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HAZARD EVALUATION AND TECHNICAL
ASSISTANCE REPORT

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SUMMARY

An indoor air quality evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) at the Office of Hearing and Appeals, Social Security Administration, on December 10 and 13, 1990. Interviews with ten employees revealed the major complaints to be asthma, sinus problems, thermal discomfort, dusty environments, and irritation from tobacco smoke. The medical histories of the two asthma cases were not suggestive of a work-related cause; however, asthma, as well as the sinus problems, could be exacerbated by exposure to tobacco smoke in the work area.

No specific health hazards were identified; however, environmental data tended to support employee concerns regarding thermal discomfort, as measurements indicated temperature and humidity combinations falling outside of, or at the far ends of the operative ranges of temperature and humidity recommended by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE). High relative humidity was measured on the sixth and seventh floors, with humidity ranging from 56 to 71%. Recommendations to correct problems and deficiencies concerning the air distribution system are made in this report, along with recommendations to restrict smoking in occupied areas, to prevent moisture incursion into occupied space and within the air handling system, and to clean the particulate build-up around air supply diffusers. Further monitoring for carbon monoxide, a product of automobile exhaust, is also recommended because the air intakes for the ventilation system are located in a parking area.

KEY WORDS: Indoor air quality, temperature, relative humidity, carbon dioxide, carbon monoxide, smoking, government office.

INTRODUCTION

At the request of the American Federation of Government Employees (AFGE) Local 2608, the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation at the Office of Hearing and Appeals (OHA), Social Security Administration (SSA), San Juan, Puerto Rico on December 10 and 13, 1990. NIOSH was asked to perform an indoor air quality evaluation in the areas occupied by SSA-OHA employees. The request was made in response to employee concerns and health complaints including cold temperatures, dust, asthma, sinus problems and irritation from tobacco smoke.

This report summarizes the activities, observations, and findings from the NIOSH evaluation, and comprises the final report of our investigation. Preliminary findings and recommendations were made at the closing meeting which was held on December 13, 1991.

BUILDING INFORMATION

At the time of the NIOSH evaluation there were approximately 70 employees of the SSA-OHA occupying portions of the 6th and 7th floors of an 18-story office building. Floor plans for these areas are included in the Appendix. The SSA-OHA office space is leased through the Government Services Administration (GSA). The building is located in downtown San Juan, with other office buildings in the immediate vicinity. The building is constructed of concrete and has windows which no longer open to the outside. The remainder of the building is occupied by other agencies and includes only office space. There were no special use areas present (photo and print shops, janitorial supply rooms, etc.) with the exception of a cafeteria located on the 8th floor.

The SSA-OHA space includes mostly single, perimeter offices, with clerical staff located in interior open areas. There were no partitions observed in the open areas. Floor tiles were present in most areas. Activities performed by SSA-OHA employees involve primarily literature research and clerical tasks involving the use of personal computers, printers, and copy machines. Staff attorneys review social security appeal cases, and hearings are held with claimants and family members in a room located on the 7th floor. At the time of this survey, smoking was allowed in elevators, hallways, and bathrooms, but not in SSA-OHA general office areas.

Three air handling units (AHUs), with only cooling capacity, supply air to this building. Two AHUs serve the east and west zones of floors 2 through 10. The AHUs are located in separate mechanical rooms in the basement, which also houses a parking garage. Outside air enters directly from the parking area. Cooling towers, which provide chilled water to these units, are located on the roof. It was unclear from our evaluation whether the ventilation system was a constant volume or variable air volume system. Because most of the thermostats were located above the false ceiling, we were not able to adjust thermostats to confirm the type of ventilation system present. In addition, we were not able to obtain ventilation plans for this building. The return air plenum was located above the false ceiling, with return air exiting through slots in the lighting fixtures. The ventilation system is reportedly in operation from 6:00 a.m. to 6:00 p.m. Monday through Friday, from 7:00 a.m. to 12:00 p.m. on Saturday, and is not in operation on Sunday.

EVALUATION DESIGN

Medical Evaluation

Medical interviews were conducted with ten (7%) of the SSA-OHA employees, four from floor 6 and six from floor 7. These employees were volunteers who felt they had building-related health complaints and who wanted to talk with NIOSH representatives. The employees provided no medical records.

