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AUSTIN FINANCE CENTER
AUSTIN, TEXAS

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I. SUMMARY

On April 16-17, 1991, and January 21-22, 1992, investigators from the National Institute for Occupational Safety and Health (NIOSH) conducted a Health Hazard Evaluation (HHE) at the U.S. Department of Veterans Affairs Austin Finance Center, in Austin, Texas. This HHE was conducted in response to a management request concerning complaints of poor indoor air quality in the building, including breathing problems, itching, headaches, coughing, and congestion. There were complaints related to work above the drop ceiling, which disturbed fibrous glass insulation and fibrous glass ceiling tiles, and concerns about exposure to paper dust.

NIOSH investigators inspected the building's air handling system, performed sampling for total dust, fibrous glass, ozone, and carbon dioxide; and measured temperature and relative humidity in the building.

The results of the fibrous glass samples collected on April 17, 1991, were all less than the analytical limit of detection of 3000 fibers per filter, which equates to a minimum detectable concentration of 0.003 fibers per milliliter of sampled air, assuming a 1084-liter sample (sample volumes for this sample set ranged from 1026 to 1084 liters). While higher levels may occur briefly following work above the ceiling, these results indicate that, on the day sampling took place, airborne fibrous glass dust concentrations were below all relevant criteria.

The eight hour time-weighted average results of the dust samples collected on April 17, 1991, ranged from 0.00 milligrams per cubic meter (mg/m^3) in the Eastern Division Variance area to 0.21 mg/m^3 in the Federal Accounting and Travel area. The latter concentration was identical to the concentration measured outside of the building. This may be the result of poor building maintenance practices (such as inadequate filtration of outside air entering the building) or an indication of the amount of paper dust generated in this area. Ozone monitoring performed in the Eastern Division Variance area on April 17, 1991, revealed that ozone concentrations were equal to or greater than the NIOSH Recommended Exposure Limit (REL) of 0.1 parts per million (ppm) at reader printer exhaust ports on four occasions, and approached the REL in one operator's breathing zone. Ozone concentrations on January 22, 1992, in the Eastern Division Variance area ranged up to 0.03 ppm. The highest concentration, 0.03 ppm, was measured in an operator's breathing zone while an adjacent reader printer was printing. Nevertheless, the ozone concentrations measured at the time of the second site visit were well below applicable evaluation criteria. This reduction may have been due to the new ozone filters installed in the reader printers in the months between site visits.

Carbon dioxide levels in the building ranged from 425 ppm to 875 ppm, with a mean of 706 ppm. Temperature in the building ranged from 72.0°F to 80.0°F, with a mean of 75.5°F. The relative humidity indoors ranged from 48.4% to 64.4%, with a mean of 54.5%. While CO_2 levels rose during the day, they did not reach the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommended limit of 1000 ppm. While relative humidity was within ASHRAE guidelines, temperatures within the building varied by as much as 8°F, and exceeded the ASHRAE acceptable range for operative temperature for the winter.

A questionnaire was left with Finance Center management personnel on April 17, 1991, to distribute to all Finance Center employees, collect, and return to NIOSH. The survey forms were submitted for data entry and statistical analysis. The results of the survey were reviewed by a NIOSH medical officer. The most common symptoms were those that have been reported in many other studies of office workers -- symptoms associated with mucous membrane irritation, fatigue or sleepiness, and headache. The percentage of persons reporting symptoms is similar to that found in other buildings studied using the same questionnaire and the same definition of a positive symptom. Although workers in the reader/printer areas reported some symptoms (especially stuffy nose, fatigue, and burning eyes) more often than workers in other areas, none of the differences was statistically significant at a probability level of $p<0.05$, based on a chi-square test.

NIOSH investigators interviewed employees regarding their perceptions about physical and psychosocial aspects of the work environment. Workers were asked to comment on their concerns about indoor environmental quality and on aspects of their jobs, including workload, job demands and expectations, and employee-management relations. Low morale was prevalent among the workers. Although workers in Government Accounts felt that management was willing to try out workers' new ideas, the feeling among workers in Commercial Accounts was that their input was largely ignored. Workers and management differed in their perceptions about how air quality and health concerns were being handled.

On the basis of the data obtained during this investigation, the NIOSH investigators did not find clear evidence to explain all of the symptoms experienced by employees. However, ozone concentrations measured during the first site visit in the vicinity of microfilm reader printers may explain respiratory symptoms among exposed employees. It seems likely that psychosocial conditions at the Austin Finance Center contributed to worker concerns about poor indoor environmental quality. In addition, maintenance of the building's air handling system should be improved. Recommendations are contained in Section

Keywords: SIC 9451 (Administration of Veterans' Affairs, Except Health and Insurance), indoor environmental quality, indoor air quality, ozone, psychosocial stress, IEQ, IAQ.

II. INTRODUCTION

On April 16-17, 1991, and January 21-22, 1992, investigators from the National Institute for Occupational Safety and Health (NIOSH) conducted a Health Hazard Evaluation (HHE) at the U.S. Department of Veterans Affairs Austin Finance Center, Austin, Texas. This HHE was conducted in response to a management request concerning complaints of poor indoor air quality in the building, including breathing problems, itching, headaches, coughing, and congestion. There were complaints related to work above the drop ceiling which disturbed fibrous glass insulation and fibrous glass ceiling tiles, and concerns about exposure to paper dust. A NIOSH letter dated May 14, 1991, reported the results of the initial site visit. A NIOSH letter dated January 10, 1992, provided the results of a questionnaire distributed during the initial visit.

III. BACKGROUND

The Austin Finance Center moved to its present location in November 1987. The Finance Center occupies 140,000 square feet of a warehouse which was converted to office space according to Department of Veterans Affairs' plans. The Finance Center supports Veterans Affairs medical centers throughout the United States. There are approximately 250 daytime employees, and 40 to 50 employees on a night shift. The General Services Administration leases the space from a private owner. The heating, ventilating, and air-conditioning system is maintained by a contractor. Smoking is permitted only in a smoking room, which has a dedicated ventilation system and is maintained under negative pressure.

