HETA 2000–0176–2829
The Centre for Well-Being at The Phoenician Resort
Scottsdale, Arizona

Teresa Seitz, MPH, CIH
Robert Malkin, Dr.Ph.
Ilze Jekabzone, MD

PREFACE

The Hazard Evaluations and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSHA) Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Teresa Seitz, Robert Malkin, and Ilze Jekabzone of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Field assistance was provided by Gregory Burr of DSHEFS, and Patty Arreola and Kristina Schaller of the Arizona Department of Health Services. Desktop publishing was performed by Ellen Blythe. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation of The Centre for Well-Being (CFWB)

The National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation at the CFWB in Scottsdale, Arizona. Employees who requested the evaluation were concerned that employee symptoms were due to problems with the indoor environment, specifically exposure to mold at work.

What NIOSH Did

We toured the work areas to look for signs of mold growth and water damage.

We measured the air flow in treatment rooms.

We measured temperature, humidity, and carbon dioxide levels in the Centre.

We interviewed 25 employees on-site and 4 employees over the phone about symptoms they were having.

We reviewed medical records and spoke to private physicians of some employees.

What NIOSH Found

Temperature and humidity problems were found. Some of the problems were due to the difficulty in providing a comfortable environment for both clients and employees. This resulted in improper adjustment of the thermostats.

Some treatment rooms were not receiving enough fresh air.

Some workers complained of fatigue, headache, memory loss, forgetfulness, or concentration problems at work. Some workers reported hair loss and breathing problems.

Widespread mold contamination was not found. A few small areas of mold growth or water damage were observed.

What CFWB Managers Can Do

Provide an environment that allows for both sufficient fresh air and thermal comfort.

Identify and promptly correct any water leaks and ventilation problems.

Talk with employees about any problems that are found and get input from employees on possible solutions.

To minimize fatigue, schedule clients to allow for a mixture of deep massages and less physical treatments.

What the Phoenician Employees Can Do

Make sure the room ventilation units are on at all times and limit changes to the temperature settings to within established guidelines.

Talk with supervisors about health and safety concerns.

Allow sufficient time for breaks and rest during the work day.

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NIOSH National Institute for Occupational Safety and Health

Health Hazard Evaluation Report 2000–0176–2829
The Centre for Well-Being at The Phoenician
Scottsdale, Arizona
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Teresa Seitz, MPH, CIH
Robert Malkin, Dr.Ph.
Ilze Jekabzone, MD

SUMMARY

In response to a confidential request from employees, the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation at The Centre for Well-Being at The Phoenician Resort, Scottsdale, Arizona. The request indicated that some employees were experiencing respiratory difficulty, chronic fatigue, gastrointestinal problems, neurological problems, hair loss, and skin rashes. Molds and mycotoxins were listed as possible agents contributing to the reported health problems.

On June 19–21, 2000, NIOSH investigators conducted a health hazard evaluation at the health spa. The environmental component included a ventilation system assessment, measurement of indoor environmental quality indicators (carbon dioxide [CO_2], temperature, and relative humidity [RH]), and limited microbial sampling. The medical component included on-site interviews with 25 employees, telephone interviews with four employees who were presently not working because of health problems they believed were related to the work environment, discussions with three private physicians, and a review of medical records for four individuals.

The environmental evaluation identified problems with temperature and humidity regulation and air delivery in the treatment rooms. Temperatures ranging from 66°F to 87°F, and RHs ranging from 31% to 67% were recorded on the day of sampling. Elevated CO_2 concentrations (up to 1800 parts per million) were recorded during client treatments, indicating insufficient ventilation. Problems with the operation of the thermostats controlling individual room fan coil units were found and contributed to the wide fluctuations in temperature and RH, and build-up of CO_2. Two rooms served by the central ventilation system were receiving little or no supply air. Visual assessment did not reveal widespread microbial contamination. Water-damaged ceiling tiles were noted in two treatment rooms, and two sinks showed evidence of water damage.

The symptoms reported most frequently by current employees were headache, memory loss, forgetfulness, concentration problems, and fatigue, all of which employees attributed to working at the Centre. Individuals interviewed over the phone reported similar, although usually more severe, symptoms.

Many of the interviewed employees reported nonspecific symptoms that are not suggestive of any particular medical diagnosis or readily associated with a causative agent. NIOSH investigators recommend that problems with the regulation of temperature, humidity, and air delivery within the Centre be corrected. A follow-up evaluation should be conducted by the employer to ensure that environmental conditions meet recommended guidelines and employee health complaints are minimized.

Keywords: SIC 7011 (Hotels and Motels), resort hotel, health spa, indoor air quality, IAQ, Indoor Environmental Quality (IEQ), microbial contamination, mold, ventilation.

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INTRODUCTION

In March 2000, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request for a health hazard evaluation (HHE) from employees at The Phoenician's Centre for Well-Being, in Scottsdale, Arizona. The request indicated that some massage therapists and aestheticians were reporting health problems such as respiratory difficulty, chronic fatigue, gastrointestinal problems, neurological problems, hair loss, and skin rashes. Molds and mycotoxins were listed as possible agents contributing to the reported health problems. NIOSH investigators visited the facility on June 19–21, 2000, to conduct an evaluation.

BACKGROUND

The Centre for Well-Being opened in 1988 and offers massage therapies and body and skin care treatments. The Centre also has a fitness studio and salon that were added in 1992 and 1993, but those areas were not included in the NIOSH evaluation because they were outside the area of concern. There are approximately 20 individual treatment rooms where the massages and aesthetic treatments are performed. There are approximately 200 Centre employees in the peak season, and about 185 in the off-season, of which approximately 64 were massage therapists and aestheticians. Most of the spa employees work part-time (less than 32 hours per week). The Centre is open from about 6:00 a.m. to 8:00 p.m., and there are two work shifts.