Environmental Evaluation

On December 13, 1990, environmental measurements were made to evaluate thermal comfort parameters (temperature and relative humidity (RH)) and carbon dioxide (CO₂) concentrations. Temperature and RH measurements were made using a Vista Scientific, Model 784, battery-operated psychrometer. Carbon dioxide measurements were made using the Draeger gas detection system with colorimetric detector tubes specific for CO₂. Initially, CO₂ measurements were also made using a direct reading GasTech portable CO₂ meter; however, due to equipment problems these data are not reliable and are not reported. Environmental measurements were made at 12 locations on floors 1-3 and outdoors, at three times throughout the day. The purpose for the sequential measurements was to observe any fluctuations in these parameters throughout the day. The first set of measurements was made between 7:30 and 8:30 a.m., the second set between 10:30 and 11:30 a.m., and the third set between 2:00 and 3:00 p.m. Additionally, carbon monoxide (CO) concentrations were measured in a few offices, and at the outside air intakes for the air handling units, using colorimetric detector tubes specific for CO.

The ventilation portion of the survey included an inspection of the two air handling units serving the 6th and 7th floors. The units were inspected for the presence of visible microbial contamination, standing water, general cleanliness, and condition of the particulate filters.

EVALUATION CRITERIA

NIOSH investigators have responded to over 600 complaints of indoor air quality problems 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. Typical symptoms have included headaches, varying degrees of itching or burning eyes, skin rashes, sinus problems, dry and irritated throats, and other respiratory irritations. The workplace environment has been typically implicated because symptoms reportedly disappear when workers are away from the office.

Less often, the symptoms are more severe and are found to be specifically related to something in the building environment. Examples of these building-related illnesses (BRI), not all of which have been found during NIOSH investigations, include environmental allergy (allergic rhinitis, allergic asthma, and hypersensitivity pneumonitis) caused by exposure to spores, organic dusts, animal "danders," bacteria and fungi, and bacterial infections (Legionnaires' disease, and Pontiac

fever). In previous NIOSH investigations, microbial contamination has resulted from water damage to carpets or furnishings and from standing water in ventilation system components. The causes of comfort and health problems experienced by building occupants are typically multifactorial, which makes determination of a specific environmental cause difficult. The problems found during NIOSH investigations include: inadequate ventilation; contamination from inside the building; contamination from outside the building; microbiological contamination; and contamination from the building materials.

Inadequate ventilation, a category which includes insufficient outside air, poor air distribution, and short-circuiting of supply air, has been reported commonly in the NIOSH building investigations. These ventilation problems make it difficult to control heating and cooling, and they allow for the accumulation of contaminants in the occupied space. The resulting conditions may cause occupants to become uncomfortable or experience adverse health effects (eye and upper respiratory tract irritation, headaches, etc.).

Some scientists suspect that work-related complaints may be attributable not to individual environmental contaminants, but to the cumulative effect resulting from exposures to low concentrations of multiple pollutants, work environments outside of comfort ranges, and other factors. Standards for indoor air quality in office buildings do not exist. NIOSH, the Occupational Safety and Health Administration (OSHA), and the American Conference of Governmental Industrial Hygienists (ACGIH) have published regulatory standards and recommended limits for occupational exposures in industrial settings. With few exceptions, however, 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, which are discussed below.^{1,2}

Carbon Dioxide (CO₂)

Carbon dioxide, a normal constituent of exhaled breath, can be used as an indication of whether adequate quantities of outdoor air are being introduced into an occupied space. The ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality,¹ 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.

Indoor CO₂ concentrations are normally higher than the generally constant outdoor CO₂ concentration (range 300-350 ppm). When indoor CO₂ concentrations exceed 1000 ppm in areas where the only known source is exhaled breath, inadequate ventilation is suspected. CO₂ concentrations in this range do not represent a health hazard. However, they do indicate that the air concentrations of other contaminants normally present in office environments may also be elevated.

Temperature and Relative Humidity

The perception of thermal 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 will find the environment thermally comfortable.² The ASHRAE recommendations for acceptable ranges of temperature and humidity for summer and winter months are shown in Figure 1.

RESULTS

Medical Evaluation

The results of the medical interviews are presented in Figure 2. The most common health concern was sinus problems, including congestion and sinus infections. Other common concerns were cold temperatures, dusty air, and irritation from cigarette smoke.

