CDC Workplace Safety and Health

NIOSH HEALTH HAZARD EVALUATION REPORT:

HETA #2001–0034–2843
USAirways Aircraft Support Center
Charlotte, North Carolina

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 Max Kiefer of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS), Atlanta Field Office. Field assistance was provided by Angela Weber. Analytical support was provided by the NIOSH Division of Applied Research and Technology. Desktop publishing was performed by Nichole Herbert and Pat Lovell. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Exposure to an Alkaline Parts Cleaner in the Tire and Wheel Shop

In February 2001, NIOSH conducted a health hazard evaluation (HHE) at the USAirways Aircraft Support Center in Charlotte, North Carolina. We measured levels of air contaminants in the wheel and brake shops, evaluated work practices, and inspected the ventilation system.

What NIOSH Did

- **We collected air and bulk samples for the Cee Bee 300LF parts cleaner.**
- **We talked to employees about their health concerns.**
- **We inspected the ventilation system.**
- **We observed chemical handling practices of people at work.**

What NIOSH Found

- **Airborne exposure to the Cee Bee 300LF is low.**
- **Eye and skin exposure could occur.**
- **Some workers were not wearing proper gloves or eye protection.**
- **The ventilation system was not working well.**

What USAirways Aircraft Support Center Managers Can Do

- **Improve the ventilation system.**
- **Make sure workers wear eye and skin protection when using the parts cleaner.**

What the USAirways Aircraft Support Center Employees Can Do

- **Wear the proper protective clothing when working with chemicals.**
- **Tell managers when and where there are health and safety problems.**

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National Institute for Occupational Safety and Health
NIOSH

Health Hazard Evaluation Report 2001-0034-2843
USAirways Aircraft Support Center
Charlotte, North Carolina
May 2001

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SUMMARY

On October 23, 2000, the National Institute for Occupational Safety and Health (NIOSH) received a management request for a health hazard evaluation (HHE) at the USAirways aircraft support center in Charlotte, North Carolina. The request asked NIOSH to determine if exposures resulting from a process change involving an industrial cleaner presented a health hazard to workers. Specific areas of concern included the aircraft wheel and brake maintenance departments where the primary industrial cleaner used in these areas had been replaced with a new product. No health complaints were reported in the HHE request, however subsequent information indicated that some employees had reportedly experienced health problems such as irritation and nose bleeds when the cleaner was first introduced.

On February 5, 2001, NIOSH researchers conducted a site visit at the USAirways facility. During the site visit, integrated personal air sampling was conducted to evaluate employee exposures to total particulate and sodium metasilicate, the primary active ingredient in the industrial cleaner, and two glycol ethers (dipropylene glycol butyl ether [DPGBE], and tripropylene glycol methyl ether [TPGME]) that were also a component of the cleaner. Samples were collected from workers in the wheel pre-wash, bearing wash, wheel tear down, brake tear down, and the brake cleaning sinks. Additionally, area air sampling was conducted using a technique to qualitatively identify a wide variety of volatile compounds. Bulk samples of the industrial cleaner were collected and the pH of each cleaning tank was determined. Work practices were reviewed, and the ventilation systems were inspected.

The results of the air monitoring indicated that exposures to total particulate and sodium metasilicate were low during the sampling period. Because all samples were either below the limit of detection (LOD), or between the LOD and the limit of quantification (LOQ), further analysis to quantify sodium metasilicate was not conducted. Both TPGME and DPGBE were detected in the air samples. Exposure criteria has not been established for sodium metasilicate, TPGME, or DPGBE. The qualitative air sampling identified a wide variety of compounds present in workplace air and indicated that air from the production areas is not migrating into the administrative offices. The pH of the cleaning tanks and washers containing the industrial cleaner ranged from 9 to 11, indicating the liquid was basic.

When the cleaner was initially used, a concentration higher than recommended by the manufacturer was inadvertently prepared. Additionally, some employees had not been informed about the new cleaner and were unaware of the hazards and necessary precautions. It is likely the problems that occurred when the material was first introduced were from the higher concentrations that were used and the lack of information employees had regarding this material.

Worker adherence to the use of proper gloves and eye protection when working with the new cleaner was not consistent. Because the cleaner is a water-based alkaline material, eye or skin damage could occur if appropriate precautions are not taken to prevent contact. The ventilation system supporting the wheel and

brake area was not providing sufficient make-up air, and some return air intakes were located near sources of contaminants.

Measured exposures to total particulate (and sodium metasilicate) were low during the NIOSH survey and it appears exposure to aerosols from the industrial cleaner are well controlled. Concerns noted by workers when the cleaner was initially used in the workplace are likely from the higher concentrations inadvertently used and the lack of effective worker communication. Employees were not consistently following good personal protective equipment practices when using the industrial cleaner. The industrial cleaner is alkaline and precautions are necessary to prevent skin and eye contact. The general ventilation system was not functioning effectively; there was inadequate makeup air. Recommendations to implement a protective equipment program, improve hazard communications, and modify the ventilation system are in the Recommendations section of this report.

Keywords: SIC 3721 (Aircraft and Parts). Sodium Metasilicate, Glycol Ethers, Aircraft Wheel and Brake Maintenance, Ventilation, Caustic Parts Cleaner.

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INTRODUCTION

In response to a management request for a health hazard evaluation (HHE), the national Institute for Occupational Safety and Health (NIOSH) investigators conducted a site visit on February 5-6, 2001, at the USAirways Aircraft Support Center in Charlotte, North Carolina. NIOSH was asked to determine if a process change involving a new industrial cleaner (Cee Bee Super Bee 300lf) presented a health hazard to workers.

During the site visit, NIOSH researchers conducted environmental monitoring to evaluate worker exposure to the components of the industrial cleaner. Bulk samples were obtained, and qualitative air monitoring was conducted to identify other volatile compounds that may be present. Work practices were reviewed, and the ventilation system supporting the areas evaluated was inspected. Informal discussions were held with USAirways' employees regarding their work activities and safety and health concerns.

BACKGROUND

The Charlotte USAirways plant was established at this location in 1998 to service the USAirways fleet. Most of the employees were relocated to the facility from the Greensboro, North Carolina, and Winston-Salem plants. The facility is comprised of several shops: wheel and brake, power plant, composite, painting, lavatory, machine, welding, and sheet metal. The facility contains a shipping and receiving department, non-destructive testing shop, test and clean area, break room, and administrative offices. Aircraft parts are serviced and repaired and then tested to meet Federal Aviation Administration (FAA) standards. Approximately 220 technicians and office support staff are currently employed at this facility. The plant operates around the clock with three shifts (7:00 a.m.-3:00 p.m., 3:00 p.m.-11:00 p.m., 11:00 p.m.-7:00 a.m.) and is closed on Saturday and Sunday. Day-shift employees receive two 12-minute breaks at 9:00 a.m. and 1:00 p.m., and a 30-minute lunch break at 11:00 a.m. The International Association of Machinists and Aerospace Workers (IAMAW) union, District Lodge 141-M, represents mechanical employees.

When the plant was newly constructed and began operations in January 1999, the exhaust ventilation system from the wheel and brake cleaning system was not ventilated properly and workers reported experiencing problems such as nose bleeds, difficulty breathing, chest pain, and burning eyes. Management took action (adjustments to ventilation system such as raising stacks, adding a mist eliminator, and substituting a different cleaning agent). This appeared to resolve the situation, and symptoms were alleviated for most employees. Some employees, however, continued to experience health problems and utilized respiratory protection (powered air purifying respirators) while working in the facility. In January 2000, NIOSH conducted an HHE at the USAirways facility and evaluated exposure to respirable and inhalable particulates and metals in the composite and brake shops.[1]

Following the initial NIOSH HHE, in the fall of 2000, USAirways replaced the main cleaning detergent used for brakes and tires with a material that performed better and was economically more desirable. The primary active ingredient in this material is sodium metasilicate, a common industrial metal cleaner. When the product was first introduced, however, employee health complaints regarding the material occurred, and its use was discontinued until it could be further evaluated. After a review and determination that an error in mixing had occurred and a higher than recommended concentration was used, the cleaner was re-introduced and NIOSH was requested to evaluate exposures during the use of this material.