IV. MATERIALS AND METHODS

A. Environmental

On April 17, 1991, five general area, full-shift, air samples for total dust were collected. Four samples were collected in various areas of the Finance Center, and one sample was collected outside of the building. These samples were collected on 37-millimeter- diameter, 5-micron (µm) pore size polyvinyl chloride filters using battery-powered sampling pumps calibrated at a flow rate of 2 liters per minute. The samples were submitted for gravimetric analysis in accordance with NIOSH method 0500,[1] with the following modifications: 1) The filters were stored in an environmentally controlled room (21 ±3° C and 40 ±3% Relative Humidity [RH]) and were subjected to room conditions for a long duration for stabilization. Therefore, the method's 8-16 hour time for stabilization between tare weighings was reduced to 5-10 minutes. 2) The filters and backup pads were not vacuum desiccated.

General area air samples were also collected for fibrous glass on April 17, 1991. Five full-shift samples were collected in the same locations as the dust samples. The fibrous glass air samples were collected on 25-millimeter-diameter, 1.2-µm pore size mixed cellulose ester filters using battery-powered sampling pumps calibrated at a flow rate of 2 liters per minute. The samples were submitted for analysis by phase contrast microscopy (PCM) in accordance with NIOSH method 7400.[1]

In addition to the sampling noted above, carbon dioxide levels, temperature, and relative humidity were measured in 20 locations inside the building on April 17, 1991. Measurements were made outside the building as well. Three rounds of sampling were conducted, the first beginning at 6:13 a.m., the second at 10:11 a.m., and the third at 2:18 p.m. Carbon dioxide levels were measured using a Gastech RI 411 carbon dioxide monitor (Gastech, Inc., Newark, CA) calibrated before and after the day's samples were collected using 800 parts per million (ppm) carbon dioxide in nitrogen (Alphagaz, Division of Liquid Air Corporation, Cambridge, MD) as a calibrant. Temperature and relative humidity were measured using a Vaisala HM 34 humidity and temperature meter (Vaisala Oy, Helsinki, Finland).

Sampling was conducted for ozone using a Mast model 727-3 ozone meter (Mast Development Co., Reno, NV). On April 17, 1991, general area ozone measurements were made near the Kodak Ektaprint® 150 Copier Duplicator in the mail room, at the exhaust ports of three Kodak IMT-350 Microimage® terminals (reader printers) in the Eastern Division Variance area, and in the breathing zone of a clerk whose work station positions him near the exhaust port of a reader printer. Ozone measurements were repeated in this area on January 22, 1992. In the interim period, the ozone filters were replaced on the reader printers.

The other elements of the initial NIOSH investigation were a walkthrough tour of the building, an inspection of the air handling units on the roof, and a review of drawings and specifications for the building's air handling system. During the second site visit, five air handling units on the roof were inspected.

B. Medical

A questionnaire was left with Finance Center management personnel on April 17, 1991, to distribute to all Finance Center employees, collect, and return to NIOSH. The survey forms were submitted for data entry and statistical analysis. The results of the survey were reviewed by a NIOSH medical officer.

NIOSH investigators conducted informal interviews with employees and management on January 21 and 22, 1992. Two groups of employees, one from Commercial Accounts and one from Government Accounts were interviewed. A five percent, systematic random sample was chosen by selecting every 20th name on a list of facility employees organized alphabetically by department. When the identified worker was unavailable because of absence or work on the night shift, the next name was selected. Using this procedure, eight of 173 workers in Commercial Accounts, and four of 87 workers in Government Accounts were selected. All workers identified in this way worked on the day shift. Individual interviews were also conducted with two randomly selected workers on the night shift.

The focus of the interviews was employees' perceptions about physical and psychosocial aspects of the work environment. Workers were asked to comment on their concerns about indoor environmental quality and on aspects of their jobs, including workload, job demands and expectations, and employee-management relations.

V. 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 from eight to ten hours a day, forty hours a week, for a working lifetime without experiencing adverse health effects. However, it is important to note that not all workers will be protected from adverse health effects if 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 to the level set by the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, thus potentially increasing 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 Criteria Documents and Recommended Exposure Limits (RELs), 2) the US Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs), and 3) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs).[2,3,4] The OSHA PELs may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; in contrast, the NIOSH-recommended exposure limits are primarily based upon the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing those levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA PEL.

A time-weighted average exposure level (TWA) refers to the average airborne concentration of a substance during a normal eight to ten hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from brief high exposures.

Indoor Environmental Quality (IEQ)

NIOSH investigators have completed over 1100 investigations of the occupational indoor environment in a wide variety of non-industrial settings. The majority of these investigations have been conducted since 1979.

The symptoms and health complaints reported to NIOSH by building occupants have been diverse and usually not suggestive of any particular medical diagnosis or readily associated with a causative agent. A typical spectrum of symptoms has included headaches, unusual fatigue, varying degrees of itching or burning eyes, irritations of the skin, nasal congestion, dry or irritated throats, and other respiratory irritations. Typically, the workplace environment has been implicated because workers report that their symptoms lessen or resolve when they leave the building.

A number of published studies have reported high prevalences of symptoms among occupants of office buildings.[5-9] Scientists investigating indoor environmental problems believe that there are multiple factors contributing to building-related occupant complaints.[10,11] Among these factors are imprecisely defined characteristics of heating, ventilating, and air-conditioning (HVAC) systems, cumulative effects of exposure to low concentrations of multiple chemical pollutants, odors, elevated concentrations of particulate matter, microbiological contamination, and physical factors such as thermal comfort, lighting, and noise.[12-17] Indoor environmental pollutants can arise from either outdoor sources or indoor sources.

There are also reports describing results which show that occupant perceptions of the indoor environment are more closely related than any measured indoor contaminant or condition to the occurrence of symptoms.[18-20] Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints.[20-23]

Less often, an illness may be found to be specifically related to something in the building environment. Some examples of potentially building-related illnesses are allergic rhinitis, allergic asthma, hypersensitivity pneumonitis, Legionnaires' disease, Pontiac fever, carbon monoxide poisoning, and reaction to boiler corrosion inhibitors. The first three conditions can be caused by various microorganisms or other organic material. Legionnaires' disease and Pontiac fever are caused by Legionella bacteria. Sources of carbon monoxide include vehicle exhaust and inadequately ventilated kerosene heaters or other fuel-burning appliances. Exposure to boiler additives can occur if boiler steam is used for humidification or is released by accident.

