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SUMMARY

A Health Hazard Evaluation (HHE) request was submitted to the National Institute for Occupational Safety and Health (NIOSH) by the Counsel to the Secretary for Drug Abuse Policy, a small office (7 professionals) located on the 6th floor of the 7-story Hubert H. Humphrey (HHH) Building located in Washington, D.C. Employee complaints included "flu-like" upper respiratory symptoms, eye irritation, headache, diffuse rash, fever, and joint pain. Several workers also expressed concern over a black material, described as "soot" or "sludge", which they felt originated from the ventilation system in the building.

On July 23, 1991, private interviews were conducted with all 7 employees in the Counsel to the Secretary on Drug Abuse Policy office, and with 3 employees selected by management who worked in other offices on the 6th floor of the HHH Building. All 10 employees interviewed were nonsmokers. Five (50%) employees reported an increase in upper respiratory irritation symptoms such as cough, nasal congestion, and hoarseness since they began working at this building. Three workers reported experiencing frequent headaches, and one employee reported eye irritation that resolves when away from the office for extended periods. Several employees reported that the temperature varied greatly throughout the day and that the humidity seemed high. The reported symptoms consisting of fever, diffuse rash, and joint pain were determined by NIOSH investigators to be associated with an acute febrile illness and not suggestive of an occupationally related disease.

The other respiratory irritation symptoms mentioned by employees in the medical interviews are common in buildings where indoor air quality is perceived to be poor. The symptoms are diverse and not suggestive of any particular medical diagnosis or readily associated with a causative agent.

During this evaluation the carbon dioxide (CO_2) concentrations on the 6th floor ranged from 425 to 675 parts per million (ppm), well below the 1000 ppm guideline which NIOSH uses to evaluate the adequacy of the ventilation in an office work area. These low CO_2 concentrations are likely a reflection of both the low employee density in the building and the quantity of outside air which the ventilation systems are introducing into the various office areas (based on the design specifications). The CO_2 concentration outside the office building was below 400 ppm. All work areas surveyed were within the ASHRAE guidelines for both temperature and relative humidity (RH). The ASHRAE "comfort chart," which presents temperature and RH ranges considered to be both comfortable and healthful, lies between 73 and 77°F and 20 to 60% RH.

The CO_2 levels measured during this evaluation were remarkably low and approached the ambient concentration. This is not unexpected considering that the ventilation systems in the building are run continuously even during non-work hours. While the percentage of outside air was not measured as part of this survey, the low

CO_2 levels suggest that sufficient outside air was being introduced into the ventilation system. The suspected mold growth near some of fan coil units was likely due to high humidity conditions possibly caused by exterior windows being opened during the work day. The fever, diffuse rash, and joint pain symptoms mentioned in the initial HHE request were not considered by NIOSH investigators to be occupationally related. The other respiratory irritation symptoms mentioned by employees in the medical interviews are common in buildings where indoor air quality is perceived to be poor and are not suggestive of any particular medical diagnosis or readily associated with a causative agent.

Recommendations have been made to clean and disinfect any surfaces where visible mold growth is apparent and to test and re-balance the ventilation system for the entire building.

Keywords: SIC 9441 (Administration of Social, Human Resource and Income Maintenance Programs), indoor air quality, carbon dioxide, temperature, relative humidity, ventilation.

INTRODUCTION

A Health Hazard Evaluation (HHE) request was submitted to the National Institute for Occupational Safety and Health (NIOSH) by the Counsel to the Secretary for Drug Abuse Policy, a small office comprised of 7 professionals located on the 6th floor of the 7-story Hubert H. Humphrey (HHH) Building. Employee complaints included "flu-like" upper respiratory symptoms, eye irritation, headache, diffuse rash, fever, and joint pain. Several workers also expressed concern over a black material, described as "soot" or "sludge", which they felt originated from the ventilation system in the building.

BACKGROUND

Previous Evaluations

NIOSH

Portions of the 7-story HHH Building have been previously surveyed by NIOSH investigators in earlier HHEs. In one of the last visits to this building, in March 1982, NIOSH researchers conducted a detailed investigation concerning flu-like illness among Public Health Service employees on the 7th floor.[1] A series of water leaks had occurred on the 7th floor prior to this HHE.

