HETA 99-0342-xxxx
U.S. Airways/Charlotte Aircraft Support Center
Charlotte

Christine Kasting, MPH
Joel McCullough, MD, MPH
Max Kiefer, CIH

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 Christine Kasting, Max Kiefer, and Joel McCullough of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies. Field assistance was provided by Max Kiefer. Analytical support was provided by Data Chem, Salt Lake City, Utah. Desktop publishing was performed by Nichole Herbert. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Composite and Brake Shop at U.S Airways Aircraft Support Center

In January and June, 2000, NIOSH investigators conducted a health hazard evaluation at U.S. Airways/Charlotte Aircraft Support Center. To evaluate exposures to inhalable and respirable particulates and metals in the Composite and Brake Shop. We evaluated work practices and collected information on health complaints.

What NIOSH Did

- **We collected air samples for particulates, fibers, and metals.**
- **We observed work practices and chemical handling procedures.**
- **We talked to employees to determine what health problems they had.**
- **We looked at the medical records of 2 employees.**

What NIOSH Found

- **All air samples were below recommended limits.**
- **The ventilation system in the sanding room was working well.**
- **Glove and respiratory protection programs were deficient in some areas.**
- **Two workers have developed lung problems possibly caused by workplace exposures.**
- **The specific chemicals causing the health problems were not identified.**

What U.S. Airways/Charlotte Aircraft Support Center Managers Can Do

- **Conduct noise monitoring in the Composite and Brake Shops.**
- **Improve the respirator program**
- **Develop a better glove program**

What the U.S. Airways/Charlotte Aircraft Support Center Employees Can Do

- **Make sure you are clean shaven when wearing respirators.**
- **Inform management when there are health and safety problems**

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National Institute for Occupational Safety and Health
NIOSH

Health Hazard Evaluation Report 99-0342-xxxx
U.S. Airways/Charlotte Aircraft Support Center
Charlotte, North Carolina
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Christine Kasting, MPH
Joel McCullough, MD, MPH
Max Kiefer, CIH

SUMMARY

On September 15, 1999, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request for a health hazard evaluation (HHE) at the U.S. Airways/Charlotte Aircraft Support Center in Charlotte, North Carolina. The request indicated some employees at this location have experienced health problems possibly associated with their workplace. Health problems identified in the request included headaches, chest pain, sore throat, and eye irritation. The composite shop, engine shop, and wheel and brake shop were identified as the primary areas of concern. Potential exposures identified included emissions from cleaning solvents during cleaning, repairing, and reassembling aircraft parts. A nearby landfill and emissions from contaminated groundwater were also identified as a potential sources of exposures.

On January 6-7, 2000, NIOSH investigators conducted an initial site visit at the Aircraft Support Center to review the current status of the health problems with plant workers and inspect the facility, observe work practices, and review chemical handling activities. During a follow up site visit on June 20-21, 2000, personal breathing zone (PBZ) air sampling was conducted to assess worker exposure to respirable and inhalable particulates and various metals. Bulk samples from the ventilation system in the sanding room and the brake teardown area were collected to determine the metals that were present. An area air sample for total fibers was obtained in the sanding room.

All measured concentrations of air contaminants were below applicable NIOSH Recommended Exposure Limits (RELs), American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLVs), and Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs). Previous in-plant air monitoring of volatile organic compounds, as an indicator of contamination from the landfill, revealed no hazardous exposures.

The medical records of two workers who reported the most severe health problems were reviewed. The medical records indicated that the workers had lung problems that were possibly work-related. However, neither the medical records nor the NIOSH HHE identified a likely cause of the health problems.

Employee exposures to metals and particulates in the Composite and Brake shops were below established standards. The nearby landfill does not present an exposure hazard to workers. Although at least two workers may have had work-related lung problems, neither their medical records nor the NIOSH HHE identified a specific likely cause. Recommendations were made to improve personal protection programs, proper labeling of solvent tanks, conduct additional industrial hygiene monitoring, and the development of an appropriate spill prevention strategy in the Phosphoric Acid Non-Tank Anodizing (PANTA) area.

