HETA 92-219-2266
NOVEMBER 1992
NATIONAL LABOR RELATIONS BOARD
JOHN WELD PECK FEDERAL BUILDING
CINCINNATI, OHIO

NIOSH INVESTIGATORS:
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I. SUMMARY

On June 16-17, and June 24, 1992, investigators from the National Institute for Occupational Safety and Health (NIOSH) conducted a Health Hazard Evaluation (HHE) at the National Labor Relations Board (NLRB) offices located in room 3003 at the John Weld Peck Federal Building, 550 Main Street, in Cincinnati, Ohio. This HHE was conducted in response to a request from the National Labor Relations Board Union, Local 9, concerning poor indoor environmental quality following a two week episode in March 1992, when six employees who worked in the southeastern and southwestern corridors of the NLRB offices experienced severe headaches for several consecutive days. While employees had not reported any such headache episodes since March, the requestors were still concerned about their work environment and the health of the NLRB employees.

An environmental evaluation by NIOSH investigators found microbial contamination of the air handler serving the NLRB offices, and outside air dampers which were compltetly closed. These findings indicate the need to improve preventive maintenance practices. The filters for the outside air are low efficiency (<20%) which could allow organic dust from outside to enter the air handler and thus provide a source of organic nutrients in the air handling system. While no air sampling was conducted for microoganisms, thermophilic actinomycetes, a type of organism well documented to be capable of producing allergic respiratory disease when airborne in sufficient quantities, were isolated from samples collected in the air handling unit. Employees reported that an episode of headaches, such as that which prompted the request for this HHE had not recurred in the interval between the request and the site visit. At the time of the site visit, no environmental conditions were evident which would be likely to cause headaches.

On the basis of the data obtained during this investigation, the NIOSH investigators did not find clear evidence that employees' headaches were caused by building contaminants. However, conditions in the air handling system which favor microbial growth, such as low-efficiency filters, should be corrected. Recommendations are contained in Section VIII.

Keywords: SIC 9651 (Regulation, Licensing, and Inspection of Miscellaneous Commercial Sectors), indoor environmental quality, bioaerosols, thermophilic actinomycetes, video display terminals

II. INTRODUCTION

On June 16-17, and June 24, 1992, investigators from the National Institute for Occupational Safety and Health (NIOSH) conducted a Health Hazard Evaluation (HHE) at the National Labor Relations Board (NLRB) offices located in room 3003 at the John Weld Peck Federal Building, 550 Main Street, in Cincinnati, Ohio. This HHE was conducted in response to a request from the NLRB Union, Local 9, concerning poor indoor environmental quality.

III. BACKGROUND

The request was submitted following a two week episode in March 1992, when six employees who worked in the southeastern and southwestern corridors of the NLRB offices experienced severe headaches for several consecutive days. While employees had not reported any such headache episodes since March, the requestors were still concerned about their work environment and the health of the NLRB employees.

IV. MATERIALS AND METHODS

A. Environmental

The indoor environmental quality investigation conducted on June 16, 1992, consisted of a walkthrough tour of the NLRB office, an inspection of Air Handling Unit (AHU) 3 that serves that office, and a review of drawings of the heating and air conditioning mechanical systems for the third floor, south.

As a result of the appearance of AHU 3 noted during the walkthrough, bulk samples of liquid from the condensate pan (with and without agitation of the sediment), scrapings from the east wall of AHU 3, downstream from the coolng coils, insulation from the north side of AHU 3 at the cold duct entrance (which is also downstream from the cooling coils), and scum from the cooling coil eliminators were collected on June 17, 1992. These bulk samples were submitted for analysis for bacteria, fungi, and thermophilic actinomycetes.

On June 24, 1992, the NIOSH investigators returned to conduct environmental measurements of carbon dioxide concentrations, temperature, and relative humidity. Sampling was conducted in five locations. Measurements were made beginning at 3:05 p.m., and repeated beginning at 3:16 p.m. Carbon dioxide concentrations

were evaluated using a Gastech RI 411 carbon dioxide monitor (Gastech, Inc., Newark, CA) calibrated before 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, Inc., Woburn, MA).