On the basis of this 1982 HHE, a health hazard in corridor 7B of the HHH Building was identified. A hypersensitivity pneumonitis-like syndrome associated with water leaks (but not with the heating, ventilating, and air-conditioning (HVAC) system) was described. The offending agent, however, was not identified in this study.

Department of Health and Human Services (DHHS)

Air sampling for carbon dioxide (CO_2) using colorimetric detector tubes had been performed in and around Room 638 in January 1991 by an employee in the HHS safety office. The CO_2 levels measured during this limited evaluation were estimated at approximately 1000 parts per million (ppm), and were considered elevated. The results of these measurements along with recommendations to relocate furniture in office 638E to improve the air distribution from the ventilation system were discussed in a one-page memorandum dated January 18, 1991.

Current Health Hazard Evaluation

NIOSH investigators conducted an initial site visit to the HHH Building on July 22-23, 1991. During this survey measurements were made for temperature, relative humidity (RH), and CO_2 within the offices of the Counsel to the Secretary for Drug Abuse Policy, at several locations on the 6th floor of the HHH Building, and outside the building. Information was obtained on the ventilation systems which serviced the building, especially in the areas on the 6th floor which were of concern to the requester. NIOSH investigators privately interviewed all 7 employees in the office of the Counsel to the Secretary for Drug Abuse Policy along with 3 additional workers located on

the 6th floor who were concerned with their work environment.

Ventilation System

The 7-story HHH Building was partially completed in 1975 when it was occupied by the DHHS (then known as the Department of Health, Education, and Welfare.) Although it was constructed as an open-space office building, it was subsequently subdivided into individual offices. Each floor has eight corridors, lettered A through H. A penthouse level (above the 7th floor) houses both the cafeteria and the primary air handlers for all of the offices.

Ventilation for the office areas is provided by a constant air volume system, which currently operates 24 hours/day, 7 days/week. Supply air is provided along the outside of the suspended ceiling panels, and returns are situated around light fixtures. Perimeter heating and cooling needs are provided by 940 individual fan coil units located throughout the building. These units have 3 operating speeds and according to the maintenance staff are cleaned annually. Although not intended to be opened by employees, several windows located in individual offices were partially open during our visit.

The original design of the building provided for automatic roll-type filtration for the outside air. In 1986 the efficiency of this system was increased when these filters were replaced with 2 x 2 foot filter panels. These filter panels are currently replaced every 3 weeks and are rated approximately 30% efficient. Bag-type filters (replaced quarterly, rated about 50-60% efficient) follow the panel filters.

Renovation of the HVAC system in 1991 involved the removal of baffles from all of the baffle boxes (estimated at between 400 and 450) that are located on floors 3 through 7. The removal of these baffles was intended to decrease resistance and improve air movement through the system.

INDOOR AIR QUALITY: A NIOSH PERSPECTIVE

NIOSH investigators have completed over 700 investigations of the indoor environment in a wide variety of settings. The majority of these investigations have been conducted since 1979, paralleling the "energy efficiency" concerns of building operators and architects.

Commonly, the symptoms and health complaints reported by building occupants have been diverse and 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. The workplace environment has been typically implicated because workers' symptoms reportedly lessen or resolve when they leave the building. Based on changes in building construction following the energy crisis of the early 1970's, an attractive hypothesis is that reduced levels of fresh air intake or increased levels of air contaminants, accompanying inadequate building ventilation, accounted for this condition. Recent NIOSH HHEs, however, have indicated that the primary cause in some building environments may be unrelated to ventilation or other measured

environmental parameters.[1,2]

Less often illness may be found to be specifically related to something in the building environment. Some examples of building-related illnesses are environmental allergy (allergic rhinitis, allergic asthma, and hypersensitivity pneumonitis), caused by exposure to spores, organic dusts, animal "danders", bacteria and fungi, and bacterial pneumonia (Legionnaires' disease, and Pontiac fever).