Employee complaints regarding indoor environmental quality (IEQ) have been reported since 1995, prompting five IEQ surveys by outside consultants, two complaint inspections by the Industrial Commission of Arizona, and a site visit by the Arizona Department of Health Services. Improvements in ventilation, plumbing, and maintenance have resulted from those surveys. The most recent studies conducted in late 1999 and early 2000 included chemical and microbiological sampling. Recommendations were made to eliminate water leakage and condensation problems, replace stained ceiling tiles, improve air movement in the treatment rooms, and conduct frequent inspections in the work area. Based on the presence of mold in some bulk samples, two showers and surrounding wall material were removed from treatment rooms and the areas disinfected and renovated. In two other rooms, vinyl molding was replaced due to the presence of mold behind the baseboard. Continued health concerns among employees prompted this request for a NIOSH health hazard evaluation.

METHODS

Environmental Evaluation

The environmental evaluation included a walk-through survey of the Centre, an assessment of the ventilation system, measurement of indoor environmental quality indicators, and limited microbial sampling.

Ventilation System

Discussions were held with the Director of Technical Services to obtain information on the operation and maintenance of the ventilation systems serving the Centre. Copies of mechanical plans, a recent test and balance report, and preventive maintenance records were obtained for review. A visual inspection was made of the two air handling units serving the spa and of several randomly selected fan coil units serving individual treatment rooms. To evaluate air distribution in the spa, air flow measurements were made at supply air diffusers and return/exhaust air grilles using a TSI model 8370 AccuBalance Flow Measuring Hood. Smoke tubes were used to observe air flow patterns in some unoccupied rooms.

Ventilation and Comfort Indicators

Measurement of ventilation and comfort indicators including carbon dioxide (CO_2) concentration, temperature, and relative humidity (RH) was performed using six Q-Trak™ Model 8550 IAQ Monitors and four HOBO H8 Pro Series loggers (temperature and RH only). Nine of the monitors were used in the data logging mode to collect measurements every one or five minutes in a given area, while one Q-Trak monitor was used to collect spot measurements during the day at numerous other locations within the Centre.

Microbial Assessment

The Centre was inspected for visible evidence of water damage and microbial contamination. An Instrument Technology, Inc., Model 125010 boroscope was used to inspect the area above the false ceiling for moisture, microbial contamination, and general cleanliness. A Delmhorst Instrument Company Moisture Tester, Model BD-9, was used to probe walls and floors for a qualitative assessment of moisture content.

Two samples of material from a stained ceiling tile in room 27 were collected for microbiological analysis. The samples were plated onto malt extract agar (MEA) for fungal identification and colony counts, and tryptic soy agar (TSA) for bacterial identification and colony counts. One sample of dust from above the ceiling in room 23 was collected and analyzed as above for bacteria and fungi, and by microscopic examination, for dust characterization.

During the evaluation, a question arose concerning the potential for microbial contamination of the fluids used for herbal treatments. The two hydroculator heating units used for this purpose contain water with packets of herbs that are steeped in the heated water, creating an aromatic liquid that infuses towels used in herbal treatments. On July 13, 2000, at the request of NIOSH, a representative of the Arizona Department of Health Services collected samples from the two hydroculators and submitted them to a NIOSH laboratory for endotoxin analysis, and a NIOSH-contracted laboratory for fungi, mycobacteria, thermophillic actinomycetes, *Legionella*, and aerobic bacteria analyses. The temperature of the fluids was measured at the time of sample collection using a thermometer. Three samples from each hydroculator were collected in nonpyrogenic 50 milliliter (mL) polypropylene centrifuge tubes for endotoxin analysis. The tubes were placed in sealed plastic bags, refrigerated, and transported via overnight delivery to the NIOSH laboratory in an insulated cooler containing ice packs. At the laboratory, the samples were frozen until analyzed using the Kinetic-QCL assay kit (BioWhittaker, Walkerville, MD) according to the manufacturer's recommended procedure. Three samples from each hydroculator were collected in sterile containers, placed in sealed plastic bags, and shipped via overnight delivery to a contract laboratory for analysis of the culturable organisms listed below. At the laboratory, the three samples were pooled, resulting in a single sample from each hydroculator. The media and growth conditions for these analyses are listed below:

Organisms	Media and Conditions
Aerobic Bacteria	Tryptic Soy Agar (TSA) with polysorbate and lecithin (TSA p/l), MacConkey Agar, and Buffered Charcoal Yeast Extract (BCYE) agar, at 35°C. Subcultures were made using TSA and BCYE. Final quantitation was based on macroscopic and microscopic morphology.
Fungi	Yeast Malt Extract (YME) and YME with gentamicin and chloramphenicol, BCYE, and Inhibitory Mold Agar (IMA), at 22°–23° C. Plates were read after 10 days.
Mycobacteria	Samples were digested, concentrated, and plated onto Middlebrook 7H10, Mitcheson 7H11S, Middlebrook 7H9 with Tween 80, and BCYE at 35°C (CO_2 incubator) and 22°–23°C (ambient air incubator). The plates were read weekly for four weeks. A Ziehl-Neelson stain

Organisms	Media and Conditions
Mycobacteria *(continued)*	was performed on colonies of differing macroscopic morphology.
Thermophillic Actinomycetes	BCYE agar and TSA p/l at 52°C. The plates were read weekly for two weeks. Gram's and Kinyouns stains were performed on each colony type.
Legionella	Samples were treated with potassium chloride, plated onto BCYE and BCYE with dyes, glycine, vancomycin, and polymyxin B (DGVP) at 35°C (CO_2 incubator) and read at days 4, 7, and 10. Subculturing was done to exclude *Legionella* spp using BAP plates.