Keywords: 3721 (Aircraft and Parts). Composites, Inhalable and respirable particulates, Fibers, Sanding, Grinding, Brake repair, Metals, Solvents, Headaches, Chest pain, Sore throat, Eye irritation, Landfill.

TABLE OF CONTENTS

INTRODUCTION

In response to a confidential employee request for a health hazard evaluation (HHE) received on September 15, 1999, the National Institute for Occupational Safety and Health (NIOSH) conducted an initial site visit on January 6-7, 2000, and a follow-up visit on June 20-21, 2000, at the U.S. Airways Aircraft Support Center in Charlotte, North Carolina. Health problems described in the request included headaches, chest pain, sore throat, and eye irritation. The composite shop, engine shop, and wheel and brake shop were reported as the primary areas of concern. Potential exposures identified included emissions from cleaning solvents during cleaning, repairing, and reassembling aircraft parts. An interim report describing the actions taken by NIOSH during the initial site visit, and preliminary findings and recommendations, was issued on February 22, 2000. A report describing the results of the air sampling during the follow-up survey was provided on September 18, 2000.

BACKGROUND

The Charlotte US Airways facility began operations at this location in January 1999 to service the U.S. Airways fleet. Most of the employees were relocated to the facility from the Greensboro, NC, and Winston-Salem NC facilities. The facility is comprised of several shops: Wheel and Brake, Power Plant, Composite, Phosphoric Acid Non-Tank Anodizing (PANTA) paint booth, lavatory, machine, welding, and sheet metal. The facility also contains a Shipping and Receiving Department, Non Destructive Testing Shop, Test and Clean Area, Break room and Office Area. Parts are serviced and repaired and then tested to meet FAA standards. Approximately 220 technicians and office support staff are currently employed at the U.S. Airways facility. The facility operates around the clock with three shifts (7-3, 3-11, 11-7), and is closed on Saturday and Sunday. The International Association of Machinists and Aerospace Workers (IAM) union represents the production and maintenance employees which comprises approximately 90% of employees.

When the facility was newly constructed and began operations in January 1999, emissions from a wheel and brake cleaning system were reportedly not ventilated properly, and workers experienced problems such as nose bleeds, difficulty breathing, chest pain, and burning eyes. Management actions including adjustments to the ventilation system (such as raising stacks), adding a mist eliminator, and substituting a different cleaning agent, appeared to resolve the problem, and symptoms were alleviated in most employees. Two employees, however, continued to experience health problems they attributed to this incident, and were using respirators during the NIOSH site visit.

The State of North Carolina Department of Environment, Health, and Natural Resources conducted ground water and soil monitoring for volatile organic components (VOCs) at this Aircraft Support Center due to concerns about a former landfill at the site. A consultant was also hired to conduct a site assessment. In August of 1999, in order to complete a comprehensive site assessment, the consultant recommended the installation of two monitoring wells to check for contaminants at the soil to bedrock interface, and an upgradient monitoring well to finish the horizontal characterization of the site. Data from the newly installed monitoring wells was not reviewed by NIOSH.

In September 1999, management hired a consultant to conduct industrial hygiene sampling for VOCs. The survey was conducted to determine if emissions from contaminated groundwater was entering the building. Sampling was conducted on a weekend to minimize potential sources of contamination during work hours. Full-shift area samples were collected 39" above floor level where it was believed that solvent vapor might enter the building from the ground via connecting joints in the concrete slab flooring. All air sampling showed concentrations below detectable limits for all contaminants with the exception of vinylidene chlride at one location. Further sampling for vinylidene chloride found levels below established occupational limits.

METHODS

On the day of monitoring of the NIOSH survey, U.S. Airways personnel indicated that production activity was unusually busy. In the Composite Shop (sanding area), full shift personal breathing zone (PBZ) samples for respirable and inhalable particulate and an area sample for fibers were collected during grinding and sanding of airplane parts. PBZ samples were collected on six workers. In the Brake Shop, two full-shift PBZ samples were collected for respirable and inhalable particulate on workers tearing down wheel brakes. One PBZ sample was collected on the utility worker who occasionally works in this area. The respirable and inhalable air samples were also analyzed for metals.