Problems which NIOSH investigators have investigated in the non-industrial indoor environment are often found to be multifactorial in origin, and can arise from a variety of reasons including poor air quality due to overcrowding, smoking, structural components of the building and contents, microbiological contamination, volatile organic chemicals from office furnishings and machines, outside air pollutants, and ventilation system deficiencies; comfort problems due to improper temperature and relative humidity conditions, poor lighting, and unacceptable noise levels; adverse ergonomic conditions; job-related psychosocial stressors; and unknown reasons.

EVALUATION CRITERIA

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.[3,4] With few exceptions, pollutant concentrations observed in the office work environment fall well below these published occupational standards or recommended exposure limits. Scientists suspect that building related occupant complaints may be attributable not to specific environmental substances, but to the cumulative effect resulting from exposures to low concentrations of multiple pollutants, and work environments outside of thermal comfort ranges. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has published recommended building ventilation design criteria, and thermal comfort guidelines.[5,6]

The basis for monitoring carbon dioxide, and the temperature and relative humidity are presented below:

Temperature and Relative Humidity (RH)

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. The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 55-1981 specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally comfortable.[5]

Carbon Dioxide (CO_2)

Carbon dioxide (CO_2) is a normal constituent of exhaled breath; measurement of CO_2 concentrations can be used as a screening technique to evaluate

whether adequate quantities of fresh air are being introduced into an occupied space. ASHRAE's Ventilation Standard, ASHRAE 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, 15 cfm/person for reception areas, classrooms, libraries, auditoriums, and corridors, and 60 cfm/person for smoking lounges.[6] This standard also provides estimated maximum occupancy figures for each area.

Indoor CO_2 concentrations are normally higher than the generally constant ambient 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. Maintaining the recommended ASHRAE outdoor air supply rates should provide for acceptable indoor air quality, barring any unusual emission source and assuming good quality outdoor air.

METHODS

Carbon Dioxide (CO_2)

Real-time CO_2 levels were determined using Gastech Model RI-411A, Portable CO_2 Indicators. This portable, battery-operated instrument monitors CO_2 (range 0-4975 ppm) via non-dispersive infrared absorption with a sensitivity (limit of detection) of 25 ppm. Instrument zeroing and was performed prior to use with "zero" air (ambient air which has passed through a special filter to remove the CO_2). Calibration was performed with a known CO_2 span gas (800 ppm). The monitor was also post-calibrated after use.

Temperature and Relative Humidity (RH)

Real-time temperature and RH measurements were made using a Vaisala Model HM 34 humidity and temperature meter. The HM 34 is a battery-operated meter which uses humidity and temperature sensors housed at the tip of an extendable probe. Humidity measurement is performed by a Humicap© sensor which has a measurement range from 0 to 100%. The temperature sensor has a measurement range from -4 to 140°F.

MEDICAL

On July 23, 1991, private interviews were conducted with all 7 employees in the Council on Drug Abuse Policy office, and with 3 employees (identified by management as employees concerned with IAQ in their work area) who worked in other areas on the 6th floor of the HHH Building. All 10 employees interviewed were nonsmokers. Seven employees had begun working at the building within the previous two years. Five (50%) employees reported an increase in upper respiratory irritation symptoms such as cough, nasal congestion, and hoarseness

since they began working at this building. Three workers reported experiencing frequent headaches, and one employee reported eye irritation that resolves when she is away from the office for extended periods. Several employees reported that the temperature varied greatly throughout the day and that the humidity seemed high. Some of the symptoms reported by the interviewed workers, such as fever, diffuse rash, and joint pain, although unusual, were considered by NIOSH investigators not to be occupationally related.

The other respiratory irritation symptoms mentioned by employees in the medical interviews are common in buildings where indoor air quality is perceived to be poor. The symptoms are diverse and not suggestive of any particular medical diagnosis or readily associated with a causative agent.