Medical Evaluation

The purpose of the on-site medical evaluation was to gain insight into current health problems among employees. Management and the requester notified all Centre employees of the HHE before our arrival and all employees were invited to participate in confidential medical interviews. Depending on the information provided by employees, treating physicians were contacted and medical records were reviewed. In addition, we were contacted by former employees or employees on long-term disability who felt their health problems were related to working at the Centre, and interviewed them by telephone. The Occupational Safety and Health Administration Log and Summary of Occupational Injuries and Illnesses (OSHA 200 logs) from January 1997 through December 1999 were also reviewed.

EVALUATION CRITERIA

Indoor Environmental Quality

A number of published studies have reported a high prevalence of symptoms among occupants of office buildings.[1,2,3,4,5] The reported symptoms 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.[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.[4,5,6,7,8] Reports are not conclusive as to whether increases of outdoor air above currently recommended amounts are beneficial.[9] However, rates lower than these amounts appear to increase the rates of complaints and symptoms in some studies.[10] Design, maintenance, and operation of ventilation systems are critical to their proper functioning and provision of healthy and thermally comfortable indoor environments.

Some studies have indicated 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.[11] Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints.[12,13]

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 (CO) poisoning, and irritant 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 CO 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 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, office 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 environmental cause of the reported health effects could be determined.

Standards specifically for the non-industrial indoor environment do not exist. NIOSH, OSHA, and the American Conference of Governmental Industrial Hygienists (ACGIH) have published regulatory standards or recommended limits for occupational exposures.[14,15,16] With few exceptions, pollutant concentrations observed in the indoor 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 and thermal comfort guidelines.[17,18] 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.[19]

Measurement of indoor environmental contaminants has rarely proved to be helpful, in the general case, in determining the cause of symptoms and complaints except where there are strong or unusual sources, or a proved relationship between a contaminant and a building-related illness. However, measuring ventilation and comfort indicators such as CO_2, temperature, and RH is useful in the early stages of an investigation in providing information relative to the proper functioning and control of HVAC systems.

Carbon Dioxide

CO_2, a normal constituent of exhaled breath, can be used as a screening technique to evaluate whether adequate quantities of outdoor air are being introduced into an area. ASHRAE Standard 62-1999, 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 25 cfm/person for beauty salons.[18] Maintaining the recommended ASHRAE outdoor air supply rates when the outdoor air is of good quality, and there are no significant indoor emission sources, should provide for acceptable indoor air quality.

Indoor CO_2 concentrations are normally higher than outdoors (range 300-350 parts per million [ppm]). When indoor CO_2 concentrations exceed 800 ppm in areas where the only known source is exhaled breath, inadequate ventilation is suspected.[20] Elevated CO_2 concentrations suggest that the concentrations of other indoor contaminants may also be increased.

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 indoors. 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.[21] 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.[17] Assuming slow air movement and 50% RH, the operative temperatures recommended by ASHRAE range from 68-74°F in the winter,

and from 73-79°F in the summer. The difference between the two is largely due to seasonal clothing selection. ASHRAE also recommends that RH be maintained between 30 and 60% RH.[17] Excessive humidity can support the growth of microorganisms.

Microorganisms

Microorganisms (including fungi and bacteria) are normal inhabitants of the environment. The saprophytic varieties (those utilizing non-living organic matter as a food source) inhabit soil, vegetation, water, or any reservoir that can provide an adequate supply of a nutrient substrate. Under the appropriate conditions (optimum temperature, pH, and with sufficient moisture and available nutrients) saprophytic microorganism populations can be amplified. Through various mechanisms, these organisms can then be disseminated as individual cells or with soil or dust particles or water droplets. In the outdoor environment, the levels of microbial aerosols will vary according to the geographic location, climatic conditions, and surrounding activity. In a "normal" indoor environment, where there is no unusual source of microorganisms, the level of microorganisms may vary somewhat as a function of the cleanliness of the HVAC system and the numbers and activity level of the occupants. Generally, the indoor levels are expected to be below the outdoor levels (depending on HVAC system filter efficiency).[22,23]

Some individuals manifest increased immunologic responses to antigenic agents encountered in the environment. These responses and the subsequent expression of allergic disease is based, partly, on a genetic predisposition.[24] Allergic diseases which have been reported to be associated with exposures in indoor environments include allergic rhinitis (nasal allergy), allergic asthma, allergic bronchopulmonary aspergillosis (ABPA), and extrinsic allergic alveolitis (hypersensitivity pneumonitis).[22] Allergic respiratory diseases resulting from exposures to microbial agents have been documented in agricultural, biotechnology, office, and home environments.[25,26,27,28,29,30,31,32]

Acceptable levels of airborne microorganisms or their mycotoxins have not been established. Relationships between health effects and environmental microorganisms must be determined through the combined contributions of medical, epidemiologic, and environmental evaluation. The current strategy for on-site evaluation involves a comprehensive inspection of problem areas to identify sources of microbial contamination and routes of dissemination. In those locations where contamination is visibly evident or suspected, bulk samples may be collected to identify the predominant species. However, associating health effects with airborne microbial contaminants can be difficult.

Endotoxins

Endotoxins, the principle surface antigens in Gram-negative bacteria, are contained in the outer cell wall of Gram-negative bacteria. Aerosolized endotoxins are suspect causative agents in the development of chronic bronchitis, abnormal cross-shift declines in pulmonary function, and asthma.[33] Occupational exposure limits for endotoxins have not been established by NIOSH or OSHA.

