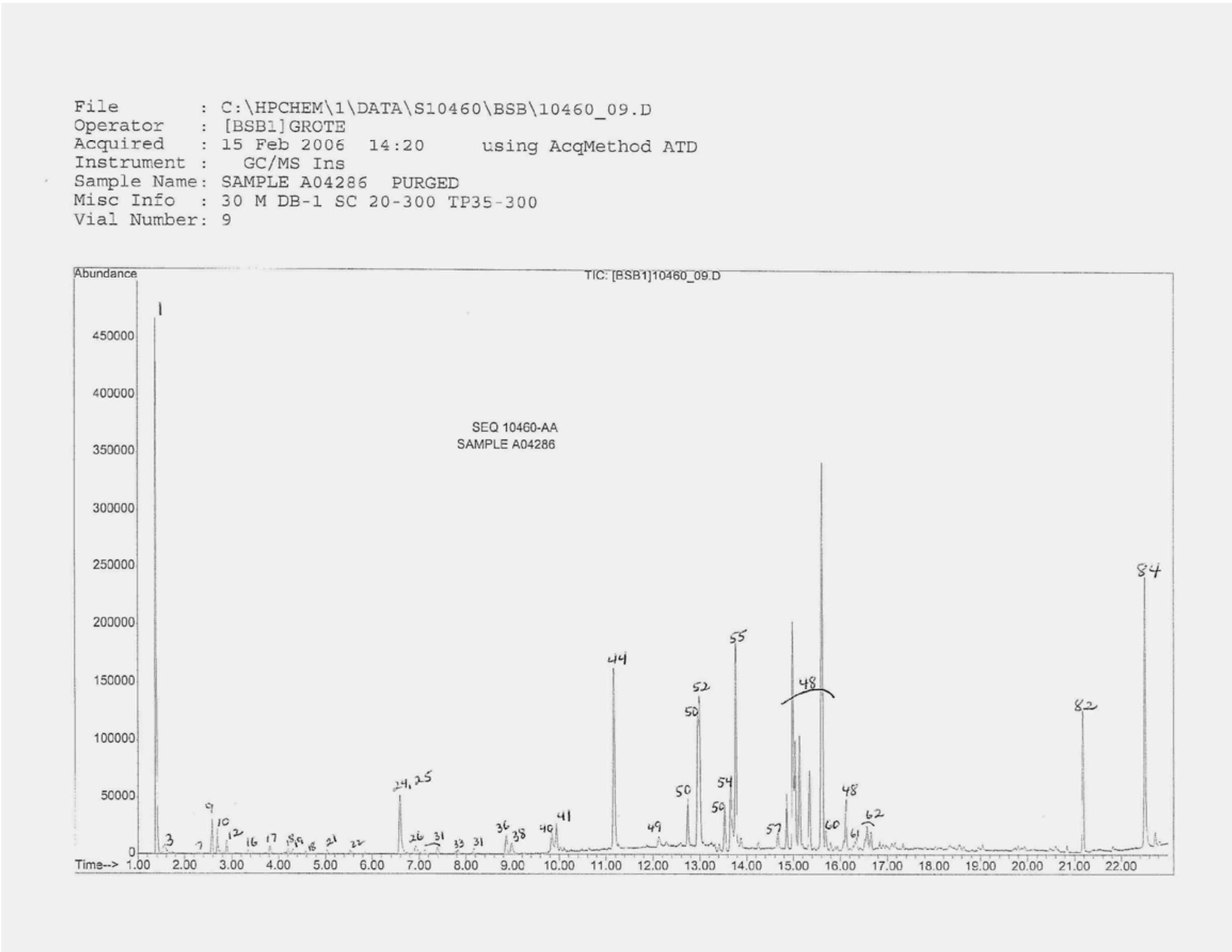


Figure 1H. TD-GC-MS chromatogram of a field blank (1 of 3 taken, all with similar profiles).