RESULTS

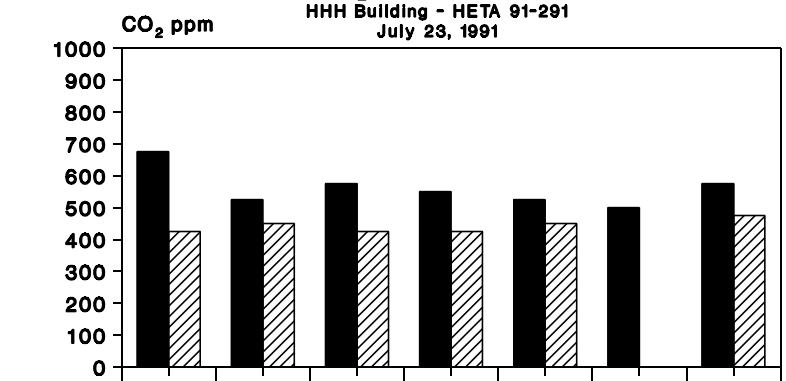
Carbon Dioxide

During this evaluation the CO_2 concentrations on the 6th floor were below 1000 ppm, a guideline which NIOSH investigators use to evaluate the adequacy of the ventilation in an office work area. These low CO_2 concentrations are likely a reflection of both the low employee density in the area evaluated and the quantity of outside air which the ventilation systems were introducing into the various office areas (based on the design specifications.) The ambient CO_2 concentration outside the office building was below 400 ppm. The results of the $C0_2$ measurements taken on July 23, 1991 are shown in Figures 1 and 2.

Temperature and Relative Humidity

All work areas surveyed were within the ASHRAE guidelines for both temperature and RH. The ASHRAE "comfort chart," which presents temperature and RH ranges considered to be both comfortable and healthful,

Figure 1
CO_2 Concentrations
HHH Building - HETA 91-291
July 23, 1991



	629H	639H	613D	647D	638E	636E	625E
Morning	675	525	575	550	525	500	575
Afternoon	425	450	425	425	450	NS	475

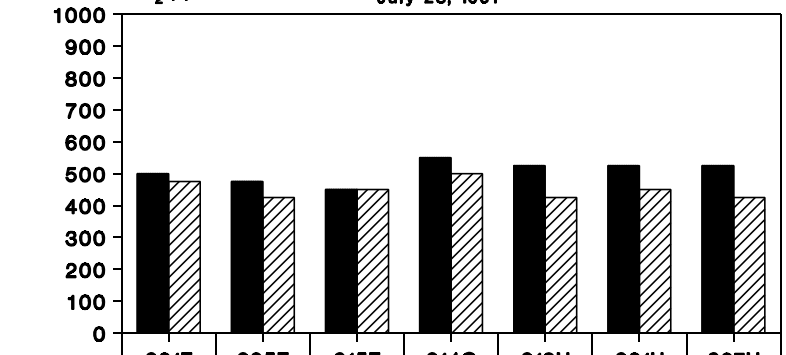
Comments:
Morning sampling session from 9:42 to 11:05 am
Afternoon sampling session from 1:25 to 2:24 pm.

Outside CO_2 = 375 ppm.
NS = no sample collected.

lies between 73 and 77°F and 20 to 60% RH.

Ventilation System

Figure 2
CO_2 Concentrations
HHH Building - HETA 91-291
July 23, 1991



	631F	605F	615F	614G	618H	631H	627H
Morning	500	475	450	550	525	525	525
Afternoon	475	425	450	500	425	450	425

Morning Afternoon

Comments:
Morning sampling session from 9:42 to 11:05 am
Afternoon sampling session from 1:25 to 2:24 pm.

Outside CO_2 = 375 ppm.
NS = no sample collected.

Air handling units (AHUs) Nos. 5, 6, 7, and 8 were visually examined on July 23, 1991. All of the filters (both panels and bag-type) were properly installed and appeared in very good condition. Drains were open and no standing water was observed in any of the systems, with the exception of a minor leak from a chilled water valve supplying AHU No. 6 (this problem was known to the maintenance staff in the building and repairs were scheduled). The visual examination of the outside air (OA) dampers revealed that on AHU No. 5 the OA dampers were closed except for the top row which was open more than 1 inch. Examination of the dampers for AHU Nos. 6, 7, and 8 revealed that the OA dampers closed except for top row which was open approximately 1 inch.