RESULTS

Environmental Evaluation

Ventilation System

There are two air handling units serving the East and West portions of the Centre (AC-1 and AC-2). These units supply conditioned outside air to the atrium, hallways, locker rooms, a few treatment rooms, and the fan coil units. Since about 1998, the main air handling units have been operating 24 hours per day, supplying the maximum volume of outside air at all times. Inspection of the two AHUs revealed that they were clean and well maintained. The AHUs were on a quarterly preventive maintenance schedule that involved visual inspections, lubrication of bearings, filter inspection

(and replacement as needed), and cleaning of drain pans and cooling coils.

For most of the treatment rooms, individual fan coil units (FCUs) located above the ceiling, filter and condition the air for delivery to the rooms. The FCUs serving rooms 23 and 28 were visually inspected. Both units were clean and effectively draining (no standing water or slime in the drain pan). The FCUs are on a quarterly preventive maintenance program that includes visual inspection, filter replacement, and cleaning of associated supply and return vents.

Operation of the FCUs is controlled by room thermostats that are adjusted by the occupants. The thermostats have settings for "heating," "cooling," or "off," and the fan can be set to "on" or "automatic." Additionally, the temperature set points can be varied. When placed in the "on" fan mode, there is a constant supply of air from the FCU and the air is conditioned (heated or cooled) as needed, depending on the thermostat set points. In the automatic mode, air is supplied only when the thermostat calls for heating or cooling; when the thermostat set point is satisfied or if the thermostat is set to "off," there is no air supplied to the room.

NIOSH investigators made note of the thermostat settings at different times during the day in several rooms. The settings varied from room to room. Nine rooms with FCUs had the fan set to "auto" and four were set to "on." Most were placed in the "cooling" mode, but some were set on "heating" or "off." The impact these settings had on ventilation and comfort indicators is discussed below.

Air Flow Measurements

Air flow measurements made in 14 rooms served by FCUs, and in two rooms served by the main air handlers are shown in Table 1. To obtain the ventilation measurements it was necessary for NIOSH investigators to temporarily adjust the thermostat settings in some rooms to call for air supply. The supply air flow rates ranged from 220 cubic feet per minute (cfm) to 295 cfm in rooms served by FCUs. The flow rates measured by NIOSH investigators were in fairly good agreement with those listed in a February 17, 2000, test and balance report. The NIOSH measurements ranged from 80 to 112% of those in the test and balance report, with a mean of 89%. The return air flow rates in these rooms ranged from 81 cfm to 320 cfm. The reason for the low return air flow (81 cfm) in room 23 was not apparent. In rooms 24 and 29, there was little or no supply air flow at the time of measurement (Table 1). These rooms are supposed to receive supply air directly from AC-2. Other areas served by AC-2 were receiving supply air at the time of measurement. The February 2000 test and balance report lists two rooms served by this unit that had zero supply air because the outlet was reportedly not connected to the supply duct. These rooms were listed only as Massage (terminal 17), and Spa (terminal 20), so it could not be determined if these were rooms 24 and 29. In addition, there was no supply air delivered to the dressing and locker areas in the women's locker room, despite adjustments made to the thermostat to call for cooling.

Ventilation and Comfort Indicators (Temperature, RH, CO_2)

Tables 1 and 2 include temperature, RH, and CO_2 measurements. Spot measurements are shown in Table 1 and continuous measurements are shown in Table 2. The indoor temperatures ranged from 66 to 87°F, showing a wide variation throughout the Centre. The highest temperatures were recorded in closed, occupied rooms. A wide variation in the RH was also found. Excluding the locker rooms, the indoor RH ranged from 31 to 67%. RHs above 60% were noted in the meditation room and in room 18, a wet treatment room. In the men's and women's locker rooms where there are whirlpools, steam rooms, and showers, RHs above 80% were recorded (Table 2).

Figure 1 shows the impact that adjustment of the thermostat in room 27 had on the room air temperature. Prior to use of this room, the thermostat had been set to "off" and "auto," thus there was no air delivered to this room by the fan coil

unit. The room temperature remained fairly stable at about 76°F until the door was closed and a waxing treatment was performed at 10:30 a.m. At the end of the treatment the temperature approached 81°F, and the thermostat was re-set to the cooling mode, presumably by the technician. The temperature continued to drop until it reached about 66°F, where it remained for several hours.

Figure 2 shows the variation in RH throughout the day in room 18, a wet treatment room. There was a gradual increase in RH over the course of the day up to 67 % RH. During each of the five treatments there was about a 15% increase in RH. The RH decreased and leveled off between treatments.

As shown in Tables 1 and 2, CO_2 concentrations ranged from 341 ppm in an open, unoccupied treatment room, to 1801 ppm in a closed, occupied treatment room. CO_2 concentrations above 800 ppm were measured only in occupied treatment rooms (with doors closed), as shown in Table 2. Figure 3 shows the elevation in CO_2 concentration in room 18 during client treatments. Between treatments, when the door was opened and the room no longer occupied, the CO_2 concentrations decreased to between 500 and 600 ppm.

Microbial Assessment

Ceiling tiles in rooms 26 and 27 showed evidence of water damage. The tile in room 26 was wet at the time of observation due to a leaking pipe above the ceiling. The tile was replaced by maintenance employees on the evening shift, and the pipe was re-wrapped. The stain on the tile in room 27 appeared old, and no source for the stain was found above the ceiling. Two bulk samples were collected from this tile for microbial analysis. One sample did not support the growth of fungi or bacteria; the other sample yielded low levels of fungi (1600 colony forming units per gram [CFU/g]) and bacteria (1600 CFU/g). *Cladosporium cladosporiodes* and sterile fungi were present along with *Bacillus* bacteria and *Micrococcus luteus*. These fungal spores and bacteria are commonly found in indoor environments.