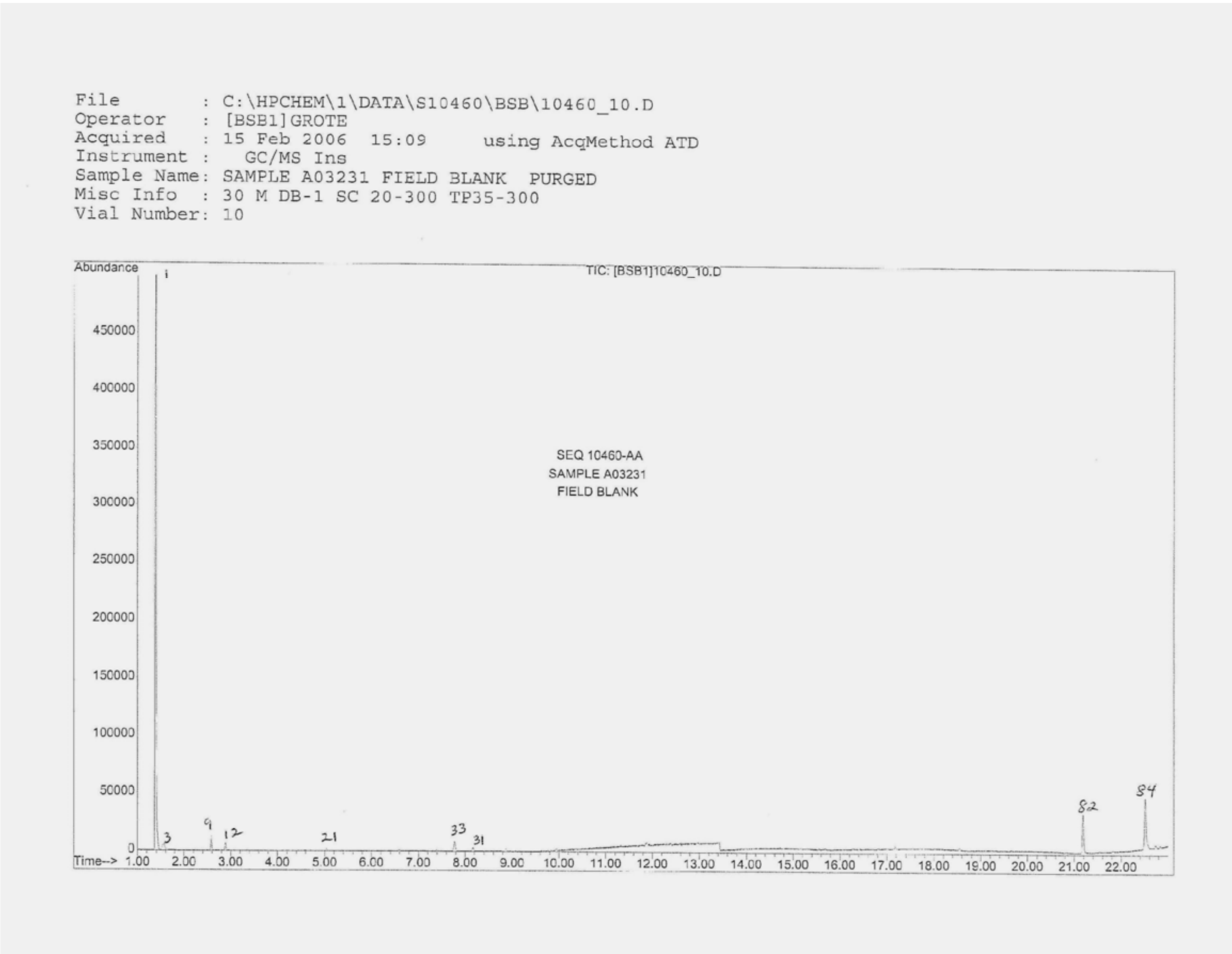


Figure. 2A. TD-GC-MS chromatogram of headspace analysis of adhesive 1.

