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Federal Express
Cincinnati, Ohio

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PREFACE

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

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SUMMARY

On November 7, 1997, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from employees at the Federal Express Call Center in Cincinnati, Ohio. The requesters submitted this confidential HHE request because of concerns about the indoor environmental quality (IEQ) in their workplace. The concerns listed on the request form were: a lack of ventilation, an unclean work area, exposures to dust, mold, and contaminants, illnesses of unknown origin, chronic upper respiratory problems, above average absenteeism, low employee morale, and a hostile work environment. NIOSH investigators visited the call center on February 20, 1997, and then returned on March 4, 1997, to perform confidential employee interviews and an industrial hygiene evaluation. The interviewed employees reported symptoms such as runny nose; stuffy nose/sinus congestion; dry throat; dry, itching, or irritated eyes; fatigue; and sleepiness. Several employees also reported pain or numbness in the shoulder, neck, hands, or wrist, and one of the interviewed employees had recently undergone surgical decompression of the carpal tunnel to relieve the pain. Also, a number of interviewed employees reported that they experienced symptoms of stress as a result of excessive work pressure and mandatory overtime. The industrial hygiene evaluation consisted of a visual inspection of the ventilation system, observations of the work area, and collection of carbon dioxide, temperature, and relative humidity measurements in both the morning and afternoon. The carbon dioxide, temperature, and relative humidity were all within acceptable ranges, and the carbon dioxide concentration did not increase throughout the day, which suggests that the ventilation system was providing good air circulation and introducing enough outside air into the work area. Visible mold growth and fine dust were observed in the roof–top air–handling unit (AHU).

As with many indoor air quality evaluations, no specific cause(s) were identified for the reported health complaints, but recommendations were made to try to improve the work environment and for immediate cleaning and improved maintenance of the AHU.

Keywords: SIC 4513 (Air Courier Services), carbon dioxide, temperature, relative humidity, ventilation, IEQ, IAQ

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INTRODUCTION

On November 7, 1997, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from employees at the Federal Express Call Center in Cincinnati, Ohio. The requesters submitted this confidential HHE request because of concerns about the indoor environmental quality (IEQ) in their workplace. The concerns listed on the request form were: a lack of ventilation; an unclean work area; exposures to dust, mold, and contaminants; illnesses of unknown origin; chronic upper respiratory problems; above average absenteeism; low employee morale; and a hostile work environment. After an initial refusal of Federal Express to accept NIOSH's authority to conduct this HHE, NIOSH investigators were permitted to visit the call center on February 20, 1997, and they returned on March 4, 1997, to conduct confidential employee interviews and an industrial hygiene evaluation.

BACKGROUND

The Federal Express Call Center occupies half of a commercial building in an office park in suburban Cincinnati. In the two–story building, Federal Express has offices, a cafeteria, and locker rooms on half of the first floor, and offices and a large open call center on half of the second floor. The call center itself is surrounded by walls of windows on three sides (one wall looks out to the atrium of the building, the other two are outside walls). The windows all have dark blinds, which are typically closed to prevent glare. The overhead lighting is also kept very dim. Within the room are 23 hexagonal desks, each of which have 6 work stations on their circumference, divided by four-foot-high partitions. Each work station has a computer, headset telephone, and chair. Also, in this same room are four rectangular areas, separated by five-foot-high partitions, each of which contain two work stations. All of the partitions are cloth with metal or wood frames, and all the furniture is plastic or wood veneer systems furniture.

There are live plants on the floor and on the center of each hexagonal desk. These plants are maintained by an outside contractor that waters them weekly and applies TriState Foliage Wonder® (a gloss enhancer that contains 4% polyethylene glycol monlauryloxy) as needed.

Janitorial services, such as dusting, edge vacuuming, sweeping, trash removal, and desktop cleaning are provided by the building owner, Heitman Properties. The desktop cleaning is done with only cloths and water; no cleansers are used except for the ones the employees use themselves to clean their own area. In response to a confidential employee complaint filed with the Occupational Safety and Health Administration (OSHA) in the fall of 1996, Federal Express contracted with a carpet shampooing company to perform a light shower shampoo and mold treatment monthly and a thorough shampoo and clear water extraction semiannually.