A boroscope was used to look above the ceiling and between walls in several treatment rooms for evidence of moisture, microbial contamination, and general cleanliness. No obvious microbial contamination or moisture source was found. Dust was observed in some areas, prompting the collection of a bulk dust sample in the ceiling plenum above room 23. Microscopic analysis of this sample revealed primarily cellulose fibers (95%), with trace amounts of animal hairs and fiberglass. This sample yielded a fungal level of 5505 CFU/g and a bacterial level of 3670 CFU/g. *Aspergillus niger* was the predominant fungal spore, and *Bacillus* was the predominant bacteria identified. These fungal spores and bacteria are commonly found in indoor environments.

The moisture meter was used on wall and floor surfaces to look for hidden moisture. This qualitative assessment did not reveal any significant moisture problems. Moisture readings were generally highest by sinks and showers, such as in the employee rest room and in Apricot Mallow where there was obvious water damage around the sinks (de-lamination and buckling of surface). The moisture meter and visual inspection did not show any water damage or microbial contamination beneath the sinks.

Results of the hydroculator fluid analyses are shown in Table 3. The temperature of the fluids ranged between 155°F and 175°F. No fungus, mycobacteria, thermophillic actinomycetes, or *Legionella* spp. were isolated from either hydroculator sample. Aerobic bacteria were present in both samples in concentrations up to 10^5 CFU/mL. The concentration of bacteria was higher in the hallway sample, as was the endotoxin content. While no Gram-negative bacteria were cultured from this sample, the presence of endotoxin, a component of the cell wall of Gram-negative bacteria, indicates that such organisms have been present. The sample collected from the unit in room 10 revealed a mix of Gram-negative, Gram-positive, and Gram-variable organisms.

Medical Evaluation

Twenty-five on-site employees asked to speak with the NIOSH investigators including 19 aestheticians or massage therapists, and 6 others. Three private physicians, treating nine employees were interviewed and four medical records were evaluated. The mean duration of work at the Centre was 5.2 years (ranging from one month to 11 years), and the mean workload was 33 hours per week.

The work schedule varied for aestheticians and massage therapists from day-to-day, but generally there were supposed to be 10-minute breaks between clients, and a 1 hour lunch break every shift. The length of the usual workday for many of the aestheticians and massage therapists was about 6 hours. The massage therapists were required to clean and set-up the room for the next client during the 10 minute breaks.

Of the 25 employees interviewed on-site, four reported that they had no health problems related to working at the Centre; these four were neither aestheticians nor massage therapists. The jobs of those four employees required substantial movement in the hall, entryways, and other rooms, and therefore these employees were not always in closed treatment rooms.

The most frequently reported symptoms were headache, memory loss, forgetfulness, concentration problems, eye, nose, and throat irritation, and fatigue at work. All of the interviewed people who had headache or fatigue mentioned gradual onset of symptoms when coming to work and alleviation of symptoms after leaving the Centre.

Other symptoms reported less frequently, but by at least 5 employees, were respiratory symptoms (shortness of breath, chest tightness, and cough) and diffuse scalp hair loss. Breathing problems were reportedly related to working in rooms 26, 27, 28, or nearby areas. Some employees mentioned feeling a "lack of oxygen" and shortness of breath during the treatments which disappeared minutes after leaving the treatment room and entering the hallway. Some interviewed employees were concerned about frequent water leaks, mold exposure, and the lack of air circulation in the treatment rooms as a potential cause of their symptoms. One employee mentioned noticeable odors; however, some employees reported a loss of the sense of smell since working as a massage therapist or aesthetician.

Three physicians representing nine Phoenician employees were interviewed over the phone, and four employee medical records were reviewed. One physician found respiratory symptoms in his four patients which he felt was consistent with an IEQ problem. One physician diagnosed chronic fatigue syndrome in four of his patients, although he did not follow the Centers for Disease Control and Prevention (CDC) guidelines in making that diagnosis.[34] Another physician diagnosed an employee with chronic fatigue syndrome using the CDC guidelines. The reviewed medical records did not add any information regarding the cause of the employee symptoms.

In addition, four people, who were either former employees or on long term disability, were interviewed by telephone. Symptoms among these employees were more severe than those who were still able to work. Symptoms included severe fatigue, night sweats, swollen glands, unrefreshing sleep, and impaired thinking. Two of the telephone interviewees reported that they had antibodies to S*tachybotrys chartarum* and felt that their symptoms were due to *S. chartarum* exposure.

OSHA 200 log entries from January 1997 through December 1999 were reviewed. There were nine entries for massage therapists and none for aestheticians. Eight entries involved muscular strains and sprains; one entry was for carpal tunnel syndrome.

DISCUSSION

The environmental evaluation identified problems with temperature and humidity regulation and air delivery in the treatment rooms. Most of the

treatment rooms have fan coil units that control air supply to the room and thermal comfort (through heating or cooling the supply air). Due to concerns about client comfort, particularly during wet treatments, some fan coil units were turned off completely, while in other rooms thermostats were adjusted to extreme temperature ranges. This resulted in temperatures ranging from 66°F to 87°F, (a variation of 21°) on a single day. Similarly, wide ranges in RH were found throughout the Centre. In fact, the highest and lowest RHs (31% and 67%) were recorded in a single treatment room. Better control of the temperature and RH is needed to minimize occupant discomfort and prevent moisture-related problems. Such control will also likely reduce energy costs at the Centre.