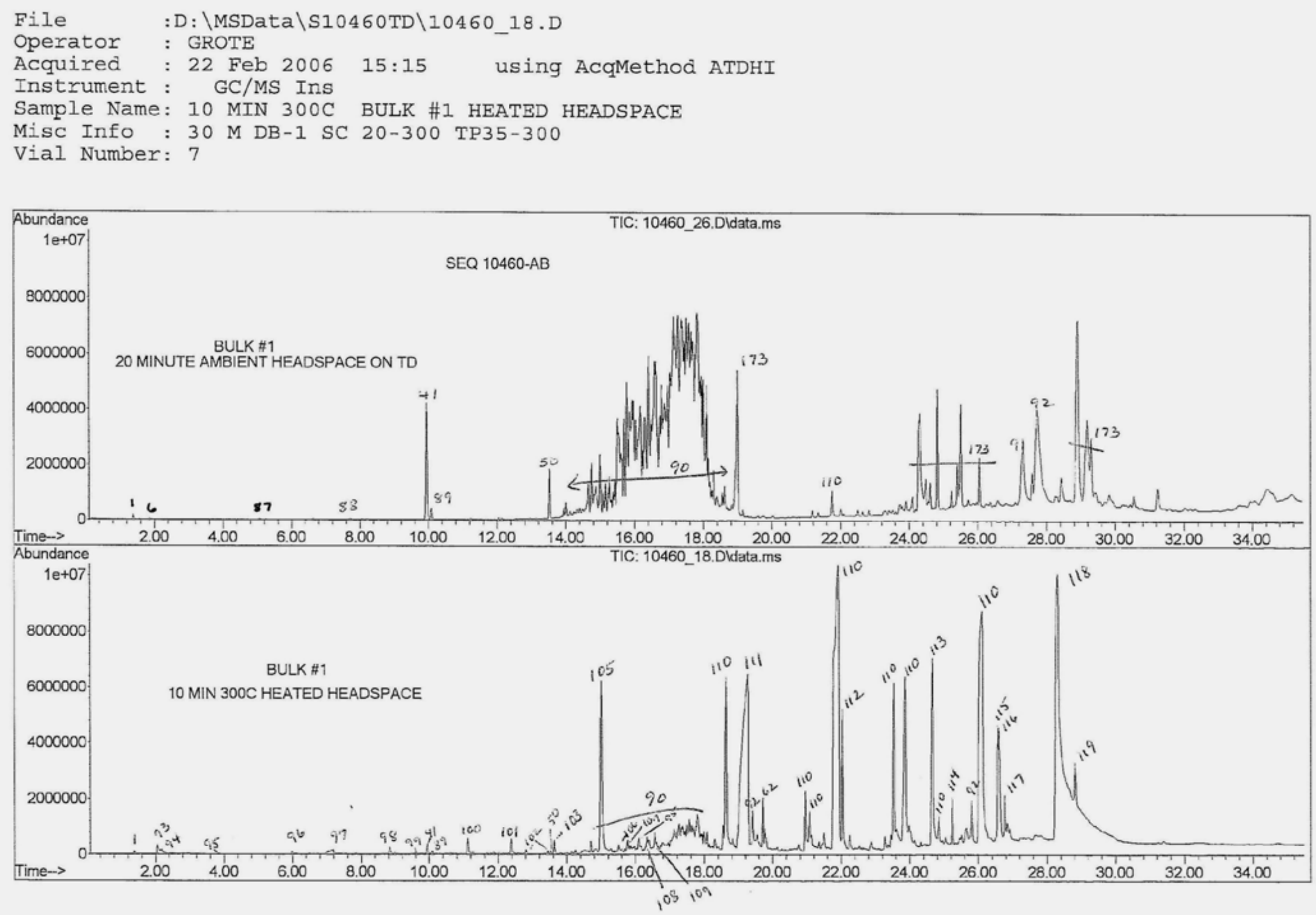


Figure 2B. TD-GC-MS chromatogram of headspace analysis of adhesive 2.

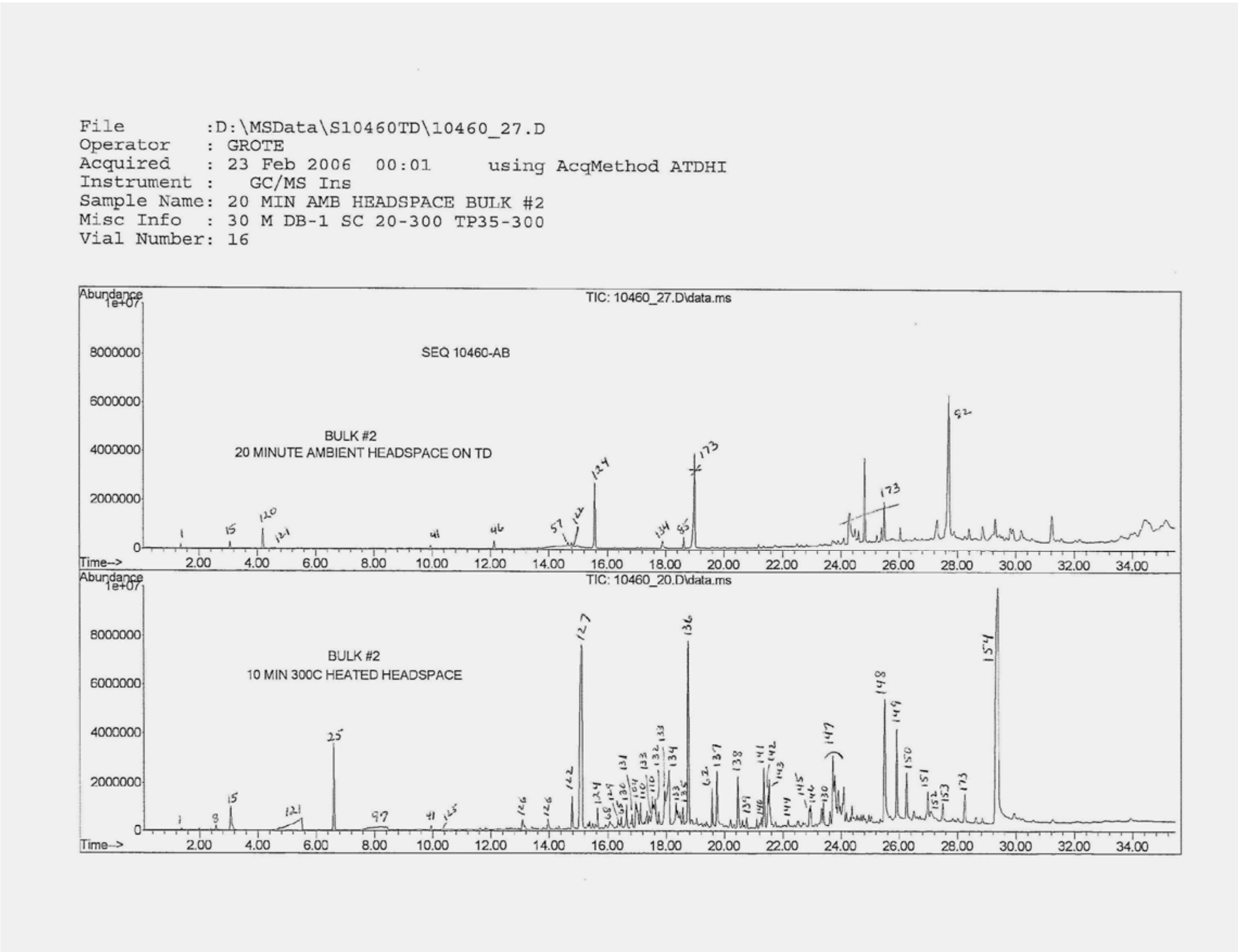


Figure 2C. TD-GC-MS chromatogram of headspace analysis of adhesive 3.