METHODS

Upon receipt of the HHE request, additional information regarding the reported health problems and suspect environmental contaminants was obtained. Information was provided by USAirways management and union representatives regarding the industrial cleaner and a previous industrial hygiene survey to evaluate exposure during the use of the cleaner. Information such as chemical composition, and company evaluation criteria for the cleaner was obtained from the manufacturer.

During the first shift (7:00 a.m.-3:00 p.m.) on February 5, 2001, personal breathing zone (PBZ) air samples for sodium metasilicate, and total particulate were collected from five employees as follows: two wheel pre-wash workers, and one worker each from wheel bearing, inspection, brake cleaning, brake tear-down, wheel tear down, and bearing washer areas. Additionally, PBZ samples were collected for selected glycol ethers, a constituent in the industrial cleaner, from five of the eight employees (two wheel pre-wash workers and one from the wheel tear down, brake teardown, and brake cleaning worker). Area air samples were collected to qualitatively identify major volatile compounds that may be present. These samples were collected in the brake pre-wash, tire pre-wash, and the wheel bearing room. A background, or control, area air sample was collected in the USAirways conference room. With the exception of the qualitative air sampling, additional air samples were collected on February 6, 2001, following the same monitoring strategy. Processes selected for monitoring were based on an assessment of the chemicals in use, employee work practices, and controls utilized. Activities of concern noted by the HHE requestors were also targeted for sampling.

Additional activities included observing work practices, evaluating controls and the use of PPE, and reviewing the ventilation system supporting the wheel and brake areas.

Analytical Methods

Total Weight and Sodium Metasilicate

Full-shift PBZ exposures to total particulate and sodium metasilicate were monitored using SKC® Universal Samplers (PCXR4) sampling pumps. Flow rates of approximately 2 liters per minute (l/m) were used to obtain the samples. The sampling pumps were pre- and post-calibrated with a primary standard (BIOS®) to verify flow rate. The total volume of air sampled is the product of flow rate and time sampled. The filters were placed as close as possible to the workers' breathing zone and connected via Tygon® tubing to the sampling pump. After collection, the samples were sent to the NIOSH laboratory for analysis.

The samples were collected on tared 37 millimeter (mm), 5 micrometer (µm) pore size, poly-vinyl chloride (PVC) filters in the closed-face mode, and analyzed gravimetrically to determine the total particulate concentration according to NIOSH method 0500.[2] Because all of the total weights were either below the limit of detection (LOD), or between the LOD and the limit of quantification (LOQ), no further analyses of the filters for sodium metasilicate was conducted.

Qualitative Air Sampling

Qualitative air monitoring was conducted to characterize volatile compounds that may be present in the wheel and tire departments. These area air samples were obtained utilizing reusable multibed thermal desorption (TD) tubes as the collection media. These stainless steel tubes contain three beds of sorbent materials - a front layer of Carbopack Y (90 milligrams [mg]), a middle layer of Carbopack B (115 mg), and a back section of Carboxen 1003 (150 mg). Prior to sampling the tubes were conditioned by heating at 375°C for two hours. This technique is designed to trap a wide range of organic compounds for subsequent qualitative analysis via thermal desorption and gas chromatography/mass spectrometry (GC/MS).

Low-flow air sampling pumps (SKC Pocket Pump™) were used to collect the air samples. The SKC pumps are constant-flow sampling devices and were pre- and post-calibrated using a primary standard (BIOS® Dry Cell) to verify the flow rate. Flow rates of 50 cubic centimeter per minute (cc/min) were used for the area monitoring and the sample time was approximately two hours.

After collection, the samples were shipped via overnight delivery to the NIOSH laboratory for analysis. At the NIOSH laboratory, each sample was analyzed by directly inserting the tube into a thermal desorber unit (Perkin Elmer ATD 400 TD system) with no other sample preparation. Samples were dry purged with helium for 30 minutes at 100 cc/min to remove water. A desorption time of 10 minutes at 300°C was used and the thermal desorber was directly connected to a HP6890A GC and HP5973 MS detector. Reconstructed total ion chromatograms were obtained for each sample, and all were scaled the same for comparison. Each peak in the chromatogram was identified.

Selected Glycol Ethers

Full-shift PBZ air samples for dipropylene glycol butyl ether (DPGBE) and tripropylene glycol butyl ether (TPGME) were collected following the protocol described in NIOSH analytical method 5523.[2] The monitoring was conducted with calibrated Gilian GilAir® air sampling pumps at a flow rate of approximately 1 l/m. The samples were collected on OSHA Versatile Samplers (OVS-7) containing XAD-7 and a glass fiber filter. After collection, the samples were refrigerated and then shipped on ice via overnight delivery to the NIOSH laboratory for analysis. TPGME and other glycol ethers were suspected to be present in the industrial cleaner based on information provided by USAirways. Bulk samples (collection and analysis is described below) of both the neat and diluted cleaner were obtained and analyzed to determine the specific glycol ethers for analysis of the air samples.

At the NIOSH laboratory, the sample sections were extracted separately with methanol and then analyzed via GC/MS for the respective glycol ethers. Because the sampling and analytical techniques used for these analyses have not been validated, all results are considered to be estimates.

Bulk Samples

Two bulk samples of the cleaning solution were obtained for analysis. One sample consisted of undiluted industrial cleaner obtained from the original container, the other sample was a 10:1 dilution of the cleaning material obtained from one of the cleaning tanks. The samples were collected in glass vials and shipped separately to the NIOSH laboratory. The samples were analyzed by directly injecting 1 microliter (µl) of each solution into the GC/MS system to separate and identify major components.

The pH of each cleaning tank was measured with pHydrion Insta-Check paper (Micro Essential Laboratory, Brooklyn, New York). The wet pH paper was compared to a color chart to determine the pH of the tested material. This type of test (litmus paper) only provides a rough indication of alkalinity or acidity.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),[3] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[4] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[5] 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 91–596, sec. 5.(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

A 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.

Specific evaluation criteria for the compounds monitored during this HHE are described below:

Total Particulate

Regulatory standards exist for many specific dusts (e.g., silica) and for a more general category termed "particulates not otherwise classified" (PNOC). Dusts considered to be physical irritants for which no substance-specific toxicological data are available are generally placed in this category by OSHA for enforcement purposes.[5] The specific composition of the particulate monitored at the USAirways facility was not characterized, and likely originated from a variety of sources in the work area. As such, this type of sample is typically classified as PNOC.

The OSHA limit for respirable PNOC, sometimes referred to as "inert" or "nuisance" dust, is 15 milligrams per cubic meter (mg/m^3). Note that the term inert is not appropriate, as all dusts will elicit some cellular response in the lung if inhaled in sufficient amounts. The respirable fraction is considered to be that portion of inhaled dust which penetrates to the non-ciliated portions of the lung.[6] In general, particles greater than 7-10 micrometers in diameter (µmd) are all removed in the nasal passages and have little probability of penetrating to the lung. Particles smaller than this can reach the air-exchange regions (alveoli, respiratory bronchioles) of the lung, and are considered more hazardous. The monitoring conducted at USAirways measured both respirable and larger particles, and is often referred to as a "total dust" sample. The ACGIH has established a TLV of 10 mg/m^3 as total dust for PNOC as a full-shift TWA.[4] NIOSH has not established an REL for PNOC.