B. Medical

Health questionnaires were distributed to all of the 60 people employed in the Cincinnati NLRB offices. Forty four (73%) of the questionnaires were returned. In the questionnaire, the employees were asked about symptoms experienced at work and whether these symptoms got worse, stayed the same, or got better when away from work. Symptoms that occurred at work with sufficient frequency (one or more time per week during the previous 4 weeks) and got better when away from work were considered work-related for this evaluation.

V. INDOOR ENVIRONMENTAL QUALITY EVALUATION CRITERIA

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 a high prevalence of symptoms among occupants of office buildings.[1-5] Scientists investigating indoor environmental problems believe that there are multiple factors contributing to building-related occupant complaints.[6,7] 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.[8-13] Indoor environmental pollutants can arise from either outdoor sources or indoor sources.[14]

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.[15-17] Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints.[17-20]

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 office furnishings, machines, structural components of the building and contents, tobacco smoke, microbiological contamination, and outdoor 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, 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.[21-23] 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.[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 proven to be helpful in determining the cause of symptoms and complaints except where there are strong or unusual sources, or a proven relationship between a contaminant and a building-related illness. The usual low-level concentrations of particles and variable mixtures of organic materials found are troublesome to understand. However, measuring ventilation and comfort indicators such as carbon dioxide (CO_2), temperature and relative humidity, is useful in the early stages of an investigation in providing information relative to the proper functioning and control of HVAC systems.

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 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 CO_2 concentration (range 300-350 parts per million [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. Microbial Aerosols

The Committee on Bioaerosols of the ACGIH has developed guidelines for the assessment and sampling of saprophytic bioaerosols* in the indoor environment.[26] These guidelines indicate that straightforward remedial action can resolve most problems where visible microbial contamination is evident. Because most microbial contamination problems in office environments have been associated with moisture incursion problems in HVAC systems, remedial actions have focused on elimination or control of these moisture problems.

*Saprophytic organisms live on dead or dying organic matter.

VI. RESULTS AND DISCUSSION

A. Environmental

The steel-reinforced concrete building was dedicated in 1964. The HVAC system for the Peck Building is comprised of four air handlers in the penthouse atop the building. Heating and cooling is accomplished mainly by these constant volume systems. In addition, there are radiators under the windows along the perimeter of the building. Each AHU serves one quadrant of the building.

Outdoor air enters the HVAC mixed-air plenum via rooftop dampers that, according to General Services Administrations (GSA) representatives, are set to provide a minimum of 10% outdoor air. The dampers were completely closed on the day of the walkthrough, and the bird screen was intact. Return air is mixed with outdoor air at this point. Air then passes through a bank of roll-type filters. The rolls are advanced to expose clean filter material when the pressure drop across the filters dictates that they be moved. These filters are less than 20% efficient, according to a representative of Airguard, one of the vendors supplying filters to GSA. Filtered air then passes through air tempering coils. The upper deck of the air handler houses steam coils which heat the air in the winter. The lower deck houses chilled-water cooling coils which condition the air in the summer. Air from the upper (hot) and lower (cold) decks is distributed throughout the building via a hot duct and a cold duct. Condensate from the air conditioner coils drips into a trough. There is a drain in the center of the trough. Condensate from the ends of the coils drains outside of the AHU. At the time of the survey the condensate trough and cooling coil eliminators were visibly contaminated with scum. The interior walls of the AHU downstream of the coil were also discolored. According to GSA representatives, the coils have not been cleaned for two years. Coils are cleaned on an "as needed" basis.