There were no medical records available for review for the asthma cases. However, the medical histories reported by the two employees with asthma were not suggestive of a work-related cause. The asthma either existed prior to the employee beginning work at the SSA-OHA building or was attributable to causes other than exposures at work.

Environmental Measurements

Figures 3a and 3b present the results of the CO₂ measurements made on the 6th and 7th floors. The test location designations on the figures correspond to sample locations shown on the floor plans in the appendix. As can be seen from these figures, CO₂ concentrations ranged from 400-1000 parts per million (ppm) on the 6th and 7th floors (locations A-J), which include measurements made in both single offices and open areas. In most cases the CO₂ concentrations were highest in the late morning, prior to the lunch hour. Two of the measurements resulted in CO₂ concentrations of 1000 ppm (locations F and D), a level which indicates that the supply of outdoor air may not be adequate to dilute normal contaminants. At location F, which is an open area shared by secretarial/clerical staff, one of the supply air diffusers had been taped-up, in response to complaints of cold temperatures and drafts, to prevent airflow into that area.

Air temperature measurements are shown in Figures 4a and 4b. While there was some temperature fluctuation throughout the day in all areas, this variation was generally on the order of a few degrees. For all indoor locations combined, the air temperatures ranged from 69.5-77.5° F, while outdoor air temperatures ranged from 80.5° in the morning to 83.5° in the late afternoon. As shown in Figures 5a and 5b, relative humidity, an indication of the moisture content of the air, ranged from 60-71% on the sixth floor and from 56-68% on the seventh floor. The outdoor air humidity ranged from 66-77% over the course of the day.

On the 6th and 7th floors there were some locations which had temperature and humidity combinations falling outside of, or at the far ends of, the "comfort" range recommended by ASHRAE, as shown in Figure 1. Those values falling outside the comfort range generally had air temperatures on the cool side (<73 degrees), with the exception of locations C and D, which had high relative humidity (>65%).

Ventilation Assessment

The two air handling units serving the sixth and seventh floors were inspected for the presence of microbial contamination, filter condition, and overall cleanliness. Both air handling units were

rated at 37,800 cubic feet per minute (CFM) and had fiberglass prefilters and final bag filters. The fiberglass filters are reportedly changed every three months, while the bag filters are changed annually. The prefilters had been changed in September and appeared to be clean and in good condition. There was no visible microbial contamination present on the fiberglass or bag filters or inside the units as far as could be seen. The areas where the condensate drain pans were located were not inspected, due to a concern that the units would have to be shut down first and would require a considerable amount of time to get back on-line. NIOSH investigators did, however, observe that condensate water was draining from both units. The building manager indicated that the units are shut down once a year for vacuuming.

Because the air handling units are located in the basement, where a parking garage is also located, there was concern about the quality of the air being supplied to the office space. Carbon monoxide, a major product of incomplete combustion, was measured in the basement area outside the doors which house the air handling units. The concentration of CO was 7 parts per million (ppm) at 4:20 p.m. outside Unit #1 (West). Measurements made around 1:30 p.m. outside Units #1 and #2 showed only trace amounts of CO (<5 ppm). Limited sampling was also conducted in a few of the office areas between 2:00 and 3:00 p.m., with results indicating CO concentrations of <5 ppm to 5 ppm in occupied areas. It should be noted that these measurements indicate the concentration of CO at a given point in time and would not reflect variations in the CO concentration which may result from variations in automobile activity in the basement during the course of the day. There are no standards for CO in office environments specifically, but the current NIOSH recommended exposure limit for CO in industrial environments is 35 ppm for up to a 10-hour time-weighted average (TWA) exposure. This limit is intended to keep the amount of CO in the body at a level where no acute health effects occur. The National Ambient Air Quality Standard for CO in outdoor air is 9 ppm as an 8-hour TWA.

Many of the supply air diffusers on the 6th and 7th floors were dirty, as were many of the ceiling tiles surrounding the supply diffusers in these areas. Some ceiling tiles also showed evidence of water damage; of particular note are the tiles in rooms 701-A and 705. Employees reported that room 705 had sustained water damage from Hurricane Hugo, and that the tiles had not been replaced. The supply air diffusers in these two rooms had a heavy build-up of black particulate material which may have contained fungal or other microbial contamination. As previously noted, one of the supply air diffusers in Location F had been taped-up due to complaints of cold temperatures.