Heitman Properties is responsible for the ventilation systems; a Heitman engineer spends approximately 20 hours per week at this location for the purpose of maintaining the four heating, ventilating, and air–conditioning (HVAC) systems. Each consists of a large roof–top air–handling unit (AHU) and several variable air volume (VAV) reheat units in the ceilings along the outside walls, and each system supplies half of a floor. The whole call center area and associated offices are supplied by one HVAC system.

METHODS

Carbon Dioxide

Real–time CO_2 measurements were obtained using a Gastech Model RI-411A, Portable CO_2 Indicator. This portable, battery–operated instrument monitors CO_2 via non-dispersive infrared absorption with a range of 0-4975 parts per million (ppm), and a sensitivity of 25 ppm. Instrument calibration was performed prior to use with a known concentration of CO_2 span gas (800 ppm).

Temperature and Relative Humidity

Real-time temperature and RH measurements were conducted using a TSI battery–operated Model 8360 Velocicalc® Plus Air Velocity meter. The TSI meter is capable of directly measuring dry bulb temperature and RH, ranging from –4 to 140°F, and 0 to 95% RH.

Epidemiologic Evaluation

On March 4, 1997, individual confidential interviews were conducted with 20 of the nearly 140 customer service representatives currently employed at the facility. Twelve of the employees interviewed were selected because they had been identified to the investigators as employees who may be experiencing symptoms related to indoor environmental quality. The remaining eight employees were randomly chosen by the NIOSH investigator from an employee roster. The purpose of these interviews was to gain further insight into employee health concerns associated with the building, building contents, and work processes. The interviews covered: (a) symptoms of different organ systems and their relation to the working environment, including symptoms commonly associated with poor indoor environmental quality; (b) symptoms that may occur due to illnesses affecting major physiological systems such as respiratory, cardiovascular, gastrointestinal, dermatological, neurological and musculoskeletal systems; (c) past medical history, including history of allergies; and (d) personal views and concerns about the indoor environmental quality and other aspects of work.

EVALUATION CRITERIA

Indoor Environmental Quality

The symptoms reported 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.

Scientists investigating indoor environmental problems believe that there are multiple factors contributing to building–related occupant complaints.[1,2] Among these factors are imprecisely defined characteristics of 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.[3,4,5,6] Reports are not conclusive as to whether increases of outdoor air above currently recommended amounts ($15 cubic feet per minute of outside air per person [CFM OA/person]) are beneficial.[6] However, rates lower than these amounts appear to increase the rates of complaints and symptoms in some studies.[7]

Design, maintenance, and operation of HVAC systems are critical to their proper functioning and provision of healthy and thermally comfortable indoor environments. Indoor environmental pollutants can arise from either outdoor or indoor sources.[8]

There are also reports describing results which show that occupant perceptions of the indoor environment are more closely related to the occurrence of symptoms than the measurement of any indoor contaminant or condition.[9] Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints.[10,11] 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.

Problems that 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 office furnishings, machines, structural components of the building and contents, tobacco smoke, microbiological contamination, and outside air pollutants; comfort problems due to improper temperature and RH conditions, poor lighting, and unacceptable noise levels; adverse ergonomic conditions; and job–related psychosocial stressors. In most cases, however, no cause of the reported health effects could be determined.

Standards specifically for the non–industrial indoor environment do not exist. NIOSH, the Occupational Safety and Health Administration (OSHA), and the American Conference of Governmental Industrial Hygienists (ACGIH) have published regulatory standards or recommended limits for occupational exposures.[12,13,14] With few exceptions, pollutant concentrations observed in the office work environment fall well below these published occupational standards or recommended exposure limits. The American Society of Heating, Refrigerating, and Air–Conditioning Engineers (ASHRAE) has published recommended building ventilation design criteria and thermal comfort guidelines.[15,16] The ACGIH has also developed a manual of guidelines for approaching investigations of building–related symptoms that might be caused by airborne living organisms or their effluents.[17]

Carbon Dioxide

Carbon dioxide is a normal constituent of exhaled breath and, if monitored, can be used as a screening technique to evaluate whether adequate quantities of outside air are being introduced into an occupied space. In ASHRAE's most recently published ventilation standard, 62-1989, Ventilation for Acceptable Indoor Air Quality, a supply rate of CFM OA/person for office spaces is recommended.[16]