Problems NIOSH investigators have found in the non-industrial indoor environment have included poor air quality due to ventilation system deficiencies, overcrowding, volatile organic chemicals from furnishings, machines, structural components of the building and contents, tobacco smoke, microbiological contamination, and outside air pollutants; comfort problems due to improper temperature and relative humidity conditions, poor lighting, and unacceptable noise levels; adverse ergonomic conditions; and job-related psychosocial stressors. In most cases, however, these problems could not be directly linked to the reported health effects.

Standards specifically for the non-industrial indoor environment do not exist. NIOSH, OSHA, and ACGIH have published regulatory standards or recommended limits for occupational exposures.[2-4] With few exceptions, pollutant concentrations observed in non-industrial indoor environments fall well below these published occupational standards or recommended exposure limits. ASHRAE has published recommended building ventilation design criteria and thermal comfort guidelines.[24,25] The ACGIH has also developed a manual of guidelines for approaching investigations of building-related complaints that might be caused by airborne living organisms or their effluents.[26]

Measurement of indoor environmental contaminants has rarely proved to be helpful in determining the cause of symptoms and complaints except where there are strong or unusual sources, or a proven relationship between contaminants and specific building-related illnesses. The low-level concentrations of particles and variable mixtures of organic materials usually found are difficult to interpret and usually impossible to causally link to observed and reported health symptoms. However, measuring ventilation and comfort indicators such as carbon dioxide (CO_2), temperature and relative humidity, has proven useful in the early stages of an investigation in providing information relative to the proper functioning and control of HVAC systems.

NIOSH and the Environmental Protection Agency (EPA) jointly published a manual on building air quality, written to help prevent environmental problems in buildings and solve problems when they occur.[27] This manual suggests that IEQ is a constantly changing interaction of a complex set of factors. Three of the most important elements involved in the development of indoor air quality problems are: 1) a source of odors or contaminants; 2) a problem with the design or operation of the HVAC system; 3) and a pathway between the contaminant source and the location of the complaint. A basic understanding of these factors is critical to preventing, investigating, and resolving indoor air quality problems.

The basis for measurements made during this evaluation are listed below.

A. Carbon Dioxide (CO_2)

CO_2 is a normal constituent of exhaled breath and, if monitored, may be useful as a screening technique to evaluate whether adequate quantities of fresh air are being introduced into an occupied space. The ANSI/ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality, recommends outdoor air supply rates of 20 cubic feet per minute per person (cfm/person) for office spaces and conference rooms, 15 cfm/person for reception areas, and 60 cfm/person for smoking lounges, and provides estimated maximum occupancy figures for each area.[24]

Indoor CO_2 concentrations are normally higher than the generally constant ambient outdoor CO_2 concentration (range 300-350 ppm). When indoor CO_2 concentrations exceed 1000 ppm in areas where the only known source is exhaled breath, inadequate ventilation is suspected. Elevated CO_2 concentrations suggest that other indoor contaminants may also be increased.

B. Temperature and Relative Humidity

The perception of comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperatures. Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. ANSI/ASHRAE Standard 55-1981 specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally comfortable.[25]

C. Ozone

Ozone gas is an irritant of the mucous membranes (eyes, nose, throat) and lungs.[28] Ozone is a chemical capable of inducing significant adverse health effects at low exposure concentrations, tenths of a ppm, with the susceptibility of exposed humans appearing to be at least equal to the most susceptible animal species.[29] Ozone is also recognized as an agent which mimics the effects of ionizing radiation, capable of inducing premature aging changes (including thickening of alveolar septa) following exposures of 0.2 to 1 ppm.[29] Air concentrations of ozone in excess of a few tenths ppm cause occasional discomfort to exposed individuals in the form of headache, eye irritation, and dryness of the mucous membranes of the nose and throat.[30] Except for one report, the threshold for effects in humans appears to be between 0.2 and 0.4 ppm.[28] In experimental animals, ozone has been shown to cause increased susceptibility to respiratory infections. Exposing mice to ozone at concentrations as low as 0.08 ppm for three hours enhanced the mortality from subsequent exposure to a bacterial aerosol of *Streptococcus* (group C).[31] Based upon information from humans and animals, it appears that exposure to ozone on the order of 0.2 ppm produces mild acute, but not cumulative effects.[30] An adaptive mechanism protects exposed subjects from some effects of subsequent exposures. For example, in an exposure study, five of six human subjects exposed to 0.5 ppm ozone for two hours a day over four days showed cumulative effects on symptoms and lung function tests for the first three days, followed by values near baseline on day four.[28] The exposure limits are intended to protect exposed individuals from these effects.

The NIOSH REL for ozone is 0.1 ppm as a ceiling exposure.[2] The OSHA PEL for ozone is 0.1 ppm as an eight hour TWA, with an STEL of 0.3 ppm.[3] The ACGIH TLV for ozone is 0.1 ppm as a ceiling.[4]

D. Paper Dust

Cellulose (paper) dust is considered a nuisance dust. Nuisance dusts have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control.[4] The lung-tissue reaction caused by the inhalation of nuisance dusts has the following characteristics: 1) the architecture of the air spaces remains intact; 2) scar tissue is not formed to a significant extent; and 3) the tissue reaction is potentially reversible.[4] Industrial exposure standards for nuisance dust do not apply to office environments: these criteria were established to minimize unpleasant deposits in the eyes, ears, and nasal passages, prevent injury to the skin or mucous membranes by chemical or mechanical action *per se* or by the rigorous skin cleansing necessary for their removal, and to prevent visual interference.[4] Instead, it may be useful to compare the results obtained from dust sampling in an office environment with the concentration of dust collected on an outdoor sample, and with the EPA National Ambient Air Quality (NAAQ) Primary Standard for particulates, referenced in the ASHRAE standard, Ventilation for Acceptable Indoor Air Quality, of 75 micrograms (µg)/m^3 annual geometric mean, 260 µg/m^3 maximum for a 24 hour period.[24]