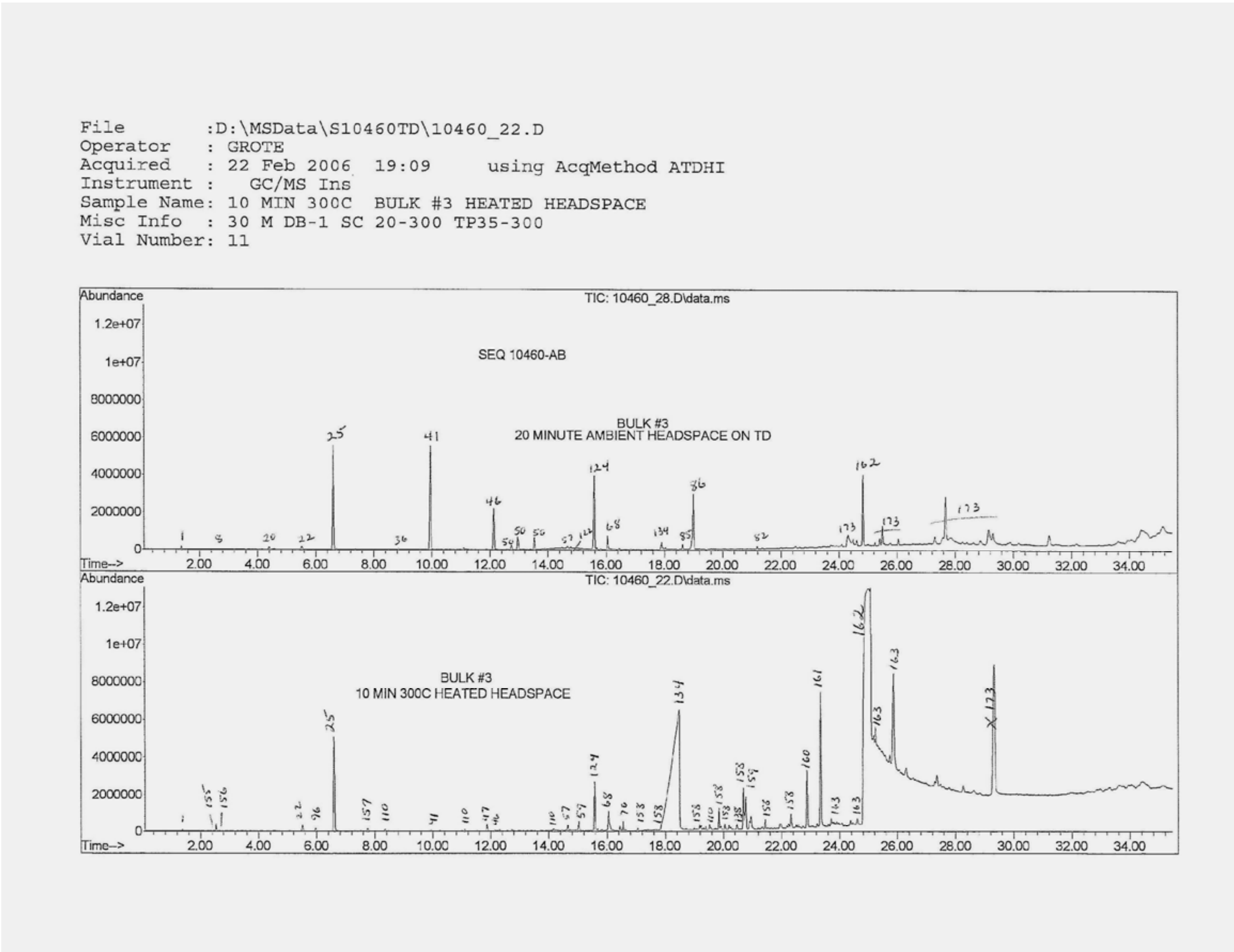


Figure 2D. TD-GC-MS chromatogram of headspace analysis of adhesive 4.