DISCUSSION AND CONCLUSIONS

Of the 10 employees interviewed, the major health complaints and comfort concerns reported included asthma, sinus problems, thermal discomfort, dusty environment, and irritation from tobacco smoke. Medical histories of the asthma cases were not suggestive of a work-related cause of these illnesses; however, asthma, as well as the sinus problems, could be exacerbated by exposure to tobacco smoke or dust.

The environmental measurements indicated that some of the work areas had a temperature and humidity combination falling outside of, or at the far ends of the range recommended by ASHRAE. If the ASHRAE recommendations for summer are used as criteria (since the local climatic conditions create the need for air conditioning all year), air temperatures tended to be on the cool side. In at least one area, employees had tried to adjust the airflow by taping up the

supply diffuser due to complaints of cool temperatures and drafts. In addition, 50% of the workers interviewed complained of thermal comfort problems.

The relative humidity in the SSA-OHA work areas was quite high, ranging from 56 to 71%. Aside from thermal comfort considerations, high relative humidity can increase the potential for microbial contamination within the building and the possibility that this contamination can result in building-related illnesses. As a result, indoor air professionals recommend that the relative humidity indoors should be maintained below 60% throughout the year.³ Preventive maintenance of the air distribution system and an environment kept clean by dirt and water removal are also important factors for controlling microbial contamination in buildings. During this survey, we observed many diffusers which were dirty and some ceiling tiles which showed evidence of water damage.

While high levels of carbon monoxide, a major component of motor vehicle exhaust, were not documented during this survey, NIOSH investigators were concerned about the location of the outside air intakes and the possible uptake and distribution by the air conditioning units of air contaminated with automobile exhaust. Further evaluation is necessary, however, as only limited sampling was performed during this survey.

Based on the results of our evaluation, the following recommendations are offered in an effort to correct existing problems and to prevent future indoor air quality problems at this facility.

RECOMMENDATIONS

1. Problems and deficiencies regarding the air distribution system should be corrected. This would include cleaning the supply air diffusers and removing tape from diffusers which have been blocked. In addition, the water damaged ceiling tiles in rooms 701-A and 705 should be replaced, and the supply ducts in these two rooms should be visually inspected for evidence of microbial contamination and cleaned if necessary. If drafts remain a problem in certain areas it may be necessary to relocate the diffusers or the employees. Taping up the diffusers is not appropriate, since it reduces the amount of outside air entering the space. Ideally, the ventilation systems serving these areas should be balanced by a ventilation engineering firm, particularly if changes or additions are made to the existing system. Attention should also be given to routine inspection of the filters, general cleaning of the air handling units, and ensuring an adequate supply of outdoor air at all times, in all areas of the building. ASHRAE recommendations outlined in standards 62-1989 and ANSI/ASHRAE standard 55-1981 should be followed.
2. Moisture incursion into occupied space and within the air handling system should be prevented. The relative humidity in the building should be maintained below 60%. Stagnant water and slime should not be allowed to accumulate in condensate drain pans, and a chlorine disinfectant should be added on a routine basis. Porous furnishings which have become wet, such as ceiling tiles, should be discarded and replaced.
3. While we did not observe smoking in SSA-OHA work areas, employees indicated that smoking was allowed in multi-use areas such as elevators, hallways, and bathrooms, and that visitors to the area did not always observe the no smoking policy in the offices. SSA-OHA employees should work with other building tenants to develop a building-wide smoking policy. If smoking is to be allowed in the building, a separate smoking room should be provided. This room should be provided with 60 CFM of outside air per person, in accordance with ASHRAE standard 62-1989.¹ Room air should be exhausted directly to the outside, with no recirculation of room air into other occupied areas.

4. Additional air sampling for carbon monoxide should be performed in office areas and at the entrance to the outside air intakes in the basement. Monitoring should be performed during peak traffic hours to document worst case conditions. If exhaust odors are noted in the work environment or symptoms suggestive of CO overexposure are reported (headache, nausea, dizziness, confusion, and weakness), further investigation of complaints is necessary.

REFERENCES

1. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. ASHRAE Standard 62-1989 -- Ventilation for acceptable indoor air quality. Atlanta, GA: ASHRAE (1989).
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