In the NLRB offices, hot and cold branch ducts enter mixing boxes above the ceiling. A vane in the mixing box, controlled by thermostats in the occupied space, modulates to mix the hot and cold air streams to maintain a constant temperature. In the summer, conditioned air from the cold duct is mixed with untempered air from the hot duct. In the winter, steam-heated air from the hot duct is mixed with untempered air from the cold duct. From the mixing boxes, supply air is distributed to diffusers around every other light fixture. Return air enters a plenum above the ceiling via return air grilles around the remaining light fixtures. Return air then travels to the AHU via a common return duct.

The only fungi detected in the condensate pan liquid samples were several different types of yeasts. The presence of these types of

environmental yeasts at such moist sites is not unexpected, and the levels of yeast were not unusually high (10,000-500,000 colony forming units per milliliter [cfu/ml]). The numbers of bacteria were generally considerably higher than the yeasts (100,000-30,000,000 cfu/ml). The bacteria isolated, however, were typical aquatic bacteria (primarily non-pathogenic *Pseudomonas* species) and should not affect the health of the building occupants. Thermophilic actinomycetes (*Thermoactinomyces* species) were detected in five of the six samples, although the levels were barely detectable above the 10 cfu/ml level of sensitivity. Agitation of the sediment did not lead to an increase in yeasts or bacteria. This may be because many of the microorganisms in the sediment were anaerobic and thus would not be detected under the aerobic conditions of incubation used with these samples. A previous HHE conducted in the Peck Building in April 1992.[27] AHU 3 was also inspected at that time. It is interesting to note that at that time, prior to the beginning of the air-conditioning season, the condensate trough was found to contain some scale deposits, but was otherwise unremarkable, suggesting that the microorganisms proliferated in the two months between these two HHEs.

Large numbers of both bacteria and fungi were detected in bulk samples collected from the east side of the lining of AHU 3, downstream from the cooling coils. Yeasts were by far the most prominent fungal species, while smaller numbers of molds were also found. The species of molds found (*Cladosporium*, *Penicillium*, and *Aspergillus*) are common saprophytic molds that are typically found in outdoor air. The number of yeasts and molds suggests that some level of moisture exists at this site (at least periodically), which leads to the proliferation of these microbes. In contrast, bacteria were not detected in two of the samples from this location, while the bacterium *Micrococcus*, an environmental species more tolerant of dry conditions, was virtually the only bacterium detected in the third sample.** Since bacteria are more sensitive to moisture levels than molds and yeasts, these data suggest that a growth-limiting amount of moisture was present at the time of sampling. Thermophilic actinomycetes were detected in each of these samples, suggesting some level of proliferation, either at the time of the survey, or in the past.

In contrast to the other sampling locations, the only species detected in the sample from the north side of the lining of AHU 3, downstream from the cooling coils, at the entrance to the cold air duct were the mold *Cladosporium* and the thermophilic actinomycete *Thermoactinomyces*. Based upon the absence of any yeasts or bacteria in these samples, along with the fact that these species propagate via aerial spores, these results reflect the

** As used here, the term "bacteria" excludes thermophilic actinomycetes, which are incubated under different conditions.

accumulation of spores at this site, rather than the proliferation of microorganisms. *Cladosporium* is a common mold found in outdoor air samples, and thus would be expected to be found in an air handler. These results indicate the need to clean the coils, condensate trough, and interior of AHU 3, downstream from the cooling coils, and the need to include the cleaning of air handling units among scheduled maintenance activities. In addition, these results suggest that the low-efficiency filters do not remove organic matter, which may provide nutrients for microbial growth.

Samples of scum from the cooling coil eliminators indicated that microbial proliferation occurred at this sampling location. The species were similar or identical to those found in the condensate pan liquid, common aquatic species of little clinical significance. The presence of *Thermoactinomyces*, particularly in one of the samples from this site (2,700 cfu/gram) could also be interpreted as indicative of proliferation at this site. However, due to the high temperature optimally needed for thermophilic (heat-loving) organisms to proliferate, the numbers may reflect only an accumulation of spores.