Sodium Metasilicate

Formulations containing sodium metasilicate, and a closely related compound, sodium silicate, are commonly used as industrial soaps and detergents for metals and other components. Sodium metasilicate is also used extensively as an anti-corrosion agent in boiler water.[7] Pure sodium metasilicate is produced as a solid in beads or crystals, but is generally used in solution as a cleaner. Sodium metasilicate is a water soluble alkaline material, and the pH of a 1 percent solution is about 13.[7] Detergents that contain sodium metasilicate and other alkaline materials can be strongly irritating to the eyes, skin, and respiratory tract; dermatitis has been reported after extensive immersion of unprotected hands in a detergent solution containing sodium metasilicate.[7,8] Exposures to sodium metasilicate dust may cause irritation of the respiratory tract and mucous membranes. Exposure to soluble silicate materials are not considered to be related to the development of silicosis (associated with crystalline silica) because their solubility provides for the ready elimination of the material.[7]

Sodium metasilicate is present in a concentration of 1-3% solution in the industrial cleaner used at USAirways.[9] Exposure criteria for sodium metasilicate has not been established by NIOSH, OSHA, or the ACGIH. According to the material safety data sheet (MSDS), the manufacturer has established an exposure limit of 2 mg/m^3, possibly by analogy to sodium hydroxide.[9] A MSDS from another manufacturer lists an ACGIH TLV of 10 mg/m^3 (for particulates not otherwise specified) as the criteria to apply to sodium metasilicate.[10]

TPGME/DPGBE

The ethers of mono-, di-, and tri-propylene glycol, such as TPGME and DPGBE, are used as solvents in a variety of applications including surface coatings, inks, lacquers, paints, oils, greases, and hydraulic brake fluids.[11] Exposure to these compounds is generally via dermal contact and inhalation. Existing toxicological data for the propylene glycol based ethers indicates that they have a low order of toxicity. Many of the toxic properties of ethylene glycol-based ethers are not exhibited by the propylene glycol-based ethers.[11] TPGME (also known as Dowanol TPM®), is a mixture of isomers that forms a colorless liquid with a low vapor pressure. TPGME is not considered to be very irritating to the skin and may cause eye irritation. Excessive exposure may result in anesthetic or narcotic effects.[11,12] Excessive exposure to DPGBE would be considered to have similar effects. Eye irritation in animal studies has been demonstrated, and there is no evidence of skin sensitization.[11] Occupational exposure criteria has not been established for TPGME or DPGBE.

RESULTS

Workplace Observations

The recently introduced parts cleaner is used in several areas in both the wheel and brake maintenance departments. Parts are soaked and manually scrubbed in heated tanks located in both areas. There are automated pre-wash systems located in both areas that cycle the brake or tire through a series of washes with the industrial cleaner and a water rinse. The wash tanks are heated to a temperature of approximately 110 °F and the automated brake wash and tire pre-wash reportedly use higher temperatures of up to 170 °F. The cleaner is not directly used in inspection, wheel tear down, or wheel bearing.

Most of the worker concerns were associated with the potential for inhalation exposure and problems that occurred when the replacement cleaner was first introduced in November 2000. No odor-related issues or skin problems were reported to the NIOSH investigators. Some workers reported that they were not informed that a different industrial cleaner was being implemented, and had not received any information regarding safe use and handling of the new cleaner.

Workers in the wheel pre-wash department wore hearing protection and two workers in this area wore hood-style powered air-purifying respirators. Respirators are not required by USAirways and the use of respirators is based on personal choice. Disposable latex gloves were worn by some of the workers, and disposable latex gloves were available in most work areas. Three types of chemical-resistant gloves were also available in the wheel and brake departments (neoprene, natural rubber latex, and a nitrile glove). Policies regarding which glove should be used for a particular task or chemical were not available.

Although the industrial cleaner is not used in the wheel tear down department; some tires are reportedly delivered to this department with industrial cleaner residue still present in the tire well. There was also worker concern that emissions from the cleaner could enter into the bearing room through the conveyor passthrough for wheel hubs entering the bearing room from the bearing washer area. The direction of airflow at this transition between the two rooms was evaluated using an Alnor Jr,® velometer. The velometer was positioned in the transition and the needle deflection showed that the bearing room was positive with respect to the bearing wash room, indicating that emissions from the bearing wash room were most likely not entering the bearing room through this route.

Food and beverage consumption was observed in some work areas where chemicals were in use. Some of the wash tanks were not properly labeled with the name of the contents and appropriate hazard warnings; labels from a previous material (Mirachem) that was no longer in use were present on one tank. Eye protection was not routinely worn by all workers at the wash tanks. Eyewash and emergency safety showers were present in the work areas.

All tanks were replenished with the industrial cleaner on January 29-30, 2001, at a 10:1 dilution with water. At some tanks, the cleaner is hand pumped into the tanks and water is added to achieve the proper dilution. On other tanks a proportioning valve is used to obtain the proper dilution. According to USAirways representatives, the tanks are changed approximately every 6 weeks depending on the pH change (drops to neutral). During periods of higher production (summer), they may be changed as often as every 3 weeks. It was not clear whether a de-foaming agent was used with the new cleaner. The pH of each tank was evaluated and found to be as follows:

pH Evaluation - Industrial Cleaner USAirways	
Tank Location	**pH**
Tire Pre-Wash Tank	10.5
Shaker at Tire Pre-Wash	11.0
Tire Pre-Wash Machine	9.0
Brake Clean Tank (Adjacent Safety Shower)	11.0
Brake Clean Tank (Middle)	10.0
Brake Clean Tank (Near Grinding Area)	10.0
Brake Clean Washer	9.0
Rust Remover (Turco 4181)	13

pH is a value on a scale of 1 to 14 that represents the acidity or alkalinity of a solution. Pure water is the standard and represents neutral, or a pH of 7. Strong acids give solutions with a pH of 1 to 3, strong bases give solutions with a pH of 12-13.[13] A pH of 8 is considered a weak base. Because the pH scale is logarithmic, the intervals between values are exponential and represent greater differences in concentration than the values themselves seem to indicate. As shown in the above table, the solutions were all basic, or alkaline. The Rust Remover tank (containing a different material [sodium hydroxide] than the industrial cleaner) was highly alkaline.

Air Sampling

The temperature and percent relative humidity (% RH) throughout the work areas evaluated during the survey were from 66-72 °F and 23-33% RH. Management and employee representatives indicated that production activity was less than normal during the sampling on February 5, 2001. Activity on February 6, 2001, was considered to be normal.

Total Particulate

The results of the air sampling for total particulate are shown in Table 1. As shown in the table, all measured concentrations were either below the LOD, or between the LOD and LOQ. This indicates that exposure to particulate aerosols were low during the monitoring period. Because the gravimetric results were low, no further analysis to quantify sodium metasilicate was conducted.

TPGME/DPGBE

The results of the air samples collected for TPGME and DPGBE are depicted in Table 2. As shown in the table, low concentrations of both glycol ethers were detected in all samples. The bulk samples collected during the NIOSH evaluation identified both TPGME and DPGBE, and the source of these glycol ethers is likely the industrial cleaner. However, the MSDS for this product does not indicate that these materials are an ingredient and TPGME was first identified by subsequent evaluation by USAirways. It may be that the concentration of these glycol ethers in the cleaner is less than one percent, which is below the OSHA requirement for reporting non-carcinogenic chemicals on a MSDS. As mentioned, because the sampling and analytical method has not been fully validated, these results are considered to be estimates only.