Bulk Samples

Bulk samples of settled dust from the ventilation system in the sanding room and the brake teardown area were collected and shipped separately to the NIOSH contract laboratory for metals analysis. Samples were collected in clean, unused containers. The bulk samples were used to determine which metals may be present in the air samples.

Gravimetric (inhalable and respirable)

Inhalable Particulates

The inhalable fraction of an air sample refers to the total aerosol mass the worker breathes into the respiratory tract; this is defined as particles less than 100-µm in diameter. Inhalable particulate samples were collected on pre-weighed 37-millimeter (mm), 5-micrometer(µm) pore size, polyvinyl chloride (PVC) filters using Institute of Occupational Medicine Inhalable Mass (IOM) samplers. Using Gilian HFS 513A, and Gil-Air sampling pumps, flow rates of approximately 2.0 liters per minute (l/m) were used to obtain PBZ samples over the entire shift.

Respirable Particulates

The respirable fraction of an air sample refers to the total aerosol that penetrates to the gas-exchange region of the lungs; this is defined as particles less than 10-µm in diameter. Respirable particulate samples were collected on tared 5-µm pore size, PVC filters using 10-mm Dorr-Oliver cyclones. Full shift PBZ exposures were monitored using SKC Universal Samplers (PCXR4), Gilian HFS513A, and Gil-Air sampling pumps. Flow rates of approximately 1.7 l/m were used to obtain the samples.

All sampling pumps were pre- and post-calibrated with a primary standard (BIOS®) to verify flow rate. The filters were placed as close as possible to the workers' breathing zone and connected via Tygon® tubing to the sampling pump. Depending on the activity, some filters were replaced periodically throughout the work shift to avoid overloading. After collection, the samples were sent to the NIOSH laboratory (DataChem, Salt Lake City) for gravimetric analysis to determine the particulate dust concentration according to NIOSH methods 0500 and 0600.

Elemental Analysis

An element specific analysis was also conducted on the air samples, according to NIOSH method 7300, to differentiate and quantify the following metal species: iron, lead, cadmium, chromium, copper, manganese, titanium, molybdenum, aluminum, zirconium, zinc, lead and nickel. With this technique, the sample filters are microwave digested in an acid mixture, and analyzed with an inductively coupled plasma emission spectrometer.[1]

Fibers

Fibers from the Composite shop (sanding area) were sampled using 0.8-µm mixed cellulose ester (MCE) filters mounted in 25-mm cassettes with an antistatic cowl. Area air samples were collected at a flow rate of 10 l/m with a high volume sampler. The samples were analyzed for total fibers by phase contrast microscopy according to the NIOSH method 7400 using "B" counting rules.[1]

Medical

The OSHA log and Summary of Occupational Injury and Illness (OSHA 200 log) for 1999 and the medical records of the two workers who reported the most pronounced health effects were reviewed. The NIOSH medical officer did not make a site visit and did not interview workers in the workplace. The NIOSH medical officer spoke with several of the physicians involved in the care of those employees whose medical records were reviewed.

EVALUATION CRITERIA

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

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),[2] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[3] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[4] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 95–596, sec. 5.(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8-to-10-hour workday. Some substances have recommended STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Composite Materials

Composite materials are combinations of resin systems and reinforcing fibers. Epoxy resin-based systems are the most common for the manufacture of advanced composites.[5,6] Other systems include phenol-formaldehyde, urea-formaldehyde, polyurethane, and polyimide resin systems. Common fiber reinforcement materials include fibrous glass, carbon/graphite, and aramid (Kevlar™).