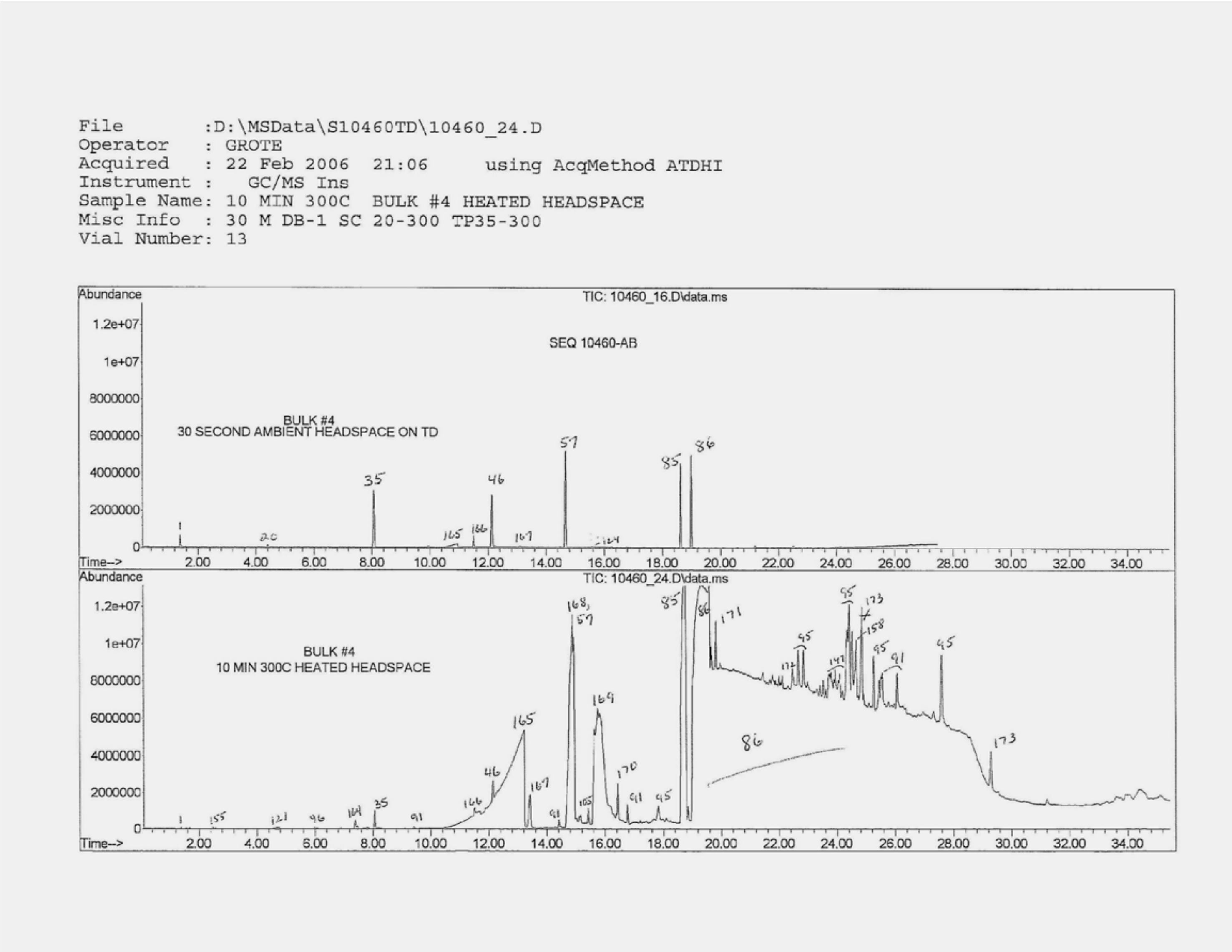


Figure 3. GRIMM real-time particle monitoring in the repair welding area.