The backup sections of the sample media were analyzed separately and did not contain any detectable amount of either glycol ether. This indicates that sample loss due to breakthrough, which is caused by saturation or overloading of the sample media, did not occur. A sample collected on February 6, 2001, from the wheel pre-wash department had a much different chromatogram (chemical fingerprint) than the other samples collected for glycol ethers. Another glycol ether (butyl cellosolve) was found on both the front and backup sections of this sample, plus ethanolamine (a component of the water soluble metal working fluid used in an adjacent area) and a series of aliphatic hydrocarbons. This sample also contained the greatest concentrations of DPGBE and TPGME in the sample set. It was observed during the monitoring period that the employee wearing this sample worked extensively at the cleaning tank. Most of the other samplers contained toluene, limonene, xylene, and aliphatic hydrocarbons as the major components on the OVS tube.

Qualitative Air Sampling

Three thermal desorption tubes for qualitative volatile organic compound (VOC) analysis were collected in the brake tear down, tire pre-wash, and wheel bearing room. For comparison purposes, a control sample was collected in the main conference room of the administrative area. Copies of the reconstructed total ion chromatograms and a table identifying each numbered peak are shown in Appendix A. The chromatograms are scaled the same for comparison. Major compounds identified on the TD tubes included acetone, isopropanol, methyl ethyl ketone, bromopropane, C_7 alkanes, toluene, limonene, butyl acetate, ethyl acetate, hexane, methyl isobutyl ketone, xylene, DPGBE, and TPGME. Probable sources for many of these compounds are the various solvents, cleaning fluids, lubricants, adhesives, and paints used in these areas. A smaller number of compounds at relatively lower concentrations were detected in the sample collected from the conference room.

Tributyl phosphate was identified in the air sample collected from the brake pre-wash area. Tributyl phosphate is a component of Skydrol hydraulic fluid, which is handled in this area.[14] Bromopropane was identified in all three samples collected from the maintenance areas; the source of this chemical was not determined. Both 1-bromopropane and 2-bromopropane are solvents that have recently been introduced as alternatives to ozone-layer depleting chemicals.[15] The specific structure of the bromopropane found in the air samples was not determined. Exposure to 2-bromopropane has been linked to both male and female reproductive and blood effects.[16,17] Exposure limits have not been established for bromopropane.

Major components detected in bulk sample #1 (10:1 dilution of industrial cleaner from tank in the brake clean area) were DPGBE and TPGME. Major components detected in bulk sample #2 (industrial cleaner - full strength from drum) were TPGME, butyl cellosolve, and limonene.

Ventilation

Dilution ventilation, in conjunction with local exhaust ventilation, is relied on to remove contaminants from the wheel and brake area. A review of the layout of air handler units (AHUs) on the roof found that the outside air intakes for the AHUs had been rerouted away from the exhaust stacks. Inspection of the AHUs supporting the wheel and brake areas indicated that there was no consistent source of outside makeup air provided to these areas. Some of the outside air (OA) dampers were closed (there were no minimum damper settings), and there was no OA being provided during the NIOSH site visit. The heating, ventilating, and air conditioning (HVAC) system is not single pass, and there is recirculation of return air from the wheel and brake areas. In the in-line tire washer room, there are OA louvers located along a perimeter wall. According to USAirways representatives, these louvers are controlled by temperature sensors. Considerable liquid was dripping from the exhaust vent on the "mart" machine in the wheel pre-wash area. The ductwork had a long horizontal run that has caused pooling of liquid in one end of the duct; liquid was observed dripping from this duct. Operational parameters and design criteria for the HVAC system were not available for review.

Ventilation drawings provided for review showed heat vents (HV) and exhaust fans (EF). The brake area units, HV-1 and HV-2 are located at ground level. HV-1 serves the grinding room and HV-2 serves the brake cleaning room. These units were not inspected, but may have the same OA supply issues as found in the wheel department.

AHU-16 serves the wheel tear down area and this unit was not operational when inspected (no OA being provided). AHU-18 serves the wheel inspection area and the OA dampers were closed on this unit.

HV-3 serves the wheel washer area and was not operational when inspected. HV-5 serves the wheel bearing room and the wheel bearing washer. The return air intake is located directly above two dip tanks containing Turco 5555B, and the bearing washer machine. USAirways' representatives indicated that the return grill had been sealed at one time, however, the plant floor was visible through the return grill while inspecting the rooftop unit. The OA dampers were shut on this unit. HV-6 serves the in-line washer room and the dampers were shut. HV-4 serves the wheel pre-wash room. The OA dampers were open on this unit, but they had been disconnected from the economizer control. The return air grill is located above the wheel washer.

There is local exhaust ventilation on the automated cleaning systems in both the tire and brake areas. The open surface tanks containing the new industrial cleaner were not ventilated.

DISCUSSION

This evaluation focused on assessing worker exposure to a sodium metasilicate-based cleaning agent in an aircraft repair and maintenance facility. PBZ air sampling found that all measured exposures to total particulate and sodium metasilicate in the brake and wheel department were low during the sampling survey. When the material was initially introduced, a number of employee health concerns were raised to management and the union safety representative. An initial industrial hygiene assessment was conducted by a consultant; however, concerns regarding the use of this cleaner remained. The new cleaner, a water-based alkaline solution with low volatility, was similar to the previous cleaner used. Employee concerns and health complaints regarding this cleaner likely originated from the initial use of the product when a more concentrated solution was inadvertently used. Additionally, it does not appear that all workers were adequately informed about the potential health effects and the necessary precautions when the cleaner was introduced. As such, there was uncertainty about the degree of risk associated with this material.

Glycol ether compounds were identified in air samples collected from areas where the industrial cleaner is used. Analysis of bulk samples indicated that the industrial cleaner is the source of these compounds. Although these glycol ethers are present in the cleaner in low concentrations, it is likely that during the heating and agitation of the material, and use in open, unventilated tanks, the glycol ethers volatilize into workplace air. Because analytical methodology for these glycol ethers has not been fully validated, the concentrations measured are considered to be estimates. Exposure criteria has not been established for these compounds.

The qualitative air monitoring found a number of volatile compounds in samples collected in the brake and wheel shops; concentrations were not determined so comparison with applicable guidelines is not possible. However, because this analytical technique is sensitive and broad spectrum, it is not unusual to find a wide variety of volatile compounds in air samples collected in industrial environments. Sources for the compounds identified include oils, greases, cleaning solvents, paints, and adhesives. As noted in the results section, tributyl phosphate, a component of Skydrol hydraulic fluid, and bromopropane, from an unidentified source, were two compounds identified in the qualitative air samples. The qualitative air sampling indicates that air from the production and maintenance areas is not migrating into the office areas.

Worker adherence to the proper use of PPE such as gloves and eye protection was not consistent. Some workers were observed working at cleaning tanks with no eye protection, and several types of gloves were available for use. The industrial cleaner is caustic and there is considerable manual scrubbing of parts at the cleaning tanks. As such, there are opportunities for exposure to splashes from these activities. Precautions such as eye protection, aprons, and chemical protective gloves are necessary when working with this material to prevent skin and eye contact.

Considerable worker concern was noted regarding the bearing room, including exposure to chemicals from the cleaning areas, and a lack of ventilation. Only one employee works in this room, and the industrial cleaner is not used; grease is packed into bearings in this room. Based on the results of an airflow assessment, it does not appear that emissions from the bearing washer are likely to enter into this room.