No attempt was made to quantitate the percentage of outside air being introduced into the various air handling systems. For reference, AHU No. 8 supplies air to the offices located along the H corridor, AHU No. 6 provides air to offices along D corridor, and AHU No. 5 supplies air to offices along corridors E and F. The offices located in F corridor (occupied by the Secretary of DHHS and his staff) are on a separate air handling system.

The black "soot" mentioned by several employees in the original HHE request was visibly examined in several offices. This material, which was generally located on the outside surface of a fan coil unit used to heat or cool the exterior office area, resembled a thin film of dirt or carbon particles on the painted surface. Although no microbiological samples were collected, NIOSH investigators regarded it possible that the slight discoloration was caused at least in part by mold growth. Higher humidity conditions favorable for the growth of mold may be created when exterior windows are opened near these fan coil units. Regardless of the source of the discoloration, however, none of

the surfaces examined during this survey were heavily contaminated.

DISCUSSION AND CONCLUSIONS

The CO_2 levels measured during this evaluation were remarkable low and approached the ambient concentration. This is not unexpected considering that the ventilation systems in the building were run continuously even during non-work hours. While the percentage of outside air was not measured as part of this survey, the low CO_2 levels suggest that sufficient outside air was being introduced into the ventilation system. The discoloration present on some of the fan coil units may be at least partially due to mold growth, likely associated with excessively humid air entering the building through open exterior windows.

A new maintenance contractor had assumed responsibility for the HHH building within the past two months preceding the NIOSH HHE. As mentioned earlier, this contractor was aware of the leaking chilled water valve observed in the penthouse and was routinely changing the filter panels and bags on all of the ventilation systems. In addition, the contractor stated that the dampers were being adjusted to provide 25% outside air to the ventilation systems.

RECOMMENDATIONS

1. The existing ventilation system in the HHH building will not function as designed with the exterior windows open. The mildew growth observed on the surfaces of several perimeter fan coil units was possibly due to excessively humid outside air entering the building and creating favorable growth conditions near the cooling coils located within these systems. For these reasons, these exterior windows should be kept closed. In addition, any visible mold growth should be removed. This can be easily accomplished using a mild bleach and water solution (1:10 dilution).

2. Considering the changes which have been made to the ventilation system since the HHH building was finished, the entire HVAC system should be re-tested and balanced by a competent engineering firm. The company performing the testing and balancing should be certified by the National Environmental Balancing Bureau or other recognized organization.

REFERENCES

1. National Institute for Occupational Safety and Health, U.S. Environmental Protection Agency, John B. Pierce Laboratory at Yale University, National Institute of Standards and Technology. [1991]. Indoor air quality and work environment study: Library of Congress, Madison Building, Washington, D.C., Vol. III, Association Between Health and Comfort Concerns and Environmental Conditions. 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 Hazard Evaluation and

Technical Assistance Report No. HETA 88-364-2104.

2. National Institute for Occupational Safety and Health. [1991]. Toledo Municipal Building. 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 Hazard Evaluation and Technical Assistance Report No. HETA 89-065-2119.

3. ACGIH [1991]. Threshold limit values and biological exposure indices for 1991-1992. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

4. Code of Federal Regulations [1989]. OSHA Table Z-1. 29 CFR 1910.1000. Washington, DC: U.S. Government Printing Office, Federal Register.

5. ASHRAE [1981]. Thermal environmental conditions for human occupancy, Atlanta, GA: (ANSI/ASHRAE standard 55-1981) American Society for Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

6. ASHRAE [1989]. Ventilation for acceptable indoor air quality. Atlanta, GA: (ANSI/ASHRAE standard 62-1989) American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

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3. Director, Office of Health Planning and Evaluation, Washington, D.C.
4. Chief of Physical Security, Office of the Secretary of Health and Human Services, Washington, D.C.5.NIOSH, Washington, D.C.
6. OSHA, Region III