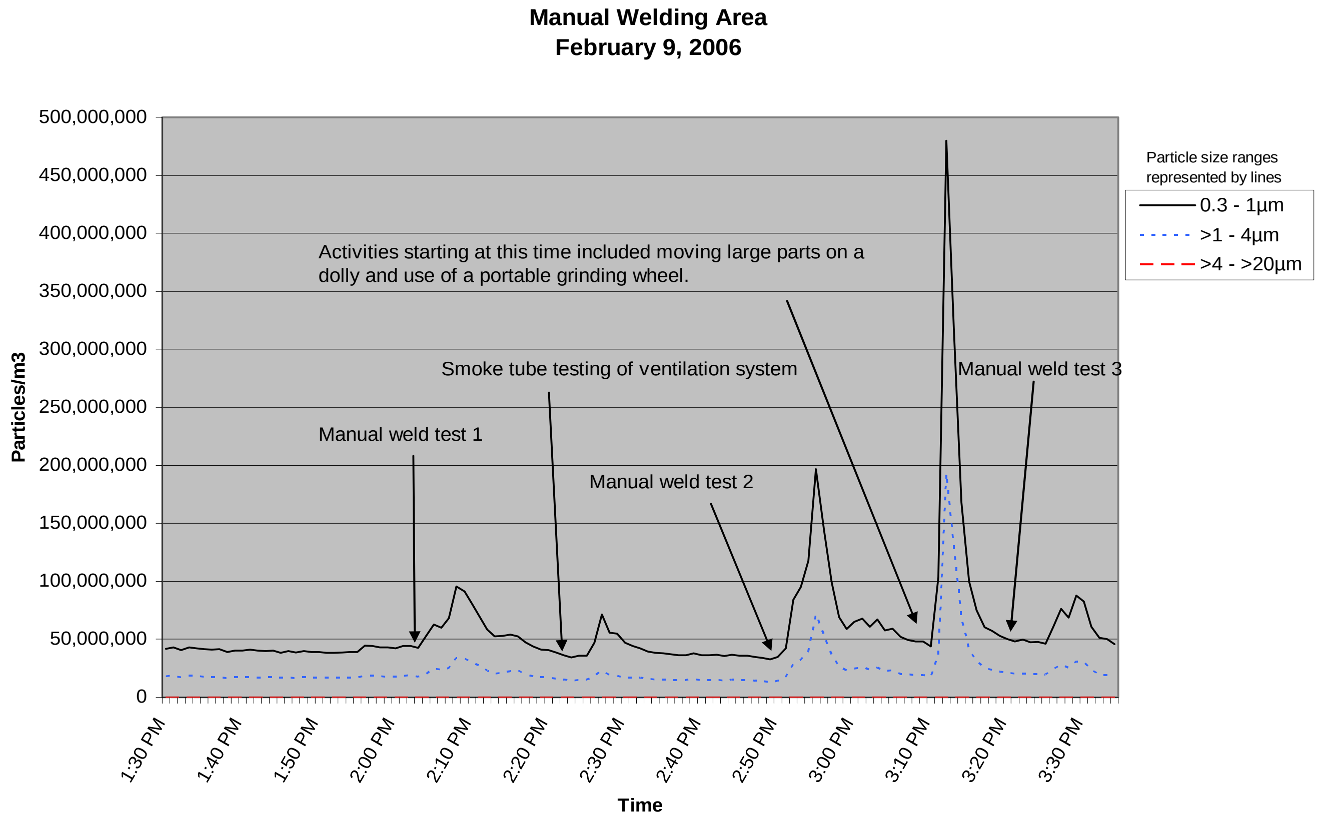


Figure 4. GRIMM real-time particle monitoring in the paint shop in T-2 area (column PBB13) and while walking through paint shop area.

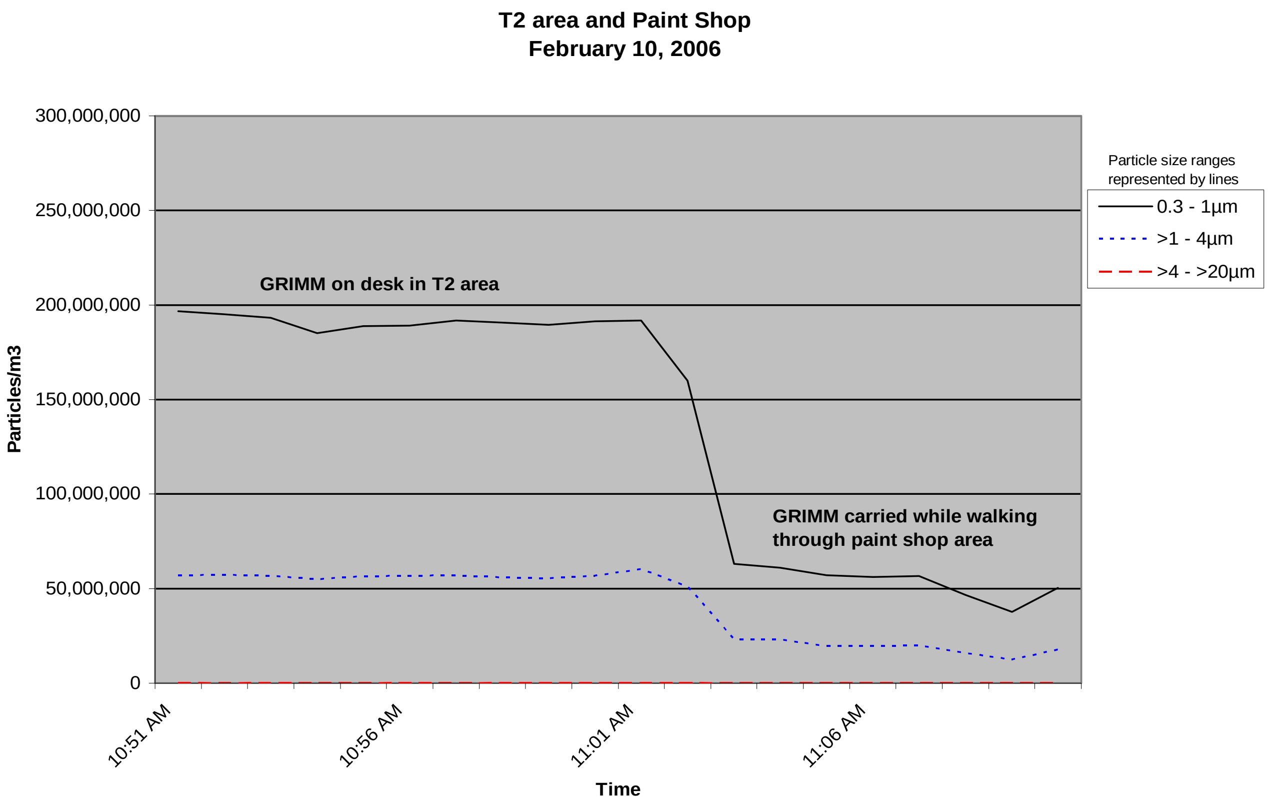
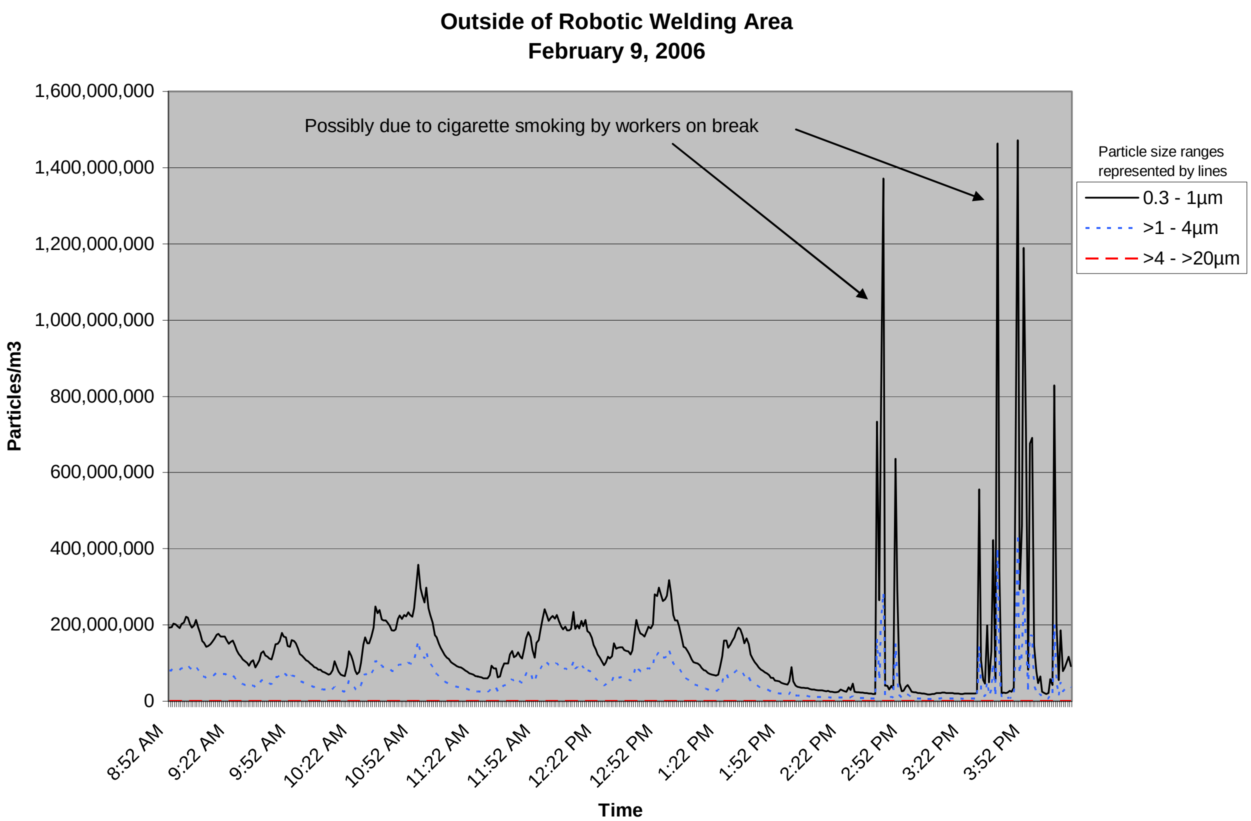