The results of temperature, relative humidity, and carbon dioxide measurements are presented in Table 1. The dry bulb temperatures ranged from 71◦F to 75◦F, with a mean of 73◦F. Relative humidities ranged from 60% to 67%, with a mean of 63%. The mean temperature and relative humidity result in a psychrometric dew point temperature of 60◦F. A dry bulb temperature of 73◦F and a dew point temperature of 60◦F place conditions in the NLRB offices within the acceptable range for operative temperature and relative humidity indicated by the ASHRAE thermal comfort chart. However, relative humidity in excess of 60% is outside of the range specified by ASHRAE to minimize the growth of allergenic or pathogenic organisms in habitable spaces and should be reduced. Carbon dioxide concentrations ranged from 400 to 600 ppm, with a mean of 478 ppm. This is well below the 1000 ppm specified by ASHRAE, but because of the limited number of occupants present on the day of the survey, it may not be an accurate indicator of the adequacy of ventilation during usual occupancy levels.

B. Medical

The symptom prevalences for the five areas of the office, as well as for the employees as a single group, are shown in Table 2. Overall, the symptom prevelances were somewhat low compared to other office buildings that NIOSH has evaluated where employees were concerned about their office environment.[17] However, a considerable proportion of the 12 workers in the central office area reported eye irritation or eye strain.

The questionnaire also asked about the employees' experience regarding workplace odors and thermal comfort in their offices. Table 3 shows the responses. It would appear that many (30%) feel that there is a dearth of air movement at least one day a week. Twenty percent feel that it is frequently too hot, while fifteen percent feel that it is frequently too cold. Ten percent report experiencing tobacco smoke odors while at work one or more times per week.

The responses indicate that a significant proportion of the employees (especially those in the central office area) frequently experience eye irritation or eye strain while working in the NLRB office. A similar proportion report frequent thermal discomfort. It is of interest that eye irritation and thermal discomfort are two of the most frequently reported complaints found in the indoor environmental quality evaluations that NIOSH has conducted.[17] The causes of the frequent eye irritation are not completely understood, but the prolonged use of video display terminals is felt to be a likely contributor to eye discomfort.[28]

The employees in the central office area reported using VDT's for an average of 4.7 hours per day. It is possible that this extensive VDT use may be contributing to their eye discomfort. The use of anti-glare screens, the careful placement of VDTs to avoid glare, and the provision of frequent periods of "breaks from looking at the screen" may help to decrease eye discomfort.[28]

Ten percent of employees report experiencing tobacco smoke odors while at work one or more times per week. Employees should be allowed to smoke only in a designated smoking area which is properly exhausted to the outside and meets ASHRAE standards for smoking lounges.[24]

VII. CONCLUSIONS

An environmental evaluation by NIOSH investigators found microbial contamination of the air handler serving the NLRB offices, and outside air dampers which were compltetly closed. These findings indicate the need to improve preventive maintenance practices. The filters for the outside air are low efficiency (<20%) which could allow organic dust from outside to enter the air handler and thus provide a source of organic nutrients in the air handling system. While no air sampling

was conducted for microoganisms, thermophilic actinomycetes, a type of organism well documented to be capable of producing allergic respiratory disease when airborne in sufficient quantities, were isolated from samples collected in the air handling unit. Employees reported that an episode of headaches, such as that which prompted the request for this HHE had not recurred in the interval between the request and the site visit. At the time of the site visit, no environmental conditions were evident which would be likely to cause headaches.

VIII. RECOMMENDATIONS

The following recommendations, based upon the results of this evaluation, may improve the indoor environment in the NLRB offices:

1. Employees should only be permitted to smoke in designated smoking areas which are supplied with 60 cfm of outdoor air or transfer air per smoker and equipped with dedicated exhaust ventilation.[24]***

2. GSA, the agency responsible for building operations and maintenance in the Peck Building, should ensure that outside air dampers are adjsuted to provide the ASHRAE-recommended minimun of 20 cubic feet per minute (cfm) of outdoor air per person for occupants of the NLRB offices.