Local exhaust ventilation (LEV) is generally the preferred method of controlling exposure to contaminants. A properly functioning general ventilation system also plays an important role by ensuring that sufficient conditioned outside air is provided, proper pressure differentials are maintained in the work area, a source of makeup air is provided, and by removing/diluting contaminants not captured by the LEV systems. Both general and LEV systems are present in the brake and wheel areas. However, the general ventilation system in these areas was not optimal. Sufficient makeup air (OA) was not being provided, and some intake grilles for return air (which is recirculated) were adjacent areas where contaminants could be released.

CONCLUSIONS

Measured exposures to total particulate (and sodium metasilicate) were low during the NIOSH survey. Although there are no exposure guidelines for sodium metasilicate, based on the total particulate results, exposure to aerosols from the industrial cleaner are well controlled. Two glycol ether compounds, present in the industrial cleaner, were measured in air samples collected in the workroom. It is likely that concerns noted by workers when the material was initially used in the workplace may have been from the higher concentrations inadvertently used and the lack of effective communication regarding the cleaner.

The results of the qualitative air sampling indicated that the administrative area is adequately isolated from the production areas. As expected, a large number of compounds were identified in the qualitative samples. Two compounds, bromopropane and tributyl phosphate, were found and additional investigation may be warranted to confirm and quantify exposures to these materials. Employees were not consistently following good PPE practices when using the industrial cleaner. The industrial cleaner is alkaline and precautions are necessary to prevent skin and eye contact. Exposure control in the areas evaluated relied primarily on dilution ventilation with some local exhaust ventilation. The general ventilation system was not functioning effectively. There was inadequate make-up air provided, and in some areas return air intakes were positioned near sources of emissions.

RECOMMENDATIONS

1. Appropriate protective gloves and eyewear designed for splash protection (goggles and faceshield) should be mandatory when working at the cleaning tanks. As described and recommended in the previous NIOSH evaluation, a comprehensive PPE program should be implemented.[1]

2. The USAirway's hazard communication program should be reviewed and modified as necessary. Workers should be informed of the hazards and necessary precautions prior to the introduction of any new chemicals in the workplace. All cleaning tanks should be labeled with the name of the material in the tank and appropriate hazard warnings, including the required protective equipment. Labels of chemicals no longer in use should be removed.

3. Liquid should be removed from the wheel wells of tires prior to transferring them to the next department.

4. A comprehensive review of the ventilation system supporting the wheel and brake areas, and bearing room, should be conducted. A mechanical engineering firm with experience in industrial ventilation should be used for this review. Design criteria should include provisions for sufficient outside air (make-up air), and locating return air grilles away from sources of emissions. Consideration should be given to providing a single pass system to avoid recirculation of shop air. Modifications to improve the efficiency of the system should be implemented.

5. Additional industrial hygiene investigation should be conducted regarding the tributyl phosphate and bromopropane that were found in the qualitative air samples. The concentrations present in the work areas and worker exposures should be characterized, and the source and structural formation of the bromopropane should be determined. Based on this industrial hygiene investigation, actions to control emissions of these two materials may be necessary.

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Table I USAIRWAYS - Charlotte, NC Personal Air Sampling Results - Gravimetric HETA 2001-0034-2834 February 5-6, 2001		
Task	**Time (min)**	**Concentration (mg/m³)**
February 5, 2001		
Utility - Wheel Pre-Wash and Bearing Washer	7:22-10:46, 11:33-14:19 (370)	<0.25
Utility - Wheel Pre-Wash	7:24-14:02 (398)	<0.22
Wheel Tear Down	7:30-14:40 (428)	<0.21
Brake Tear Down	7:33-14:36 (422)	<0.22
Brake Cleaning Sinks	7:35-14:37 (421)	(0.09)
Wheel Bearing Room	7:26-10:49, 11:26-14:39 (397)	<0.24
Bearing Washer	7:39-10:46, 11:36-14:05 (396)	<0.23
Inspection	7:36-14:39 (423)	<0.20
February 6, 2001		
Utility - Wheel Pre-Wash and Bearing Washer	6:57-10:47, 1143-1400 (366)	(0.1)
Utility - Wheel Pre-Wash	7:08-14:01 (413)	<0.22
Wheel Tear Down	7:10-14:33 (443)	<0.21
Brake Tear Down	7:20 - 8:29, 11:31-14:32 (250)*	<0.34
Brake Cleaning Sinks	7:18-14:33 (435)	(0.32)
Wheel Bearing Room	7:16-14:21 (425)	<0.20
Bearing Washer (not operational until 10 AM)	7:15-14:45 (450)	<0.19
Inspection	7:37-7:50, 8:47-11:15 (161)*	<0.21
NIOSH REL		**

Note:
*Air sampling pump faulted and was restarted.
Values in parentheses indicate the concentration measured was between the analytical limit of detection and the limit of quantitation.
mg/m³ = milligrams of contaminant per cubic meter of air sampled
** = NIOSH does not have an REL for total particulate not otherwise classified (PNOC). The OSHA permissible exposure limit and ACGIH threshold limit value for PNOC is 15 mg/m³ and 10 mg/m³, respectively.

Table 2 USAIRWAYS - Charlotte, NC Personal Air Sampling Results -Glycol Ether HETA 2001-0034-2834 February 5-6, 2001			
Task	Time (min)	Concentration (mg/m³)	
		DPGBE	TPGME
February 5, 2001			
Utility - Wheel Pre-Wash and Bearing Washer	7:22-10:46, 11:33-14:19 (370)	(0.06)	0.29
Utility - Wheel Pre-Wash	7:24-14:02 (398)	(0.081)	(0.16)
Wheel Tear Down	7:30-14:40 (428)	(0.07)	(0.17)
Brake Tear Down	7:33-14:36 (422)	(0.09)	(0.13)
Brake Cleaning Sinks	7:35-14:37 (421)	0.24	(0.20)
February 6, 2001			
Utility - Wheel Pre-Wash and Bearing Washer	6:57-10:47, 1143-1400 (366)	(0.058)	(0.23)
Utility - Wheel Pre-Wash*	7:08-14:01 (413)	0.40	0.67
Wheel Tear Down	7:10-14:33 (443)	(0.056)	(0.14)
Brake Tear Down	7:20 - 10:56, 11:31-14:32 (396)	(0.10)	(0.22)
Brake Cleaning Sinks	7:18-14:33 (435)	(0.15)	(0.19)

DPGBE = dipropylene glycol butyl ether

TPGME = tripropylene glycol methyl ether

Values in parentheses indicate the concentration measured was between the analytical limit of detection and the limit of quantitation.

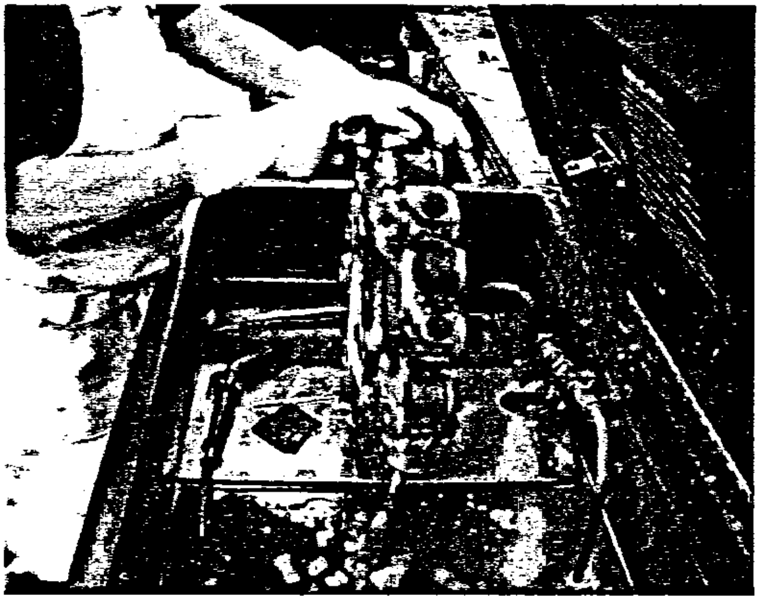
mg/m³ = milligrams of contaminant per cubic meter of air sampled

Occupational Exposure Limits have not been established for DPGBE or TPGME.