E. Fibrous Glass

Glass fibers of diameters greater than 3.5 µm are known to cause skin irritation. The risk of dermatitis is increased in warm, humid climates or in the winter when the relative humidity is low. For most workers, symptoms disappear within a week or two of exposure but may persist in some individuals. Allergic contact dermatitis is not thought to be related to the fibers, but to the resins used in fibrous glass products.[32] Fibrous glass can also cause eye irritation and respiratory irritation.[32,33]

Based on experimental studies in animals and epidemiologic studies in humans, the International Agency for Research on Cancer (IARC) concluded that certain man-made mineral fibers (MMMF), including glass wool, are possibly carcinogenic to humans.[34]

Several experimental studies in animals have shown that fibrous glass of dimensions similar to that of asbestos fibers (that is, thin and long) has the potential to induce cancer when implanted into the pleura (lining of the lung) or instilled into the trachea (airway between the throat and the lungs).[35-38] In addition to fiber size, durability of fibers and their persistence in tissues are also recognized as important factors in carcinogenesis.[39]

Doll analyzed the combined results of epidemiologic studies conducted in the United States, Canada, and Europe, and drew the following conclusions: The risk of lung cancer in workers employed in the early days of both the mineral wool and glass wool sectors of the MMMF industry amounted to some 25% above expected 30 years after first employment; the risk has been greater in the mineral wool sector than in the glass wool sector; and the uncertainty about fiber counts in the early days of the industry and the extent of the contribution of other carcinogens make it impossible to provide a precise quantitative estimate of the likely effect of exposure to current air concentrations of fibers.[40] Doll also postulated that "MMMF are not more carcinogenic than asbestos fibers" and "exposure to current mean levels in the manufacturing industry of 0.2 fibers/cc or less is unlikely to produce a measurable risk after another 20 years have passed."[40] A follow-up study of US MMMF workers showed a continued small excess of respiratory cancer deaths in MMMF workers.[41] However, when workers were grouped by type of fibrous glass produced (filament, wool, or both), increasing duration of employment was not associated with increasing excesses in respiratory cancer deaths. This lack of trend could be explained by the fewer than expected respiratory cancer deaths in workers with 30 or more years since first employment in plants that produced only fibrous glass wool. In this study, no exposure factor (such as process, plant, duration of employment, average intensity, or cumulative fiber exposure) could be identified as a possible explanation for the excess in respiratory cancer deaths.

Studies have shown that most fibers found in lungs are less than 3.5 µm in diameter.[42] Inhaled fibers of greater diameters are deposited primarily in the upper airways (nose, mouth, throat), where they are more readily removed by the clearance mechanisms of the respiratory system.

In 1977, NIOSH proposed a REL of 5 mg/m^3 (TWA) for total fibrous glass dust and a 3 fiber/cc limit for fibers having a diameter equal to or less than 3.5 µm and a length equal to or greater than 10 µm, based on evidence that small diameter fibers produce fibrosis in animals and respiratory tract irritation in humans.[43] In 1988, as part of the proposed rules on air contaminants, OSHA proposed to adopt the NIOSH recommendation of 5 µg/m^3 for total fibrous dust, but not the 3 fiber/cc limit for small-diameter fibers. In its testimony to OSHA, NIOSH identified several studies that suggested a carcinogenic risk in workers exposed to certain types of MMMF, including glass wool.[36,40,44] NIOSH concluded that the proposed OSHA PEL of 5 µg/m^3 for total fibrous dust is unlikely to be protective and that a 3 fiber/cc limit for small-diameter fibers is a significantly better alternative.[45] OSHA temporarily delayed a final decision regarding the establishment of a separate PEL for fibrous glass because of the complexity of the issues raised by the extensive evidence submitted to the record.[46]

VI. RESULTS AND DISCUSSION

A. Environmental

The heating, ventilating, and air-conditioning (HVAC) system for this facility consisted of 15 constant air volume (CAV) air handlers, supply and return ductwork, and thermostat controls (one thermostat per unit). These units use electricity for heating and cooling. The size of the air handlers ranges from 3000 cubic feet per minute (cfm) to 6000 cfm (five @ 3000 cfm, nine @ 4000 cfm, and one @ 6000 cfm, 57000 cfm total). The design specifications call for each of these to deliver a constant amount of outside air, equal to 7.5 or 10 percent of the supply rate (4900 cfm total). The outside air dampers were open on the day of the initial NIOSH investigation. Each of the air handlers is designed to have the outside air filtered. The ducted return air is also filtered, although, in an unusual design, the filters are located at the return air grilles. During both site visits, it was noted that filters were not present in the air handlers designed to have internally-mounted filters. At the time of the initial investigation, a filter had fallen from the filter mounting on one of the units designed to have externally-mounted filters, and on several of these units the filters did not fit snugly in their mounts or where they abutted adjacent filters. There were accumulations of dust in the slots on these filter mounts, demonstrating that some dust was entering the air handlers around the edges of the filters. At the time of the follow-up visit, in addition to units missing internally-mounted filters, Roof Top Unit (RTU) 11 was noted to have a dirty coil.

Ozone monitoring performed on April 17, 1991, in the Eastern Division Variance area revealed that ozone concentrations were equal to or greater than the NIOSH REL of 0.1 ppm at reader printer exhaust ports on four occasions, and approached the REL in one operator's breathing zone. However, it should be noted that ozone levels fall off very quickly with distance from the source, and that the levels decline rapidly once the ozone-producing operation ceases. This behavior is due to the highly reactive nature of ozone. Ozone concentrations on January 22, 1992, in the Eastern Division Variance area ranged up to 0.03 ppm. The highest concentration, 0.03 ppm, was measured in an operator's breathing zone while an adjacent reader printer was printing. The ozone concentrations measured at the time of the second site visit were well below applicable evaluation criteria. This reduction may have been due to the new ozone filters installed in the reader printers in the months between site visits.