3. GSA should clean coils and condensate troughs on at least an annual basis to prevent the accumulation of organic matter which could support the growth of microorganisms. In addition, GSA should consult the manufacturer of the AHUs to determine the mist efficient filter media the system can accept without a decrement in performance.

4. Complaints of thermal comfort and poor air distribution may be addressed by first ensuring that adequate outdoor air is provided. Reducing the humidity in the space to within the ASHRAE-recommended range of 30% to 60% may also help. Ensuring adequate air distribution may also require that GSA perform a test and balance of the HVAC system.

5. The use of anti-glare screens, the careful placement of VDTs to avoid glare, and the provision of frequent periods of "breaks from looking at the screen" may help to decrease eye discomfort.[28]

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***Transfer air is air moved from one indoor space to another.

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Copies of this report have been sent to:

1. Regional Administrator, National Labor Relations Board
2. President, Local 9, NLRB Union
3. OSHA, Region V
4. NIOSH

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1
Temperature, Relative Humidity and Carbon Dioxide Measurements
National Labor Relations Board, Cincinnati, Ohio
HETA 92-219
June 24, 1992

Location	Time	Carbon Dioxide (ppm)	Temperature (Degrees Fahrenheit)	Relative Humidity (Percent)	Occupants Present
Between 3023 E&F		1505	400	75	64	0
Outside 3009 F		1506	400	73	61	0
Outside 3104 F		1508	525	72	60	0
Outside 3104 K		1509	525	72	61	1
Outside 3003 L		1511	475	71	67	0
Between 3023 E&F		1516	425	75	67	0
Outside 3009 F		1517	425	73	63	0
Outside 3104 F		1518	525	72	60	0
Outside 3104 K		1519	600	72	60	0
Outside 3003 L		1520	475	71	66	0
Outdoors, Street Level		----	450	78	63	-

Table 2
Work Related Symptoms Experienced
One or More Days per Week
National Labor Relations Board, Cincinnati, Ohio
HETA 92-219
June 24, 1992

SYMPTOMS	Northwest Corridor 5 workers	Northeast Corridor 6 workers	Central Office 12 workers	Southwest Corridor 12 workers	Southeast Corridor 9 workers	All Respondents 44 workers
dry, itching, or irritated eyes	20%	16%	42%	8%	22%	17%
wheezing	0	16%	8%	0	0	3%
headache	0	16%	17%	8%	0	7%
sore throat	0	0	0	0	0	0
unusual tiredness, fatigue or drowsiness	0	0	0	8%	11%	3%
chest tightness	0	0	0	0	0	0
stuffy or runny nose, or sinus congestion	0	16%	8%	0	11%	5%
cough	0	0	8%	8%	11%	5%
tired or strained eyes	0	16%	33%	17%	11%	13%
difficulty remembering things or concentrating	0	0	0	0	0	0
dry throat	0	16%	8%	0	22%	7%
dizziness or lightheadedness	0	0	0	0	11%	2%
shortness of breath	0	0	0	0	0	0

Table 3
Description of Workplace Conditions
National Labor Relations Board, Cincinnati, Ohio
HETA 92-219
June 24, 1992

CONDITIONS FREQUENTLY EXPERIENCED	Northwest Corridor 5 workers	Northeast Corridor 6 workers	Central Office 12 workers	Southwest Corridor 12 workers	Southeast Corridor 9 workers	All Respondents 44 workers
Too much air movement	0	0	8%	0	0	2%
Too little air movement	0	33%	42%	58%	11%	30%
Temperature too hot	0	50%	42%	17%	33%	20%
Temperature too cold	0	33%	33%	17%	22%	15%
Air too humid	0	33%	8%	8%	11%	8%
Air too dry	0	0	17%	0%	22%	7%
Tobacco smoke odors	20%	33%	17%	8%	0	10%
Chemical odors (e.g., paint, cleaning fluids, etc.)	0	0	8%	0	11%	3%
Other unpleasant odors (e.g., body odor, food odor, perfume)	0	33%	17%	8%	11%	10%