Indoor CO_2 concentrations are normally higher than the generally constant ambient CO_2 concentration (range 300-350 ppm). Carbon dioxide concentration is used as an indicator of the adequacy of outside air supplied to occupied areas. When indoor CO_2 concentrations exceed 1000 ppm in areas where the only known source is exhaled breath, inadequate ventilation is suspected and other indoor contaminants may also be increased. NIOSH has stated that a level of 800 ppm should trigger inspection of ventilation system operation.[18]

Temperature and Relative Humidity

Temperature and RH measurements are often collected as part of an indoor environmental quality investigation because these parameters affect the perception of comfort in an indoor environment. The perception of thermal comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperature.[15] Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. The American National Standards Institute (ANSI)/ASHRAE Standard 55-1992 specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally acceptable.[15] Assuming slow air movement and 50% RH, the operative temperatures recommended by ASHRAE range from 68-75°F in the winter, and from 73–79°F in the summer. In separate documents, ASHRAE also recommends that RH be maintained between 30 and 60% RH.[15,16]

RESULTS

Carbon Dioxide Concentrations

Carbon dioxide concentrations were measured in 21 locations throughout the south side of the second floor – 4 office areas, 16 locations within the open call center area, and 1 location in the separate international calls room. A measurement was also taken outside for comparison. During the morning (8:30–9:30 am), the inside CO_2 concentrations ranged from 425–575 ppm (475–525 ppm within the actual call center area), and outside was 350 ppm. During the afternoon (3:30–4:10 pm), the inside CO_2 concentrations ranged from 375–525 ppm (375–525 ppm within the actual call center area), and outside was 350 ppm.

Temperature and Relative Humidity Levels

Temperature and relative humidity measurements were taken at the same time and place as the CO_2 measurements. In the morning, the inside temperature ranged from 73–75°F, and the relative humidity ranged from 27–32%. The outside measurements were 51°F and 67%. In the afternoon, the inside temperature ranged from 75–77°F, and the relative humidity ranged from 28–32%. The outside measurements were 65°F and 32%.

Ventilation Assessment

The inspection of the HVAC system was limited to a visual examination of the AHU that supplies the south side of the second floor and its supplies and returns. The roof–top AHU is a 50–ton, single–duct, variable–air volume (VAV) central system with perimeter reheat. This AHU serves 25 zones (15 in the call center area), each with their own temperature control. The automatic night–time set–back was set so the AHU was in full operation between 6:00 am to 8:00 pm but can be readjusted when necessary. The VAV air temperature set point was 55°F. Building air is returned to the AHU through a ceiling plenum and then mixed with outside air (OA), filtered, conditioned, and recirculated back to the building space. The OA intake adjusts automatically, and has a minimum of 15% OA and a maximum of 100%. The air is filtered first through pleated

panel filters (25–35% efficiency and >90% arrestance) that are changed quarterly, and then through bag filters (55–65% efficiency) that are changed annually. The onsite Heitman Properties engineer is responsible for daily/weekly visual inspections, filter changing, and responding to any problems. An outside ventilation maintenance firm is contracted to perform semi–annual inspections, cleaning, and maintenance. At the time of this site visit, the last formal inspection and cleaning was in October, 1996. There was no record or report of any formal test and balance of this HVAC system, but Heitman Properties planned to do one after this HHE.

Visual inspection of the AHU revealed a mechanically well–maintained unit with secure panels and easy accessibility to most areas of the AHU. There was a fine dust covering most of the inside areas, both before and after the filters. However, the filters fit securely in their places and there was no evidence of by–pass on the edges of the filters. The source of the dust downstream of the filters (and correspondingly on the supply grills and ceiling panels near the air supplies) was not apparent. Perhaps air can by–pass the entire filter area along the sides of the AHU.

Since it was not cooling season, the drain pan was dry. The pan did contain residue and possibly small amounts of mold mixed in with that residue, and GC Formula 316 microbiocide tablets. Visible mold growth was noted on the pipe insulation above and near the drain pan, and also on some walls near the drain pan and coils. The coils did not have visible mold growth on them, but did have caked dust and debris on them, especially closer to the bottom. One of the drain pans was not accessible because the plastic pipe that needed to be removed to open the access door was stuck. This stuck pipe would obviously have prevented the daily/weekly inspections in this area by the onsite Heitman Properties engineer.

General Observations

The air supplies in the office space and their nearby ceiling panels had visible dust stains on them. The supplies and the returns in this work area had not been altered by the occupants, but some employees reported that some supplies blew more air than others. Plants and papers under some supplies were noticeably moved more than others from the air flow, and occasionally employees requested to move their locations because of too much or too little air flow.