The results of the CO_2, temperature, and relative humidity readings are provided in Tables 1, 2, and 3. Figure 1 shows the sampling locations. Carbon dioxide levels in the building ranged from 425 to 875 ppm, with a mean of 706 ppm. Temperatures in the building ranged from 72.0 to 80.0°F, with a mean of 75.5°F. The relative humidity indoors ranged from 48.4 to 64.4%, with a mean of 54.5%. While CO_2 levels rose during the day, they did not reach the ASHRAE guideline of 1000 ppm.[24] While relative humidity was within ASHRAE guidelines, temperatures within the building varied by as much as 8 degrees, and exceeded the ASHRAE acceptable ranges for operative temperature for the "winter."[25] The results of a recent study by ASHRAE reported that some people find this "winter" range ideal year-round.[47] This indicates that there is a need to test and balance the heating, ventilating, and air conditioning system.

The specifications on the drawings (sheet M-6, RTU Schedule) for the air handling system indicate that outside air intakes are specified at either 7.5% (units RTU 1, RTU 7 through RTU 10, and RTUs 12, 14, and 15) or 10% (units RTU 2 through RTU 6, and RTU 11 and RTU 13) outside air. This results in a total of 4900 cubic feet per minute (cfm) of outside air for approximately 250 daytime occupants, or 19.6 cfm of outside air per occupant. ASHRAE recommends 20 cfm of outside air per occupant.[24]

The results of the fibrous glass samples collected on April 17, 1991, were all less than the analytical limit of detection of 3000 fibers per filter, which equates to a minimum detectable concentration of 0.003 fibers per milliliter of sampled air, assuming a 1084-liter sample (sample volumes for this sample set ranged from 1026 to 1084 liters). While higher levels may occur briefly following work above the ceiling, these results indicate that, on the day sampling took place, airborne fibrous glass dust concentrations were below all relevant criteria.

The eight-hour TWA results of the dust samples collected on April 17, 1991, ranged up to 0.21 mg/m^3 in the Federal Accounting and Travel area. This value is identical to the concentration of dust measured outside of the building on the day of the survey. This is either an indication that air entering the building is not adequately filtered, or of the amount of paper dust generated in this area. The dust concentration in the Federal Accounting and Travel area is less than the EPA NAAQ Primary Standard of 260 $\mu g/m^3$ (0.260 mg/m^3) maximum for a 24-hour period. Two approaches may be used to make this comparison. The first approach is to assume that employees are exposed to this concentration of dust for eight hours of a twenty-four hour day, with no further exposure. Extrapolating the measured 8-hour TWA concentration to a 24-hour TWA thus results in a 24-hour TWA of 0.07 mg/m^3. The second approach assumes that exposure remains constant during the twenty-four hour period, based upon the measured outdoor concentration, which was equal to the indoor concentration in this area. While both of these approaches indicate that the EPA NAAQ Primary Standard has not been exceeded, the source of this dust should be investigated.

B. Medical

Three hundred thirteen questionnaires were distributed on April 17, 1991. Completed employee questionnaires were collected by management at the Austin Finance Center and returned to NIOSH. Employee responses to the questionnaire were anonymous. Two hundred forty-six (79 percent) of the questionnaires were completed and returned. The purpose of the questionnaire was to determine the types of health symptoms experienced by employees at the Austin Finance Center. A positive symptom was defined as one reported to have occurred "often" or "always" in the preceding six weeks and that usually got better when away from work. As can be seen in Table 4, the most common symptoms were those that have been reported in many other studies of office workers -- symptoms associated with mucous membrane irritation, fatigue or sleepiness, and headache.[20,48-50] The percentage of persons reporting symptoms is similar to that found in other buildings studied using the same questionnaire and the same definition of a positive symptom.[20,50] Although workers in the reader/printer areas reported some symptoms (especially stuffy nose, fatigue, and burning eyes) more often than workers in other areas, none of the differences was statistically significant at a probability level of $p<0.05$, based on a chi-square test.

Workers and management interviewed at the time of the second site visit described a new, mandatory program in Commercial Accounts called Quantum Leap. The Quantum Leap program was implemented several weeks prior to the NIOSH visit in January 1992. The goal of the program was to process in-coming mail on the day it is received. To accomplish this goal, workers were transferred from their regular assignments to the mail room at unscheduled intervals for varying lengths of time, depending on the volume of mail. In the new assignment, workers opened mail and entered invoice information. These tasks, for most workers, were not part of their regular job. Overall, workers' attitudes about the Quantum Leap program were negative. Workers frequently voiced complaints about the large volume of paper dust generated by the increased volume of paper being processed. Workers were also unsure about the effect of transfers to Quantum Leap assignments on the production quotas in their usual jobs.

Most jobs in Commercial Accounts had production quotas. Many workers felt that these quotas were unreasonable. This feeling increased as complex computer programs handled routine cases and workers were more often dealing with the most difficult problems. Whereas a worker's inability to meet his or her production quota had a negative impact on the performance evaluation, there were no incentives or rewards for exceeding the quota. Jobs in Government Accounts did not have production quotas, although workers had to meet deadlines for making payments. Many workers were concerned about the lack of promotion opportunities, especially in Commercial Accounts.

Workers felt that temperature regulation and air circulation were inadequate. Many suspected that pollen from outside air was entering the building and noticed that symptom complaints seemed to be more common after hay fields surrounding the building were plowed. The sense that housekeeping, particularly dusting and vacuuming, was deficient was widespread among the workers. Although cigarette smoking was prohibited in work areas, smoking was permitted in one room next to the lunch room. Workers reported that smoke odors escaped from this room, and NIOSH investigators noted strong cigarette smoke odors in the hallway and rooms adjacent to the smoking area.

Workers expressed concerns about the effects of an on-going hiring freeze. To meet work demand during the freeze, workers were detailed to temporary assignments in areas other than those in which they usually worked.

During the second survey, NIOSH investigators noted that most work areas were crowded, with little attention apparently paid to ergonomic aspects of workstation design. Some attempts had been made to address ergonomic issues by purchasing adjustable chairs and wrist rests for computer keyboards. These accommodations however, were infrequent.

Low morale was prevalent among the workers. Although workers in Government Accounts felt that management was willing to try out workers' new ideas, the feeling among workers in Commercial Accounts was that their input was largely ignored. Workers and management differed in their perceptions about how air quality and health concerns were being handled.