There is a great deal of information on the health effects of various components of most composite materials as they exist in the *uncured* state. Some components have the potential to irritate the eyes, mucous membranes, and upper respiratory tract. Other ingredients, such as toluene diisocyanate and formaldehyde, are sensitizers as well as irritants. Some composite agents, such as glycidyl ethers and 4,4'-methylenedianiline (MDA), have adverse systemic effects or are suspect human carcinogens.[5,6]

Not much is known, however, about the health effects of composite components as they exist in the *cured* state. Most research on the medical hazards of cured composite have involved investigations into pulmonary toxicity. Carbon fibers typically have a diameter of 7-8 micrometers (µm) and are too large to be respirable.[8] Some studies indicate that the bulk of composite dust is primarily comprised of particulate and contains few fibers.[7] Morphological/chemical studies suggest that cured composite dust contains lower concentrations of reactive components than dust of other plastics, and that overexposure to decomposition products during milling and other mechanical processes is unlikely.[7]

Fiber reinforcement materials come in various forms, including mats, woven fabrics, braids, rovings, and yarns. Carbon fiber is produced from polyacrylonitrile (PAN) or petroleum pitch.[8] PAN-based fibers are purer and are used more commonly in composites than fibers produced from petroleum pitch.[8] Animal and bacterial tests suggest that pitch-based fibers are biologically active, whereas PAN-based fibers produced negative results.[5,8] The primary health effect of exposure to fiber reinforcement materials, including carbon and glass fibers, is mechanical irritation of the eyes, skin, and upper respiratory tract.[5]

Sweden has established an occupational exposure standard for composite dust of 3 milligrams of dust per cubic meter of air (mg/m^3). The Swedish standard applies to total dust, and includes "dust with or without fiberglass from set or non-set plastic material . . . "[7] The U.S. Navy has set a limit of three fibers per cubic centimeter of air (f/cc) for exposure to carbon fibers.[5] No REL, PEL, or TLV has been established for exposure to composite dust.

Metals

The NIOSH RELs, ACGIH TLVs, and OSHA PELs for the metals measured in the environmental samples during this survey are shown in the following table.

Element	NIOSH REL (mg/m^3)	ACGIH TLV (mg/m^3)	OSHA PEL (mg/m^3)
Chromium	0.5 TWA	0.5 TWA	1 TWA
Iron	5 TWA	5 TWA	10 TWA
Manganese	1 TWA 3 STEL	0.2 TWA	5 TWA
Cadmium	LFC	0.01 TWA	0.005 TWA
Aluminum	10 TWA	10 TWA	15 TWA
Lead	<0.1 TWA	0.05 TWA	0.05 TWA
Zirconium	5 TWA	5 TWA	5 TWA
Copper	1 TWA	1 TWA	1 TWA
Nickel	0.015	1.5 TWA*	1 TWA

Element	NIOSH REL (mg/m^3)	ACGIH TLV (mg/m^3)	OSHA PEL (mg/m^3)
Zinc	5 TWA 10 STEL	10 TWA	15 TWA

* criteria applies to the inhalable fraction
TWA = time-weighted average
STEL = short term exposure limit
LFC = lowest feasible concentration

Irritant-associated Vocal Cord Dysfunction

Vocal cord dysfunction (VCD) is a disorder of the larynx is which the vocal cords adduct inappropriately during the respiratory cycle. The various causes can be varied. VCD is frequently misdiagnosed as asthma or can occur concomitantly with asthma.[9] Irritant-associated VCD was distinguished from VCD by occupational or environmental exposure to respiratory irritants, but the pathological and the laryngoscopic findings are the same: adduction of the anterior two thirds of the vocal cords with a "posterior chink."[10] This abnormality can occur in inspiration, expiration, or in both phases of the respiratory cycle.[11]

Occupational Asthma and Irritant-Associated Asthma

Asthma is characterized by reversible airway obstruction, airway inflammation, and increased airway responsiveness to a variety of stimuli. In occupational asthma, there is variable airway obstruction or airway hyperresponsiveness due to workplace exposure(s). Work-related variable airway obstruction can be caused by several mechanisms, including type-I immune reactions, pharmacologic effects, inflammatory processes, and direct airway irritation. Asthma associated with the workplace can also occur when workplace exposures lead to exacerbations of preexisting non-occupational asthma.