Providing acceptable thermal comfort will likely be more challenging in this environment than in many other indoor environments because of the need to satisfy both clients and employees. In addition to the individual differences in perception of thermal comfort that occur in any environment, clients and employees in this setting are often clothed differently (some clients wear little or no clothing during treatments), the level of activity is different (employees performing deep massages, for example, have a higher metabolic heat production than clients who are at rest), and the transfer of heat to the environment by clients is altered by the application of wet towels, mud, or hot wax. While some flexibility is needed to accommodate the different treatments and individual client requests, the NIOSH investigators believe that the temperature range should be narrowed as much as possible. The existing thermostats could be marked to show a desired temperature range and a baseline setting. The employees could then adjust the thermostat within this range to call for heating or cooling depending on specific treatment and client needs, returning the thermostat to the baseline setting after the treatment is completed.

In addition to providing acceptable thermal comfort, ventilation is used to dilute normal contaminants and odors arising from occupants and their activities. The products used in some of the spa treatments present an additional source of contaminants, many of which are odorous, and some of which can cause eye, nose, and throat irritation. When the fan coil unit in the treatment rooms is off, there is no air supplied to the treatment room to dilute these contaminants. Using CO_2 as an indicator, we measured CO_2 concentrations up to 1800 ppm in closed rooms. These elevated CO_2 concentrations suggest that the concentrations of other indoor contaminants may also be increased. When CO_2 concentrations exceed 800 ppm, inadequate ventilation is suspected and further evaluation of the ventilation systems is warranted. As a first step, the thermostats in the treatment rooms should always be set to the "on" fan position, thus some outside air will be provided at all times.

The visual inspection did not reveal widespread mold contamination or moisture incursion problems. Isolated patches of mold were found on a ceiling tile in one treatment room, and a wet ceiling tile was observed in another room. In the latter situation, the source of the wet tile was found to be a leaking pipe. The pipe was repaired and re-wrapped, and the tile was replaced by maintenance employees on the evening shift. Water damage to the sink in the employee rest room, and in Apricot Mallow was also observed and should be addressed to prevent microbial contamination and dissemination. Results of the microbiological analysis of the hydroculator units indicate the need for more frequent cleaning of the units.

Results from the medical evaluation indicated that many employees had nonspecific symptoms that are neither suggestive of a particular medical diagnosis nor readily associated with a causative agent. It is important to note that the interviewed employees may not be representative of all employees at the Centre. The 25 on-site employees who volunteered to be interviewed may have experienced more (or less) health symptoms, and different symptoms, than other employees.

Those employees that were interviewed outside the workplace may be different from those interviewed on-site. Since we were unable to offer the interview

to all employees who were not working, the sample of workers interviewed off-site was smaller, and their participation was dependent on knowing about the study. Therefore, we cannot assume that the experiences of these employees reflect the experiences of all off-site employees, but we felt that understanding and addressing their concerns was an important aspect of our investigation. Because of this difference in selection, the information received from those employees was not combined with the information from the interviews conducted on-site.

The employees at the Centre reported fatigue, headache, and sore throat; these symptoms have been linked to deficiencies in the HVAC system for a building.[35,36,37,38] and are commonly associated with "sick building syndrome."[39] Fatigue and headache are common findings in studies of the indoor environment. In a NIOSH study of 80 office buildings, fatigue was reported by 42% of all workers and headache was reported by 35%.[39]

However, chronic fatigue syndrome, which was mentioned by some employees, is clinically defined by the CDC as severe, disabling fatigue (severe mental and physical exhaustion) that is not the result of exertion, not alleviated by rest, and results in substantial reductions in previous levels of occupational, educational, social or personal activities.[34] It is diagnosed by symptoms and is a diagnosis of exclusion; the true etiology of the syndrome is unknown. When making the diagnosis, it is important that the patient not have any other medical reason for fatigue. To make the diagnosis, the patient must have any four of the following eight symptoms that occurred in six or more consecutive months of illness:

1. Impairment of short term memory or concentration severe enough to cause substantial reduction in previous levels of occupational or other activities
2. Sore throat
3. Tender cervical or axillary lymph nodes
4. Muscle pain
5. Multi-joint pain without joint swelling or redness
6. Headaches of a new type, pattern, or severity
7. Unrefreshing sleep
8. Postexertional malaise lasting more than 24 hours

This criteria for diagnosis was not used by most physicians that were contacted for this evaluation.

The complaints of the scalp, hair, and eyelash loss cannot be explained for the majority of affected individuals, by IEQ problems. Causes of hair loss include certain medications, stressful events, discontinuation of birth control pill use, high fever, shock, extreme dieting, severe psychiatric stress, dietary deficiencies, and thyroid problems. Some chemicals, such as lead, mercury, and selenium result in hair loss as well as several medical agents, including cancer chemotherapy agents, anticoagulants, antihypertensive, antiepileptic, and antipsychotic drugs. Vitamin A and its analogs can also cause diffuse hair loss.[40] Six employees who were concerned about hair loss were females who possibly had andro-genetic hair loss, which is usually hereditary. The medical literature reports that among healthy women, forehead hair recession may occur in 13% of pre- and in 37% of postmenopausal women.[41]