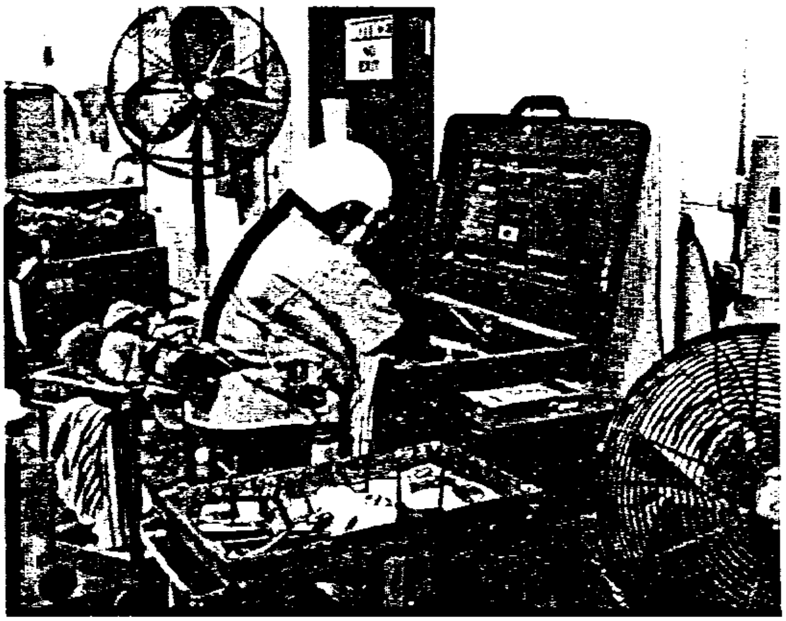
The sampling and analytical techniques used for these analyses have not been validated and all results should be considered estimates.

* This sample had a much different chromatogram than the other samples; butyl cellosolve on both the front and backup section, plus ethanolamine, and a series of aliphatic hydrocarbons were detected.

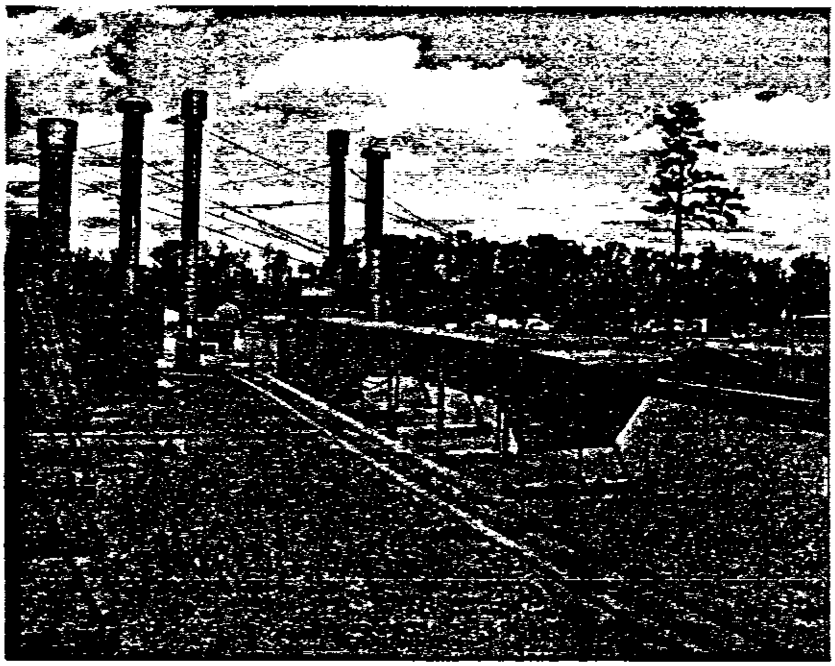
Most of the other samplers contained some amounts of toluene, limonene, xylene, and aliphatic hydrocarbons.