VII. CONCLUSIONS

Poor preventive maintenance practices in this building, as evidenced by missing or ill-fitting air filters, allowed dust to enter the building. Furthermore, the practice of using the cooling coils as defacto air filters clogged coils, reduced efficient heat exchange, and allowed dust that blew by the coils to enter the building. Ozone levels, a cause of concern at the time of the first site visit, were measurably lower at the time of the second site visit.

Psychosocial conditions at the Austin Finance Center, described above, may have contributed to workers' concerns about deficiencies in the office's physical environment. The Quantum Leap program in Commercial Accounts appeared to have resulted in a situation in which there was uncertainty and conflict regarding job expectations. Workers felt that being taken away from their regular job duties to work in the mail room conflicted with their ability to maintain expected production quotas. Moreover, what was expected by management in terms of performance quotas of these individuals was uncertain. It is noteworthy that the presence of such role conflict and ambiguity has been associated in other office settings evaluated by NIOSH investigators with symptoms such as headache, fatigue, and tension. It is conceivable that Center employees experiencing such stress-related symptoms attributed them to the physical environment of the office.

VIII. RECOMMENDATIONS

The following recommendations may help to relieve the conditions which are leading to the health and environmental complaints at the Austin Finance Center:

A. Environmental

1. Work above the ceiling should be performed when the building is not occupied. Polyethylene sheeting should be placed over the area underneath the panels to be removed, and the area should be vacuumed after the completion of the work with a vacuum cleaner equipped with a high-efficiency particulate air (HEPA) filter.

2. Building maintenance personnel should ensure that the reusable metal mesh filters on the RTUs equipped with external filters meet the RTU manufacturer's specification for filter efficiency. While new HVAC systems are often designed to provide 90-95% arrestance* and 40-60% dust spot efficiency, the unit's manufacturer is the best source of information on filter selection. Filters should fit snugly in their mounts and not permit dust to blow by where the filters meet the mounts or where adjacent filters meet. Filters missing from the units with internal filter mounts should be replaced. Without these filters in place, air entering these units is not filtered until it reaches the return air grilles. After cleaning, metal mesh filters should be recoated with their manufacturer-recommended adhesive to improve the filters' efficiency and dust-holding capacity.

3. Management should contact the manufacturers of the copiers, laser printers, and reader printers at the Finance Center regarding the availability of ozone filters or exhaust ventilation kits. Replacement of ozone filters should be part of a scheduled system of preventive maintenance based upon the manufacturer's recommendations.

4. A test and balance of the heating, ventilating, and air- conditioning system should be implemented to ensure that the system is operating in accordance with design parameters and current ASHRAE standards, and to correct for the temperature variations seen within the building. If a test and balance does not correct this problem, the control systems should be evaluated, followed by an energy audit, if the condition persists.

5. Management needs to investigate the design and performance of the smoking room ventilation to ensure that it complies with ASHRAE recommendations.[24]

6. Free-standing air cleaners (that utilize filters, rather than electrostatic collectors) may help to reduce complaints of dust associated with opening mail. Improved house-cleaning practices may also help to reduce complaints.

B. Medical

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*Arrestance is a measure of a filter's ability to remove *coarse* dust particles, such as insects or dirt, and is expressed in terms of the percentage by weight of material removed from the air. Efficiency is a measure of a filter's ability to remove fine dust particles.

1. Workers in the Quantum Leap program need to be made aware of organizational expectations regarding their job duties. The roles and responsibilities of these workers need to be better defined to overcome current perceptions of conflict and ambiguity concerning job expectations. In this role clarification process, individual workers should be given the opportunity to have input on decisions or actions that affect their jobs and the performance of their tasks (including production quotas). It would also seem helpful to make the scheduling of assignments to the mail room more predictable to employees.

2. Current ongoing efforts aimed at assessing and ameliorating ergonomic problems associated with work stations need to be accelerated. However, ergonomically-designed equipment is only effective if those using it know how to adjust it to their advantage. Appropriate training should therefore be provided, addressing ergonomic principles related to office work and VDT use. A joint labor-management committee is often the best mechanism for addressing ergonomic problems.

3. Finally, greater attention needs to be devoted to improving routine housekeeping procedures. As noted above, there was a widespread belief among workers that housekeeping was inadequate.

IX. REFERENCES

1. NIOSH [1989]. Eller PM, ed. NIOSH manual of analytical methods. 3rd rev. ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) publication No. 84-100.

2. CDC [1988]. NIOSH recommendations for occupational safety and health standards 1988. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control; National Institute for Occupational Safety and Health. MMWR 37 (supp. S-7).

3. Code of Federal Regulations [1989]. 29 CFR 1910.1000. Washington, DC: U.S. Government Printing Office, Federal Register.

4. ACGIH [1992]. Threshold limit values and biological exposure indices for 1992-1993. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

5. Kreiss KK, Hodgson MJ [1984]. Building associated epidemics. In: Walsh PJ, Dudney CS, Copenhaver ED, eds. Indoor air quality. Boca Raton, FL: CRC Press, pp 87-108.

6. Gammage RR, Kaye SV, eds. [1985]. Indoor air and human health: Proceedings of the Seventh Life Sciences Symposium. Chelsea, MI: Lewis Publishers, Inc.

7. Woods JE, Drewry GM, Morey PR [1987]. Office worker perceptions of indoor air quality effects on discomfort and performance. In: Seifert B, Esdorn H, Fischer M, et al, eds. Indoor air '87, Proceedings of the 4th International Conference on Indoor Air Quality and Climate. Berlin Institute for Water, Soil and Air Hygiene.

8. Skov P, Valbjorn O [1987]. Danish indoor climate study group. The "sick" building syndrome in the office environment: The Danish town hall study. Environ Int 13:399-349.

9. Burge S, Hedge A, Wilson S, Bass JH, Robertson A [1987]. Sick building syndrome: a study of 4373 office workers. Ann Occup Hyg 31:493-504.

10. Kreiss K [1989]. The epidemiology of building-related complaints and illness. Occupational Medicine: State of the Art Reviews. 4(4):575-592.

11. Norbäck D, Michel I, Widstrom J [1990]. Indoor air quality and personal factors related to the sick building syndrome. Scan J Work Environ Health. 16:121-128.