Figure 5. GRIMM real-time particle monitoring between columns EE-38 and EE-39 near robotic welding.



APPENDIX

DEPARTMENT OF HEALTH AND HUMAN SERVICES

U.S. Public Health Service

Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

Atlanta Field Office
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June 25, 2004
HETA 2004-0002

Mr. Robert Moon
Industrial Hygienist
DaimlerChrysler
CIMS 423-09-27
26311 Lawrence
Centerline, Michigan 48015

Dear Mr. Moon:

On October 2, 2003, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request to conduct a health hazard evaluation (HHE) at DaimlerChrysler's Jefferson North Assembly Plant in Detroit, Michigan. The request indicated that employees at this facility were concerned about poor air quality resulting from inadequate and improperly functioning ventilation, and work tasks including welding, rolls testing, painting, and battery charging. The request indicated that employees have experienced headaches, heart problems, stroke, and cancer. You were identified in the HHE request as the person responsible for employee safety and health at this plant. This letter describes the actions we took in response to the HHE request and our findings and conclusions.

NIOSH is the federal agency responsible for doing research in workplaces and making recommendations intended to prevent occupational illnesses and injuries. NIOSH is part of the Centers for Disease Control and Prevention. Researchers from the NIOSH health hazard evaluation program evaluate occupational concerns of workers, worker representatives, and employers. NIOSH is not a regulatory agency and we have no compliance or enforcement authority.

Background

Assemblers and skilled tradesmen assemble automobiles in the body shop where stampings are welded together and the body is constructed. Spot welding of automobile body components involves high density spot welding robotic cells via AC electric resistance welding through epoxy compounds and sealers. The high density welding cells make 400 welds in 45 seconds. The body shop is ventilated and a preventive maintenance program is in place for the ventilation system.

Actions Taken

From discussions with the HHE requestors we learned that the primary concern among employees was related to their potential exposures to emissions during welding. Since some requestors had health concerns, we reviewed available medical records.