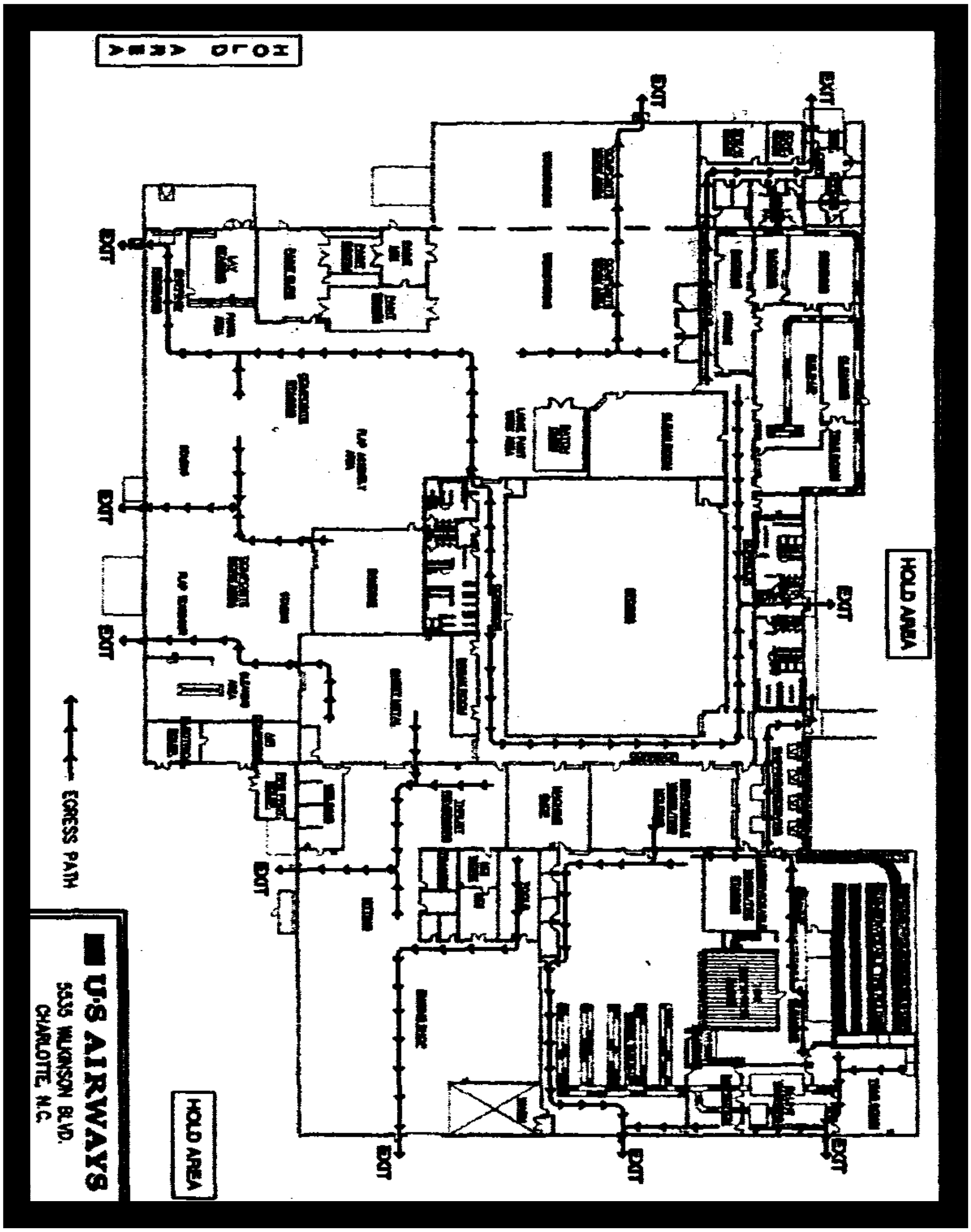
Brake Washing



Cleaning Tank in Tire Pre-Wash



Outside Air Intake - USAirways

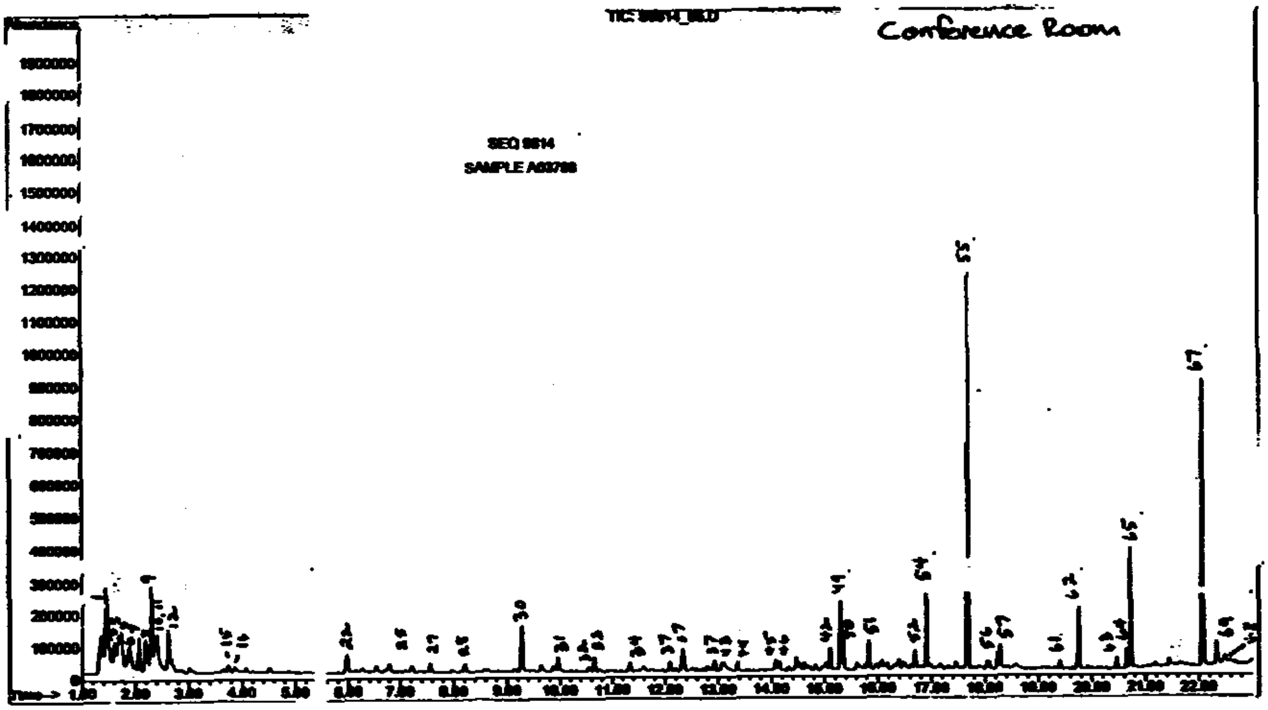

U·S AIRWAYS
5535 WILKINSON BLVD.
CHARLOTTE, N.C.
EGRESS PATH
HOLD AREA
EXIT

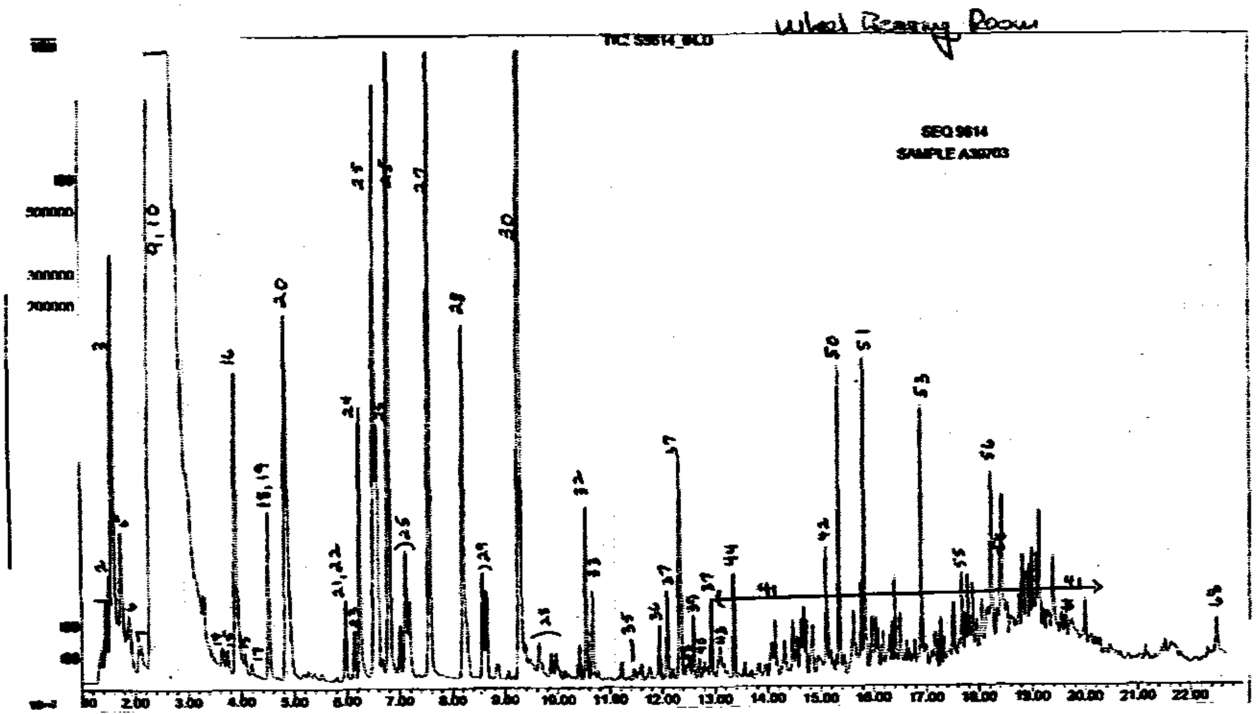
APPENDIX A - QUALITATIVE AIR SAMPLE RESULTS

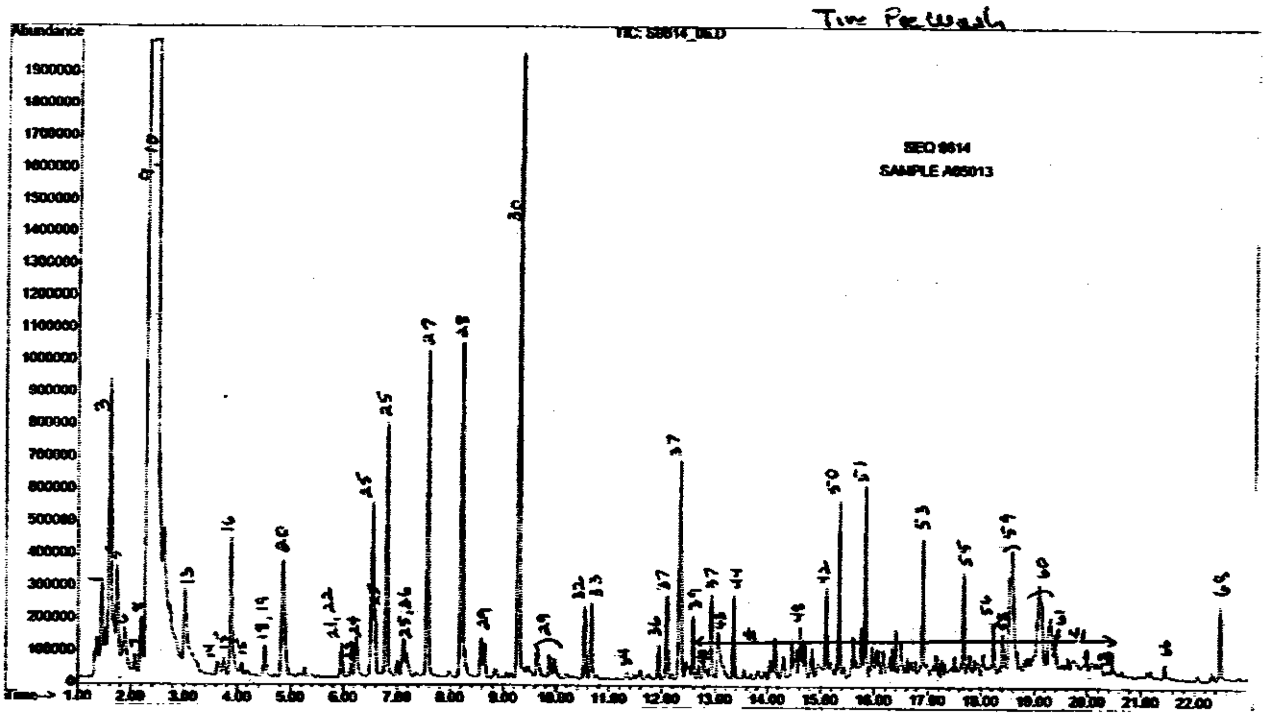
SEQ 9614
THERMAL DESORPTION TUBES
PEAK IDENTIFICATION

1) Air*/CO_2*
2) Tetrafluoroethane
3) Propane*/propene
4) Chlorodifluoroethane
5) Methanol*/isobutane*
6) Butane*
7) Ethanol
8) Acetonitrile*
9) Acetone
10) Isopropanol
11) Isopentane*
12) Pentane*
13) Carbon disulfide/trichlorotrifluoroethane
14) 3-Buten-2-one
15) C_6 alkanes (methylpentanes)
16) Methyl ethyl ketone (MEK)
17) 2-Butanol
18) Hexane
19) Ethyl acetate
20) Bromopropane
21) Butanol/isopropyl acetate
22) Benzene*
23) C_7 alkane/carbon tetrachloride
24) 1-Methoxy-2-propanol
25) C_7 alkanes
26) Trichloroethylene
27) Heptane
28) Methylcyclohexane/methyl isobutyl ketone (MIBK)
29) C_8 alkanes
30) Toluene*
31) Hexanal*
32) Butyl acetate
33) Perchloroethylene/octane
34) Hexamethylcyclotrisiloxane*
35) 4-Vinylcyclohexene