There are two major types of occupational asthma. Sensitized-induced asthma is characterized by a variable amount of time during which "sensitization" to an agent in the workplace takes place. This type of asthma is characterized by specific responsiveness to the etiological agent. Irritant-induced asthma occurs without a latent period after substantial exposure to an irritating dust, mist, vapor, or fume. Reactive airways dysfunction syndrome (RADS) is a term used by some to describe irritant asthma caused by a short-term, high intensity exposure.

Reactive Airways Dysfunction Syndrome (RADS)

RADS was first described in 1985 by Brooks et al. The criteria for the diagnosis of RADS include the following: 1) Exposure to a high concentration of a gas, smoke, fume, or vapor that has irritant qualities. 2) Symptoms consistent with asthma, such as cough, wheeze, and shortness of breath. 3) Onset of symptoms within 24 hours after the acute exposure and persistence of symptoms for at least 3 months. 4) Possibly airflow limitation on pulmonary function tests. 5) Airway responsiveness on methacholine challenge tests. 6) Absence of preceding respiratory complaints. 7) Other types of pulmonary diseases excluded.[12]

The criteria for irritant-induced asthma (IIA) differs from RADS in that there may have been one or more acute, high-level exposures to a respiratory irritant.[13] Other studies have included those with an onset of symptoms up to 7 days after the accidental exposure.[14] Some researchers report two distinct clinical presentation of IIA: the first was sudden-onset and analogous to RADS. In contrast, for the not-so-sudden-onset asthma subjects, the causative irritant exposure was not brief, usually not massive, continued for more than 24 hours, and the initiation of asthma took longer to evolve. Preexisting allergy/atopy and/or preexisting asthma were significant contributors to the pathogenesis of not-so-sudden-onset irritant-induced asthma.[15]

Difficulties can arise in the diagnosis of RADS or IIA in individual patients due to the lack of any specific objective test. Spirometry demonstrating airflow limitation with a significant bronchodilator response or airway hyperresponsiveness on histamine or methacholine challenge is sufficient to confirm a diagnosis of asthma and is necessary to diagnose RADS or IIA, but does not exclude the possibility of pre-existing, coincidental, asymptomatic or symptomatic airway hyperresponsiveness.[16]

Some case reports suggest that asthma may be induced by moderate or relatively low exposures to potential respiratory irritants.[15,17] Few epidemiologic studies have assessed asthma prevalence among workers exposed to moderately high levels of respiratory irritants. There is controversy whether airway hyperresponsiveness develops after exposure to low to moderate levels of respiratory irritants.[18]

RESULTS

Air Sample Results

All measured concentrations of contaminants were below applicable NIOSH RELs on the day of monitoring. The gravimetric, or total particulate contaminant results are shown in Table 1. The metal air sampling results are shown in Table 2. In the Composite Shop, no fibers were detected, with a limit of detection of 0.002 fibers per cubic centimeter. Work load was considered by the workers to be unusually busy during the monitoring.

Workplace Observations

Disposable latex gloves were used inappropriately to protect against contact with industrial chemicals in the facility. Glove selection should be based on a chemical and job specific analysis.

Although respirators were worn voluntarily by employees for certain processes, all required components of a respirator protection program (RPP) had not been established.

During the NIOSH survey, noise levels in the sanding area and brake area were such that communication was difficult. No reports regarding noise levels in these areas were available. Most employees were wearing hearing protection.

An insufficient spill cleanup protocol and spill prevention strategy existed in the PANTA area. This process involves applying several layers of bonding materials to an airplane part (wing, rudder, etc.) to patch a defect. The process uses a 10% phosphoric acid solution. Acetone is used to clean the part and then the part is electro-etched. One or two operators performs this task, which is conducted intermittently. The 55 gallon drum of phosphoric acid was stored unprotected in the middle of the area floor. A fork lift was sometimes parked in front of the drum. The worker had to carry a pan of the phosphoric acid solution to the PANTA work area which is several feet away. By the second NIOSH site visit, management had addressed these concerns.

In the power plant, two workers per shift run the degreasing tank. The tank was unlabeled with the contents and appropriate hazard warning.

In the sanding area, personal protective equipment included Tyvek suits and respirators (air purifying, powered air purifying, filtering facepiece respirators). Some employees wore gloves. Respirator use in this area was voluntary, but all employees were wearing them. One person wearing a respirator had facial hair which interferes with the face to facepiece seal.