During our telephone conversation on December 9, 2003, we advised you of the recent NIOSH HHE request and provided you with information regarding the HHE program. On December 12, 2003, we provided you with information regarding the request in writing. The specific concerns that were described in the request were:

1) Exposures to welding fumes and thermal combustion products resulting from inadequate ventilation while welding through the epoxy glue sealer on the seams of body panels and emissions resulting from application of die lubricant to the sheet metal prior to welding.
2) Exposures to lead fumes in the battery charging room.
3) Exposures to automobile exhaust in the rolls test area due to improperly functioning ventilation and a general lack of preventive maintenance and routine testing to verify function of ventilation.
4) Exposures to paint solvents in the paint booth.
5) Poor ventilation in the facility and inadequate maintenance on existing ventilation systems (e.g., infrequent change-out of filters and improper outdoor air intake settings), including the following:
    - Equipment failure and lack of process interlocks intended to prevent exposure to harmful contaminants when ventilation is inoperative.
    - Interlocks manipulated so that ventilation equipment continues to run while in an unsafe mode.
    - Reliance of dilution method for airborne contaminants instead of point source collection.

During our telephone conversation on March 18, 2004, you provided information to address these employee concerns, including the following:

1) Welding is robotic except for one area where epoxy glue is used; employees use supplied air respirators in this area. Employees have limited exposures to the welding fume.
2) Industrial hygiene monitoring for acid fumes was conducted in the battery area and exposures were below any relevant occupational exposure limits.
3) Industrial hygiene monitoring for carbon monoxide and hydrocarbons was conducted in the rolls area and exposures were below the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL). A noticeable odor associated with the engine exhaust is present; however, local exhaust ventilation is located behind the vehicle to capture the exhaust gases.
4) The paint booth is equipped with downdraft ventilation. Air sampling has been conducted at similarly designed paint booths at other DaimlerChrylser plants.
5) There is a physician on site available for consultation regarding work-related health complaints.

During our telephone conversation you also mentioned that you are pilot testing a new health and safety program at the plant to incorporate health and safety responsibilities at the floor supervisor level. Joint management and union walk-throughs are conducted weekly to identify safety hazards. If hazards are identified, a ticket is completed and the hazard is tracked until corrected. An annual monitoring strategy is not in place for the plant. The decision to conduct air monitoring is based on your professional judgment. It may also be conducted in response to an employee complaint or concern. If more serious hazards are identified, then Mr. Billy Thomson, Union Safety Representative, is contacted. Mr. Thomson works with management to address the hazard.

Welding Fumes

The NIOSH publication, ANIOSH Criteria for a Recommended Standard: Welding, Brazing, and Thermal Cutting,@ is enclosed.[1] This document describes potential health risks associated with welding activities and provides information on ways to eliminate these hazards from the workplace. Information on welding fumes and control strategies is summarized in Appendices A and B.

Medical Interviews and Record Review

Individual telephone interviews were conducted with four employees concerned about health problems possibly related to poor air quality at the DaimlerChrysler's Jefferson North Assembly Plant. Medical records made available from 2002 were reviewed. It is the perception of some of these employees that their current health problems, including chronic neurological and allergic conditions, are a result of exposure to poor air quality due to mold, dust, odors, and fumes, including welding fumes. The neurological and allergic symptoms reported by these employees are chronic and may be exacerbated by environmental factors such as dust, mold, odors, and fumes. No employee reported receiving an impairment or disability rating. There were no employee reports of diagnosed asthma, metal fume fever, pneumonitis, pulmonary edema, infection, skin disease, kidney disease, liver disease, heart attack, or cancer. Our interviews and review of the records revealed no indication that a worker has an illness related to work as an assembler or skilled tradesman. We were not able to determine whether some workplace factor(s) may have contributed to the exacerbation of chronic neurological and allergic symptoms.

Conclusions

Based on our review of likely exposures at DaimlerChrysler's Jefferson North Assembly Plant, our interviews with employees, and our review of the available medical records, there is no indication that occupational illness (for example, metal fume fever or occupational asthma) is occurring among assemblers or skilled tradesmen. We are not able to determine whether employees may have experienced exacerbation of chronic neurological and allergic symptoms from some workplace exposure. While limited air sampling has been conducted in several areas of the plant, a comprehensive air sampling program is not in place. A comprehensive plan should be established which prioritizes areas for air monitoring based on the toxicity of the contaminant and probability of a high exposure. Previous monitoring results should also be considered when determining priorities for exposure evaluations.

This letter is the final report regarding the HHE. For the purpose of informing employees, please make this letter available to all employees for a period of 30 calendar days. This can be accomplished by posting the letter in a location normally used for employee communication.

We hope you find this report helpful. We are also enclosing some general information on welding and brazing fumes and control of welding fumes. If you need additional information or would like to discuss any other issues specific to the DaimlerChrysler's Jefferson North Assembly Plant, please contact Ms. Lisa Delaney at (404) 498-2516 or Dr. Radke at (404) 498-2579.

Yours truly,

Marilyn S. Radke, MD, MPH, FACOEM
Medical Officer
Atlanta Field Office
Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations and Field Studies

Lisa J. Delaney, MS
Industrial Hygienist
Atlanta Field Office
Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations and Field Studies

CC: Confidential requestors

Enclosures: NIOSH Criteria for a Recommended Standard: Welding, Brazing, and Thermal Cutting
Appendix A: Welding and Brazing Fumes
Appendix B: Control of Welding Fumes

1. NIOSH [1988]. Criteria for a Recommended Standard Welding, Brazing, and Thermal Cutting. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 88-110.

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
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