36) Propylene glycol methyl ether acetate
37) Xylene/ethyl benzene isomers
38) Cyclohexanone
39) Methyl amyl ketone (MAK)
40) Styrene
41) C_9-C_{15} aliphatic hydrocarbons and alkyl benzenes
42) C_9H_{12} alkyl benzenes (trimethyl-, methylethyl benzenes, etc.)
43) Butyl cellosolve
44) Nonane
45) Benzaldehyde
46) α-Pinene
47) Butyl methacrylate?
48) Ethylethoxy propionate?
49) Octamethylcyclotetrasiloxane*
50) Decane
51) Limonene
52) C_8-C_{10} aliphatic aldehydes*
53) Undecane
54) Dimethyl glutarate
55) Decamethylcyclopentasiloxane*
56) Dodecane
57) Dimethyl adipate
58) Benzothiazole
59) Dipropylene glycol butyl ether
60) Tripropylene glycol methyl ether
61) Tridecane
62) Siloxane compound*
63) Tetradecane
64) Diisopropyl adipate
65) Dimethyl phthalate*
66) Pentadecane
67) Diethyl phthalate*
68) Tributyl phosphate
69) System contaminants

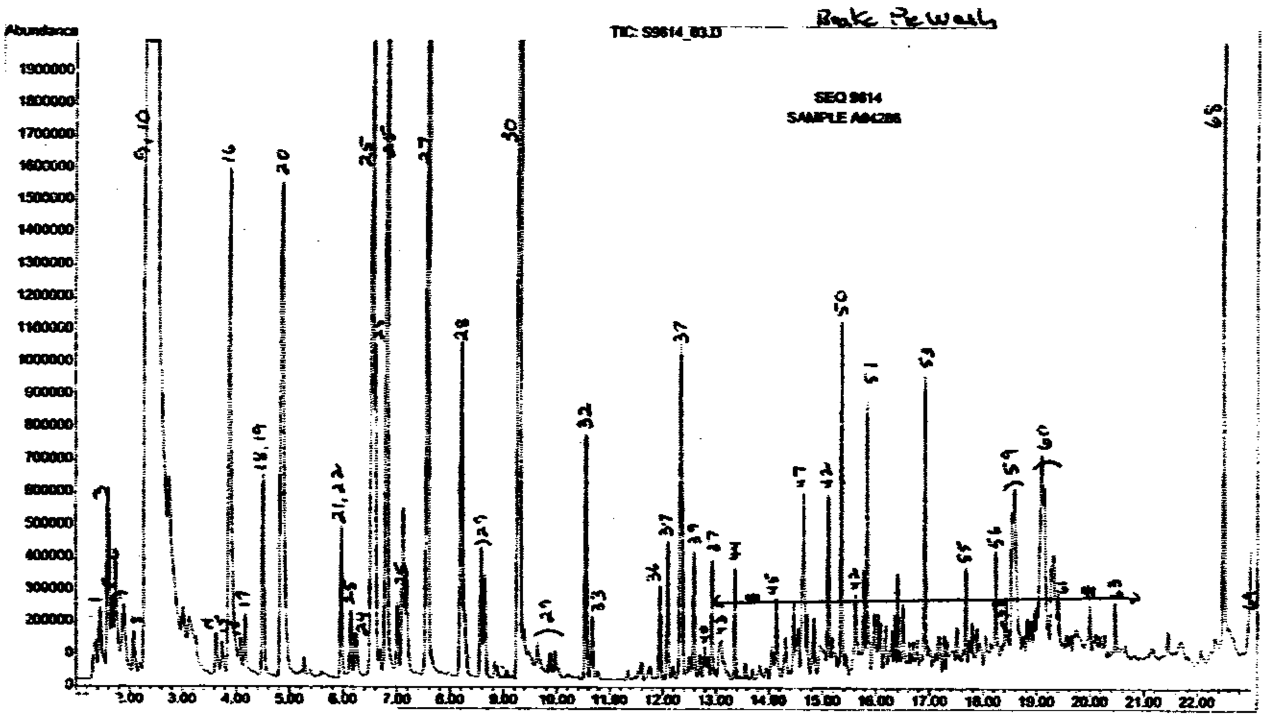
* Also present on some field and/or media blanks


Conference Room
SEQ 9814
SAMPLE A03798


Wheel Bearing Room
SEQ 9814
SAMPLE A30703



Tire Prewash
Abundance
SEQ 9614
SAMPLE A05013
Time-->



Brake Prewash
Abundance
TIC: S9614_03.D
SEQ 9614

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