Medical

According to their medical records, the two workers developed variable obstructive lung disease that their physicians attributed to exposure to workplace irritants. The workers had no history of previous lung disease. They developed worsening upper and lower respiratory symptoms over the course of 1 to 2 months. They were thought to have a variant of reactive airways dysfunction syndrome (RADS) by several physicians. The workers were placed on restricted duty which did not allow exposure to workplace fumes. Irritation of the upper respiratory tract was also noted, specifically irritation of the vocal cords. One worker had spirometric evidence of extrathoracic airway obstruction, which may have been consistent with obstruction due to vocal cord abnormalities (Extrathoracic airflow obstruction may be shown with truncation of the inspiratory loop of the flow-volume loop). Their symptoms appeared to improve with treatment and restricted duty over the course of several months. The specific irritant chemical(s) responsible for these reported health effects were not identified in the medical records. One physician identified a product called Turco Foamgo #2 as a possible chemical responsible for symptoms. The MSDS on this product noted that it may cause irritation of the eyes with exposure. However the main ingredient, polydimethylsiloxane (synonym: dimethicone), is a low inhalational hazard, in part due to its low vapor pressure. Pulmonary edema, pneumonitis, pleural effusion, and shortness of breath have occurred but only from injection or implantation.[19] Other exposures mentioned in the medical records were several different types of low volatility petroleum products, such as oils and greases.

DISCUSSION

The NIOSH investigation found all measured concentrations of contaminants were below the NIOSH RELs, ACGIH TLVs, and OSHA PELs on the day of monitoring. Although our monitoring results did not indicate the need for respiratory protection, respirators were worn by some workers, and some employees may wish to continue using respirators for certain tasks. If employees choose to wear respirators, certain elements of a respiratory protection program are necessary. The new OSHA regulations require a complete respirator program whenever respirators use is required by the employer. However, when respirators are used voluntarily by employees, the employer needs only to establish those respirator program elements necessary to assure the respirator itself is not a hazard. The exception is that filtering facepiece respirators can be used without any respirator program when used voluntarily. Although there are no know studies of such voluntary respirator use, NIOSH supports OSHA's voluntary use provisions because they provide safe ways not previously available to use respirator to reduce exposure will below established exposure limits. Elements of a respiratory protection program include a written program, training, fit testing, medical clearance, cleaning, regular inspection, and maintenance. The requirements for a respirator program are described in the OSHA regulation 29 CFR 1910.134. The effectiveness of tight-fitting respirators is compromised if facial hair is present in the seal area.

A comprehensive program for proper selection and use of gloves has not been established. Disposable latex gloves were used indiscriminately in the facility. It is important to keep in mind that 3-4% of the population will develop latex allergy if using latex gloves.[20] Glove selection should be based on a chemical and job specific analysis.

The medical records revealed that 2 workers developed variable obstructive lung disease and upper airway irritation. Their doctors reported that these health conditions were related to workplace exposures. Neither the agent(s) responsible for the lung disease and the type of variable airway obstructive lung disease were identified with certainty.

CONCLUSIONS

During the NIOSH survey, employee exposures to metals and particulates in the Composite and Brake shops were below established occupational exposure limits. Data from a consultant's evaluation (prior to the NIOSH HHE) indicate that the landfill on site is not presenting an exposure hazard to workers. Although at least two workers may have had work-related lung problems, neither their medical records nor the NIOSH HHE identified a specific likely cause.

RECOMMENDATIONS

1. Appropriate gloves should be provided and proper glove use should be mandatory for dispensing or using chemicals. Prevention of skin contact, and the reduction of opportunities for skin contact, should be a primary focus of a chemical safety and health program. A comprehensive glove personal protective equipment program should be implemented. The elements of an effective program include:

   Written procedures: Define the necessary gloves and ensure it is properly and consistently used and maintained. For certain tasks, the use of appropriate gloves should be mandatory.

   Proper Selection and Use: There are many gloves available which provide adequate protection and still allow considerable dexterity. Gloves should be individually assigned.