Some researchers have reported that exposure to certain fungal toxins (mycotoxins) may produce cold and flu-like symptoms, sore throat, diarrhea, headache, fatigue, skin rash, intermittent local hair loss, and generalized malaise.[42,43] We did not find widespread mold contamination within the spa at the time of the evaluation. Localized patches of mold growth (including *Stachybotrys*) were found in earlier investigations at this facility behind vinyl molding in one room and around the showers in two wet treatment rooms. This prompted the removal and replacement of the molding and showers by an outside consultant. The presence of antibodies to *Stachybotrys chartarum* was reported by some of the workers at the spa but, whether the spa was the source of the exposure cannot be determined. The California Department of Health Services reports[44] that the *Stachybotrys chartarum* antigen used in one commercially available test was recently shown to cross-react with antibodies to *Aspergillus fumigatus* and *Alternaria alternata*, two common

outdoor fungi.[45] Thus, the reporting of a positive *S. chartarum* titre from a test does not necessarily mean the person has developed antibodies to *S. chartarum*. Even if a person was truly exposed to *S. chartarum* and has developed an antibody response to that agent, the exposure may have occurred outside the workplace. Although buildings are not routinely tested for this fungus, one study conducted in Southern California reported its presence in 2.9% of 68 homes.[46] Further, while the presence of fungal antibodies indicates that the individual has been exposed to a specific or an immunologically related fungal species, it does not necessarily mean that the individual has or will develop symptoms or health problems as a result of that exposure.

CONCLUSIONS

The NIOSH evaluation revealed that many of the interviewed employees reported non-specific symptoms that are not suggestive of any particular medical diagnosis or readily associated with a causative agent. The environmental evaluation found problems with the regulation of temperature, RH, and air delivery at the Centre. Widespread microbial contamination was not found. NIOSH investigators recommend that the ventilation problems be corrected to minimize health complaints among occupants and prevent moisture-related problems. Whether the existing ventilation systems can provide sufficient dilution ventilation, acceptable thermal comfort, and maintain RH below recommended levels, is not known. Further evaluation by the Phoenician will be needed after modifications are made to the operation of the ventilation systems.

RECOMMENDATIONS

1. The thermostats controlling the fan coil units should remain in the "on" fan mode whenever the Centre is occupied so that there is a constant supply of air to the treatment rooms. The thermostats should be marked to delineate an "acceptable temperature range," and any adjustments made to the thermostats to call for heating or cooling (based on specific treatment and client needs) should be within this acceptable range. NIOSH investigators suggest that this range be limited to at most a 10°F temperature span. Once the treatment is completed, the thermostats should be returned to a designated baseline setting to minimize temperature fluctuations with surrounding areas. This baseline setting should be the same as the setting for the central ventilation system that serves the hallways and other common areas. The rationale for making these changes should be communicated to all employees and training offered regarding proper operation of the thermostats. In addition, the thermostats should be re-calibrated because the readings were not always consistent with the NIOSH instruments.

2. After changes are made to the operation of the fan coil units, the Phoenician should conduct a follow-up evaluation to determine if the changes were sufficient to maintain acceptable thermal comfort, dilute contaminants, and prevent moisture problems (maintaining RH below 60%). This evaluation should be conducted during occupied hours. If CO_2 levels exceed recommended levels, additional outdoor air may need to be provided. While ASHRAE standard 62–1999 does not provide specific recommendations for health spas, recommendations for outdoor air ventilation rates for beauty salons (25 cfm of outdoor air [OA] per person) and offices (20 cfm OA/person) can be used as a guideline.[18]

3. Further evaluation is needed by the Phoenician to determine why two rooms and a portion of the women's locker room were not receiving mechanical ventilation, and the problems corrected as soon as possible.

4. Identify and promptly eliminate sources of excessive moisture or leaks that may cause water damage to office building interior or furnishings. Water damaged material in the employee rest room and Apricot Mallow should be remediated.

Comprehensive guidelines on the assessment and remediation of fungi from contaminated materials in indoor environments have been developed by the New York City Department of Health and can be consulted for additional guidance.[47]

5. The hydroculator units should be placed on a timer and the temperature monitored periodically to ensure that overheating does not occur. The product manufacturer should be consulted for information on appropriate temperature settings. To minimize the potential for microbial contamination of the hydroculator fluids, the frequency of cleaning (complete replacement of water and thorough disinfection) should be increased.

6. Some of the massages given at the Phoenician were deep massages which would require moderate to high physical effort. Thus, an adequately planned work day, with massages that require less physical strain (for example, wet treatment) interspersed with massages requiring greater strain (for example, deep tissue massage), may help prevent or minimize the development of fatigue in some of the massage therapists at the Phoenician.

7. Communication between management and employees should be increased to facilitate the discussion of concerns about environmental conditions at the Centre. Employees should be made aware of the problems with the building and should be informed of and consulted about solutions to the identified problems. Ongoing communication is particularly important in this situation to ensure that any changes made to the environment are effective in minimizing employee health problems.

8. Employees who continue to experience health problems should see a physician.

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Table 1
Indoor Environmental Quality Data – Spot Measurements
Centre for Well-Being at The Phoenician
Scottsdale, Arizona
HETA 2000–0176
June 20, 2000