12. Morey PR, Shattuck DE [1989]. Role of ventilation in the causation of building-associated illnesses. Occupational Medicine: State of the Art Reviews. 4(4):625-642.

13. Mendell MJ, Smith AH [1990]. Consistent pattern of elevated symptoms in air-conditioned office buildings: A reanalysis of epidemiologic studies. Am J Public Health. 80(10):1193-1199.

14. Molhave L, Bach B, Pedersen OF [1986]. Human reactions during controlled exposures to low concentrations of organic gases and vapors known as normal indoor air pollutants. Environ. Int., 12, 167-175.

15. Fanger PO [1989]. The new comfort equation for indoor air quality. ASHRAE J 31(10):33-38.

16. Burge HA [1989]. Indoor air and infectious disease. Occupational Medicine: State of the Art Reviews. 4(4):713-722.

17. Robertson AS, McInnes M, Glass D, Dalton G, Burge PS [1989]. Building sickness, are symptoms related to the office lighting? Ann Occup Hyg 33(1):47-59.

18. Wallace LA, Nelson CJ, Dunteman G [1991]. Workplace characteristics associated with health and comfort concerns in three office buildings in Washington, D.C. In: Geshwiler M, Montgomery L, and Moran M, eds. Healthy buildings. Proceedings of the ASHRAE/ICBRSD conference IAQ'91. Atlanta, GA. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

19. Haghighat F, Donnini G, D'Addario R [1992]. Relationship between occupant discomfort as perceived and as measured objectively. Indoor Environ 1:112-118.

20. NIOSH [1991]. Hazard evaluation and technical assistance report: Library of Congress Madison Building, Washington, D.C. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Report No. HETA 88-364-2104 - Vol. III.

21. Skov P, Valbjørn O, Pedersen BV [1989]. Influence of personal characteristics, job-related factors, and psychosocial factors on the sick building syndrome. Scand J Work Environ Health 15:286-295.

22. Boxer PA [1990]. Indoor air quality: A psychosocial perspective. J Occup Med 32(5):425-428.

23. Baker DB [1989]. Social and organizational factors in office building-associated illness. Occupational Medicine: State of the Art Reviews. 4(4):607-624.

24. ASHRAE [1990]. Ventilation for acceptable indoor air quality. Atlanta, GA: American Society of Heating, Refrigerating, and Air-conditioning Engineers. ANSI/ASHRAE Standard 62-1989.

25. ASHRAE [1981]. Thermal environmental conditions for human occupancy. Atlanta, GA: American Society for Heating, Refrigerating, and Air-conditioning Engineers. ANSI/ASHRAE Standard 55-1981.

26. ACGIH [1989]. Guidelines for the assessment of bioaerosols in the indoor environment. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

27. NIOSH [1991]. Building air quality: a guide for building owners and facility managers. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 91-114

28. Proctor N, Hughes J, Fischman M [1988]. Chemical hazards of the workplace. 2nd ed. Philadelphia, PA: J.B. Lipincott Company.

29. NIOSH [1988]. NIOSH testimony to the U.S. Department of Labor: testimony of the National Institute for Occupational Safety and Health on the Occupational Safety and Health Administration's proposed rule on air contaminants, August 1, 1988, OSHA Docket No. H-020. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health.

30. ACGIH [1990]. Documentation of the threshold limit values and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

31. Amdur MO [1980]. Air pollutants. Chapter 24. In: Doull J, Klaassen, CD, Amdur MO, eds. Casarett and Doull's toxicology. 2nd ed. New York, NY: Macmillan Publishing Co., Inc., pp. 619-622.

32. Adams RM [1990]. Dermatitis due to fibrous glass. In: Adams RM, ed. Occupational skin disease. 2nd ed. Philadelphia, PA: W.B. Saunders Company, pp. 16-17.

33. Milby TH, Wolf CR [1969]. Respiratory tract irritation from fibrous glass inhalation. J Occup Med 11:409-410, 1969.

34. IARC [1988]. IARC monographs on the evaluation of the carcinogenic risks of chemicals to humans: man-made mineral fibers and radon. Vol. 43. Lyon, France: World Health Organization, International Agency for Research on Cancer, pp. 39-171.

35. Stanton MF, Wrench C [1972]. Mechanisms of mesothelioma induction with asbestos and fibrous glass. J Nat Cancer Inst 48:797-821.

36. Stanton MF, Layard M, Tegeris A, Miller E, May M, Morgan E, et al. [1981]. Relation particle dimension to carcinogenicity in amphibole asbestos and other fibrous minerals. J Nat Cancer Inst 67:965-975.

37. Mohr U, Pott F, Vonnahme FJ [1984]. Morphological aspects of mesothelioma after intratracheal instillation of fibrous dusts in Syrian golden hamsters. Exp Pathol 26:179-183.

38. Pott F [1987]. Problems in defining carcinogenic fibers. Ann Occup Hyg 31:799-802.

39. Pott F, Ziem U, Reiffer F-J, Huth F, Ernst H, Mohr U [1987]. Carcinogenicity studies on fibers, metal compounds, and some other dusts in rats. Exp Pathol 32:129-152.

40. Doll R [1987]. Symposium on MMMF, Copenhagen, October 1986: overview and conclusions. Ann Occup Hyg 31(4B):805-819. Enterline PE, Marsh GM, Henderson V, Callahan C [1987]. Mortality update of a cohort of U.S. man-made mineral fibre workers. Ann Occup Hyg 31:625-656.

41. Marsh GM, Enterline PE, Stone RA, Henderson VL [1990]. Mortality among a cohort of US man-made mineral fiber workers: 1985 follow-up. J Occup Med 32:594-604.

42. Timbrell V [1976]. Aerodynamic considerations and other aspects of glass fiber. In: Occupational exposure to fibrous glass (proceedings of a symposium), NIOSH. Rockville, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76-151.

43. NIOSH [1977]. A recommended standard for occupational exposure to fibrous glass. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Center for Disease Control, National Institute for Occupational Safety and Health; DHEW (NIOSH) Publication No. 77-152

44. Marsh GM, Enterline PE, Stone RA, Henderson VL [1990]. Mortality among a cohort of US man-made mineral fiber workers: 1985 follow-up. JOM 32:594-604.