   Inspection and Maintenance: Gloves should be inspected before and after each use, cleaned prior to removal and replaced frequently. After cleaning, gloves should be stored properly. OSHA has established a PPE program which requires conducting a hazard assessment of all tasks and determining the appropriate PPE.

2. Ensure that all appropriate elements of a respiratory protection program are in place if employees wear respirators voluntarily. The requirements for a respirator program are described in the OSHA regulation 29 CFR 1910.134. Facial hair should not be allowed with tight-fitting respirators.

3. The 55-55 solvent tanks in the Power Plant degrease shop should be appropriately labeled with the contents and appropriate hazard warning..

4. A noise survey should be conducted in the sanding and brake area to determine if a hearing conservation program is required.

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Table 1 Air Gravimetric Sample Results U.S. Airways, Charlotte, N.C.: HETA 99-0342 June 21, 2000			
Sample #	Location/Task	Sample Time (min)	TWA Concentration (mg/m^3)
379 385	Aileron Sanding, Composite Shop	379	
		respirable fraction	<0.06
23 25		376	
		inhalable fraction	0.33
386	Brake Tear Down and Cleaning	344	
		respirable fraction	0.59
18		255	
		inhalable fraction	2.98
376 382	Brake Tear Down	430	
		respirable fraction	<0.06
15 12		434	
		inhalable fraction	0.13
13	Utility/AB Blaster	215	
		inhalable fraction	1.14
1476	Sanding Outboard Midflap	107	
		respirable fraction	<0.10
26		107	
		inhalable fraction	2.15
384	Sanding Flaps	149	
		respirable fraction	<0.07
10		148	
		inhalable fraction	1.66

Table 1 Air Gravimetric Sample Results U.S. Airways, Charlotte, N.C.: HETA 99-0342 June 21, 2000			
Sample #	Location/Task	Sample Time (min)	TWA Concentration (mg/m^3)
425	Sanding Radome	156	
		respirable fraction	0.14
1479	Sanding Radome	162	
		respirable fraction	<0.07
		65	
8		inhalable fraction	0.77
1480	Sanding Radome	211	
		respirable fraction	<0.05
		212	
17		inhalable fraction	4.01

NOTES:
All samples were field blank corrected
Gravimetric = total weight of contaminants detected on filter
mg/m^3 = milligrams of contaminant per cubic meter of air sampled
TWA = time-weighted average concentration calculated as follows:

$$TWA = \frac{C_1T_1 + C_2T_2 + C_nT_n}{T_1 + T_2 + T_n}$$

Where: C = concentration measured during the sampling period T

Inhalable Fraction = total aerosol mass the worker breathes into the respiratory tract; this is defined as particles less than 100-µm in diameter

Respirable Fraction = the portion of the total aerosol mass that penetrates to the gas-exchange region of the lungs; this is defined as particles less than 10-µm in diameter