Three of the four walls of the call center area are windows and two of these walls are outside walls. Even though there are blinds on all the windows, the windows could still be a significant source of radiant heat, especially since the blinds are black (which absorbs light and re–radiates the energy as heat) and not white (which reflects light). Most of the ceiling lights were kept off and the blinds lowered, which resulted in a rather dark work area. Although appealing to some workers because of glare reduction, it was a discomfort to others.

The work space was generally well–maintained but quite dusty. Similarly, the bathrooms and cafeteria, although neat, were somewhat dirty, especially along the floor edges. A few of the ceiling panels had signs of water damage on them, but no mold growth was visible on the surface.

Two policies at this location that serve to improve the indoor air quality are that smoking is not permitted in the building and employees are not permitted to wear perfumes or hair sprays. A policy that appears to have a negative effect on the work environment is that overtime is required and employee schedules may be changed weekly.

Epidemiologic Evaluation

The predominant symptoms which were reported by interviewed employees were those that have been found in numerous NIOSH investigations

conducted in office environments where the concern is poor indoor environmental quality. These symptoms included runny nose, stuffy nose/sinus congestion, dry throat, dry itching or irritated eyes, fatigue, and sleepiness. Many of the employees reporting these symptoms experienced the symptoms on more than one day and several have sought treatment for their symptoms from their physicians. Several employees reported pain or numbness in the shoulder, neck, hands, or wrist. One employee had recently undergone surgical decompression of the carpal tunnel to relieve pain. A number of interviewed employees reported that they experienced symptoms of stress as a result of excessive work pressure and mandatory overtime.

DISCUSSION AND CONCLUSIONS

The CO_2 concentrations were all within recommended guidelines and they did not increase in the afternoon, which suggests that the HVAC system was circulating enough outside air to the work area. Also, the temperature and relative humidity measurements were all within the recommended comfort range.

The ventilation system, although fairly well maintained, did have a few problems. It was very dusty even downstream of the filters, and there was mold growing in several areas near the drain pans. Both dust and mold are antigenic (cause allergies) and can also be irritating. Any contaminant in the AHU, especially downstream of the filters can be entrained into the air flow and distributed to the work environment. Additionally, molds produce spores which are biologically designed to be released into the air for dispersion.

Reports of building-related symptomatology, like those described above, have become increasingly common in recent years; unfortunately the causes of these symptoms have not been clearly identified. As discussed in the Evaluation Criteria section of this report, many factors are suspected (e.g., multiple chemical pollutants, microbial proliferation withing the building, inadequate amounts of outside air, etc.). While it has been difficult to identify concentrations of specific contaminants that are associated with the occurrence of symptoms, many researchers in the field (including some at NIOSH) believe that the occurrence of IEQ-related symptoms can be lessened by providing a clean interior environment.

RECOMMENDATIONS

Although no clear environmental causes for the symptoms reported by employees of this Federal Express facility were found, the NIOSH evaluation identified some environmental deficiencies in this facility. The following recommendations are offered to correct those deficiencies and to optimize employee comfort.

1. The AHU should be thoroughly cleaned to remove all the dust and mold. The source of the downstream dust should be identified and the problem rectified. The routine inspections should include checking for microbial growth, and any contamination should be cleaned whenever it is noticed.

2. The HVAC system should be tested and balanced to ensure that it is operating properly. The routine inspections, filter changing, and maintenance should be continued.

3. The janitorial services could be improved, especially the dusting and the cleaning of the bathrooms and cafeteria.

4. Since some workers complain of excessive heat in the work area, consider replacing the black window blinds with more reflective white ones. The windows and black blinds could potentially

result in an increase of radiant heat, making the work place uncomfortably hot.

5. Always replace any water–damaged material, especially porous material such as ceiling panels or carpets, before any microbial growth can occur.

6. Communication between management and staff should be improved to ensure that all employees are kept informed of activities regarding IEQ.

7. Explore alternative methods for work scheduling. Stress among employees resulting from required overtime may be exacerbating health problems related to existing environmental conditions. Consider a voluntary overtime policy.

8. Consider a more frequent or more lenient rest break policy.

9. Since the lack of lighting was disturbing to some of the employees, but others seemed to prefer the dark work atmosphere, local management should try to resolve the lighting problem with input from the employees.

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