45. NIOSH [1988]. NIOSH testimony to the U.S. Department of Labor: statement of the National Institute for Occupational Safety and Health. Comments of the National Institute for Occupational Safety and Health on the Occupational Safety and Health Administration's proposed rule on air contaminants, July, 1988. NIOSH policy statements. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health.

46. 54 Fed. Reg. 2510 [1989]. Occupational Safety and Health Administration: Air contaminants; final rule.

47. Schiller GE, Arens EA [1988]. Thermal comfort in office buildings. ASHRAE J 30(10):26-32.

48. Skov P, Valbjorn O, Pedersen BV [1990]. Danish Indoor Climate Study Group: Influence of indoor climate on the sick building syndrome in an office environment. Scand J Work Environ Health 16: 363-371.

49. Wilson S, Hedge A [1987]. The Office Environmental Study: A Study of Building Sickness. London, England: Building Use Studies, Ltd.

50. EPA [1991]. Indoor Air Quality and Work Environment Study: EPA Headquarters Buildings. Volume I and Volume III. Washington, DC: U.S. Environmental Protection Agency.

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For the purpose of informing affected employees, 42 CFR 85.11 requires the employer to post a copy of this report at or near the workplace(s) of affected employees for a period of 30 calendar days.

Table 1
Carbon Dioxide Concentrations
U.S. Department of Veterans Affairs, Austin Finance Center
Austin, Texas
April 17, 1991
HETA 91-120

Location	Carbon Dioxide Concentration (parts per million)		
	Morning	Mid-Day	Afternoon
1	475	925	875
2	425	825	875
3	450	825	875
4	450	775	800
5	450	825	850
6	---	875	825
7	450	875	875
8	450	775	825
9	450	775	825
10	475	850	850
11	425	575	625
12	---	700	825
13	450	850	875
14	450	825	775
15	475	825	825
16	475	850	875
17	450	850	875
18	475	750	825
19	500	775	775
20	500	775	850
Outside	400	400	375

Table 2
Relative Humidity
U.S. Department of Veterans Affairs, Austin Finance Center
Austin, Texas
April 17, 1991
HETA 91-120

Location	Relative Humidity (percent)		
	Morning	Mid-Day	Afternoon
1	64.4	49.4	51.0
2	59.2	52.3	52.9
3	59.0	53.3	53.8
4	58.8	56.6	56.0
5	57.9	56.0	55.4
6	----	54.0	55.1
7	56.1	53.3	52.8
8	56.7	53.9	53.3
9	55.5	53.3	51.6
10	53.7	57.8	50.9
11	63.0	60.7	55.0
12	----	58.2	48.4
13	50.0	54.0	50.4
14	51.9	56.5	52.6
15	52.5	55.0	52.5
16	51.4	53.1	52.0
17	54.0	54.9	51.4
18	55.7	54.4	55.0
19	54.7	53.7	55.6
20	54.6	55.0	52.0
Outside	93.0	77.3	75.1

Table 3
Temperature
U.S. Department of Veterans Affairs, Austin Finance Center
Austin, Texas
April 17, 1991
HETA 91-120

Location	Temperature (degrees Fahrenheit)		
	Morning	Mid-Day	Afternoon
1	72.0	73.6	74.8
2	73.5	74.5	75.1
3	73.3	74.4	75.1
4	73.3	74.2	75.2
5	73.4	74.7	75.3
6	----	76.5	76.6
7	74.5	76.5	76.7
8	74.6	76.0	77.0
9	75.4	76.7	78.0
10	75.5	76.9	78.0
11	74.0	76.9	80.0
12	----	76.4	77.6
13	74.6	76.5	76.7
14	74.3	76.4	76.0
15	74.0	75.6	75.5
16	73.5	75.4	75.3
17	75.5	76.7	75.6
18	76.4	76.8	76.0
19	76.4	76.7	76.0
20	75.2	74.5	75.5
Outside	72.0	77.7	80.0

Table 4
Frequency of Symptoms by Work Area[1]
U.S. Department of Veterans Affairs, Austin Finance Center
Austin, Texas
April 17, 1991
HETA 91-120

SYMPTOM	"Often" or "Always" and Gets Better Away From Work		
	Reader/Printer Areas (n=78)	Other Areas (n=124)	Total (n=202)[1]
	No. (%)	No. (%)	No. (%)
sore eyes	25 (32)	31 (25)	56 (28)
stuffy nose	24 (31)	25 (20)	49 (24)
dry, itching, tearing eyes	21 (26)	25 (20)	46 (23)
headache	17 (22)	25 (20)	42 (21)
fatigue/tiredness	21 (27)	20 (16)	
sleepiness/drowsiness	13 (17)	28 (13)	
pain in upper back	18 (23)	22 (18)	
sneezing	19 (24)	21 (17)	
burning eyes		(15)	39 (19)
pain in shoulder/neck		(19)	36 (18)
pain in lower back		(15)	36 (18)
runny nose		(17)	35 (17)
tension/nervousness		(14)	27 (13)
aching joints		(11)	24 (12)
dry throat		(12)	23 (11)
pain in hands/wrists		(11)	22 (11)
chills		12 (10)	21 (10)
cough		14 (11)	20 (10)
trouble concentrating		13 (11)	19 (9)
feeling depressed		12 (10)	19 (9)
blurry eyes		10 (8)	
16 (8)			
dry skin	5 (6)	10 (8)	15 (7)
trouble remembering	6 (8)	9 (7)	15 (7)
hoarseness	6 (8)	9 (7)	15 (7)
sore throat	5 (6)	9 (7)	14 (7)
wheezing	8 (10)	6 (5)	14 (7)
contact lens problems[2]	4 (40)	5 (31)	9 (35)
dizziness	2 (3)	6 (5)	8 (4)
chest tightness	5 (6)	3 (2)	8 (4)
shortness of breath	2 (3)	3 (2)	5 (3)
nausea	1 (1)	3 (2)	4 (2)
fever	1 (1)	2 (2)	3 (2)

[1]Total number of respondents=202; excludes 44 with missing work area response on questionnaire.

[2]Percentages based only on those who wore contact lenses at work.