Table 2
Elemental Sampling Results
US Airways, HETA 99-0342
June 21, 2000

Task	**Sample #**	**Concentration (mg/m^3)**												
		Fe	Mn	Cd	Cr	Cu	Mg	Ti	Mo	Al	Zn	Zr	Pb	Ni
Aileron Sanding Composite Shop	379	ND	ND	ND	0.003	ND	ND	(.0003)	ND	ND	ND	ND	ND	ND
	385	ND	ND	ND	.004	ND	ND	.001	ND	ND	ND	ND	ND	ND
	TWA	NA	NA	NA	.006	NA	NA	(.005)	NA	NA	NA	NA	NA	NA
	23	ND	ND	ND	.009	ND	ND	.01	ND	ND	ND	ND	ND	ND
	25	ND	ND	ND	.01	ND	ND	.005	ND	ND	ND	ND	ND	ND
	TWA	NA	NA	NA	NA	NA	NA	.008	NA	NA	NA	NA	NA	NA
Brake Tear Down and Cleaning	386	(.01)	ND	ND	ND	(.0005)	ND	ND	ND	ND	ND	ND	ND	ND
	381	(.01)	ND	ND	ND	(.0003)	ND	(.001)	ND	ND	ND	ND	ND	ND
	TWA	(.01)	NA	NA	NA	(.0004)	NA	NA	NA	NA	NA	NA	NA	NA
	18	.158	.001	(.001)	.006	.026	(.005)	.006	.009	ND	.024	ND	(.005)	.013
	14	.07	(.0003)	ND	.003	.003	ND	(.0009)	.003	ND	(.006)	(.0003)	ND	(.002)
	TWA	.103	(.0006)	NA	.004	.009	NA	(.002)	.004	NA	(.009)	NA	NA	(.005)
Brake Tear Down	376	.008	.0001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	382	(.02)	(.0002)	ND	ND	ND	ND	(.0007)	ND	ND	ND	ND	ND	ND
	TWA	(.013)	(.0001)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	15	.02	ND	.0007	(.001)	(.002)	(.002)	(.0014)	ND	ND	ND	ND	ND	ND
	12	(.009)	ND	.0016	(.002)	(.0009)	ND	(.0003)	.003	ND	(.003)	ND	ND	ND
	TWA	(.016)	ND	.001	(.001)	(.002)	NA	(.001)	NA	NA	NA	NA	NA	NA
Utility	13	.03	(.0001)	ND	(.002)	.008	(.005)	(.0005)	(.0005)	ND	ND	(.0002)	ND	ND

Table 2
Elemental Sampling Results
US Airways, HETA 99-0342
June 21, 2000

Task	**Sample #**	**Concentration (mg/m^3)**												
		Fe	Mn	Cd	Cr	Cu	Mg	Ti	Mo	Al	Zn	Zr	Pb	Ni
Sanding Outboard Midflap	1476	.01	(.0002)	ND	(.003)	ND	ND	(.0016)	ND	ND	ND	ND	ND	ND
	26	(.01)	ND	(.0009)	(.02)	ND	.03	.08	ND	.16	ND	ND	ND	ND
Sanding Flaps	384	ND	ND	ND	ND	ND	ND	(.0007)	ND	ND	ND	ND	ND	ND
	10	(.01)	(.0002)	ND	ND	ND	ND	.004	ND	ND	ND	ND	ND	ND
Sanding Radome	1479	(.011)	ND	ND	ND	ND	ND	(.0007)	ND	ND	ND	ND	ND	ND
	8	(.05)	ND	ND	.01	ND	ND	.07	ND	ND	ND	(.0007)	ND	(.003)
Sanding Radome	1480	(.005)	ND	ND	ND	ND	ND	.007	ND	ND	ND	ND	ND	ND
	17	(.01)	ND	ND	(.002)	(.0005)	.007	.08	ND	(.009)	(.007)	(.0002)	ND	ND
Sanding Radome	425	ND	ND	ND	ND	ND	ND	.004	ND	ND	ND	ND	ND	ND
NIOSH REL		5	1.0	LFC	0.5	1.0	1.0	NE	NE	10	5.0	5.0	<0.1	0.015
ACGIH TLV		5	0.2	.01	0.5	1.0	NE	10	10	10	10	5.0	0.05	1.5
OSHA PEL		10	5	5	1.0	1.0	15	15	15	15	15	5.0	0.05	1.0

Note:
mg/m^3 = milligrams of contaminant per cubic meter of air sampled
Values in parentheses indicate the contaminant concentration was between the analytical limit of detection and the limit of quantification (LOQ).
All results are field blank corrected
LFC = lowest feasible concentration, ND = None Detected, NA = Not Applicable, NE = None established
TWA = time-weighted average concentration calculated as follows:

$$TWA = \frac{C_1T_1 + C_2T_2 + C_nT_n}{T_1 + T_2 + T_n}$$

Where: C = concentration measured during sampling period T

Mn = manganese, Ni = nickel, Fe = iron, Pb = lead, Cd = cadmium, Zn = zinc, Cu = copper, Cr = chromium, Ti =titanium, Mo = molybdenum, Al = aluminum, Zn = zinc, Zr = zirconium, Pb = lead, Ni = nickel

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