Location†	Time	Temp (°F)	RH (%)	CO_2 (ppm)	Total Supply Air (cfm)	Total Return or Exhaust Air (cfm)
CFWB Reception Desk	09:40	76.8	32.3	436		
CFWB Reception Desk	14:15	74.7	39.6	445		
Meditation Atrium	10:00	72.8	40.4	435		
Meditation Atrium	11:10	72.2	41.9	472		
Water Bar Desk	09:50	74.5	37.6	465		
Rm 2 Desert Blazing Star	10:30	71.8	42.6	482		
Rm 4 Desert Hibiscus	10:40	74.0	41.9	492		
Rm 7 Creosote Bush (FC–8)	10:58	73.1	42.9	483	275	320
Rm 7 Creosote Bush (FC–8)	14:08	74.5	42.8	680		
Rm 8 Arizona Lupine (FC–9)	10:47	72.9	42.3	484	290	325
Rm 8 Arizona Lupine (FC–9)	14:03	75.1	44.0	653		
Rm 9 Barrel Cactus	11:02	72.7	42.6	506		
Rm 10 Anemone	11:05	71.2	41.6	524		
Rm 10 Anemone	15:27	70.6	46.4	658		
Rm 11 Desert Marigold (FC–16)	13:58	75.3	42.8	605	265	245
Rm 12 Desert Senna (FC–19)	13:37	71.4	47.4	62.2	235	215
Rm 13 Desert Star (FC–18)	11:12	73.0	41.2	516	225	220
Rm 13 Desert Star (FC–18)	13:42	73.1	45.2	616		
Rm 15 East Prickly Pear (FC–22)	13:48	73.5	46.9	614	250	210
Rm 16 Indian Paintbrush (FC–23)	13:51	71.7	48.2	717	230	172^
Rm 18 Owl's Clover (FC–26)	13:54	74.9	46.0	670	220	170^

Table 1
Indoor Environmental Quality Data – Spot Measurements
Centre for Well-Being at The Phoenician
Scottsdale, Arizona
HETA 2000–0176
June 20, 2000

Location†	Time	Temp (°F)	RH (%)	CO_2 (ppm)	Total Supply Air (cfm)	Total Return or Exhaust Air (cfm)
Rm 19 Paper Daisy (FC–24)	13:56	74.7	43.9	700	245	220
Rm 22 Creosote Bush (FC–34)	10:05	72.7	43.0	648	245	215
Rm 23 Beaver Tail (FC–35)	15:07	73.3	38.5	454	235	81
Rm 24 Range Ratany	12:07	72.1	43.1	430	0	44
Rm 25 Sunflower (FC–33)	15:10	72.0	40.7	480	260	215
Rm 26 Spring Primrose (FC–31)	10:10	73.7	43.1	558	235	196
Rm 26 Spring Primrose (FC–31)	15:13	71.8	41.8	446		
Rm 27 Trixis (FC–29)	10:15	73.1	46.0	422	295	191
Rm 27 Trixis (FC–29)	11:45	73.6	41.2	528		
Rm 27 Trixis (FC–29)	15:15	68.4	48.4	482		
Rm 28 Unicorn Plant	10:17	74.0	45.6	415		
Rm 29 Velvet Mosquite	10:20	73.7	45.2	432	‡	38
Rm 29 Velvet Mosquite	15:18	70.1	----	521		
Apricot Mallow	10:45	74.3	42.9	480		
Women's Locker Rm	10:35	72.4	51.8	610		
Women's Locker Rm	14:25	72.5	53.0	565		
Women's Locker Rm	15:00	76.5	47.0	662		
Outside (Front Entrance)	09:30	94.7	36.0	371		
Outside (Front Entrance)	14:12	81.0	66.4	350		

† Text in parentheses refer to the fan coil unit number from the February 17, 2000, test and balance report.
^ partially obstructed; should be considered an estimate.
‡ variable air flow; reading fluctuated between 48 to 75 cfm.

Table 2
Indoor Environmental Quality Data – Continuous Measurement
Centre for Well-Being at The Phoenician
Scottsdale, Arizona
HETA 2000–0176
June 20, 2000

Location	Time	Range		
		Temp (°F)	RH (%)	CO_2 (ppm)
Rm 14 (massage room)	07:47 – 18:37	72.4 – 79.6	35.9 – 53.8	399 – 1467
Rm 18 Owl's Clover (wet treatment room)	07:35 – 18:36	73.6 – 87.4	30.6 – 66.9	386 – 1536
Rm 26 Spring Primrose (no treatments)	07:36 – 18:06	71.2 – 74.1	41.1 – 46.3	347 – 624
Rm 27 Trixis (skin care treatments)	07:42 – 18:07	65.6 – 80.9	37.2 – 57.2	341 – 1801
Waterbar	07:29 – 18:04	72.0 – 74.7	39.9 – 45.8	389 – 631
Meditation Room	07:12 – 18:22	68.7 – 74.7	42.0 – 63.2	NA^
Men's Locker Room	07:07 – 18:17	70.6 – 79.0	40.7 – 88.3	NA
Women's Locker Room	07:12 – 18:22	70.6 – 76.6	38.1 – 81.4	NA
Outside (near front entrance)	07:07 – 18:22	70.6 – 114	16.7 – 65.7	NA

^NA = not applicable; HOBO H8 Pro Series monitor used.

Table 3
Microbiological Content of Hydroculator Fluids
Centre for Well-Being at The Phoenician
Scottsdale, Arizona
HETA 2000–0176
July 13, 2000

Sample †	Temp (°F)	Aerobic Bacteria (CFU/mL)^	Endotoxin (EU/mL)‡
Hydroculator 1 (Hallway)	161–175	1.0 X 10^5 Gram-positive rods	142–154
Hydroculator 2 (Room 10)	155–160	6.5 X 10^4 Gram-positive, Gram-negative and Gram-variable rods	22–49

† 3 samples from each hydroculator were collected. Results presented are the ranges for these analyses with the exception of the aerobic bacteria content because the three samples were pooled for this analysis.

^ CFU/ml = colony forming units per milliliter of fluid.

‡ EU/ml = endotoxin units per milliliter of fluid.

Figure 1. Temperature in Room 27 on June 20, 2000

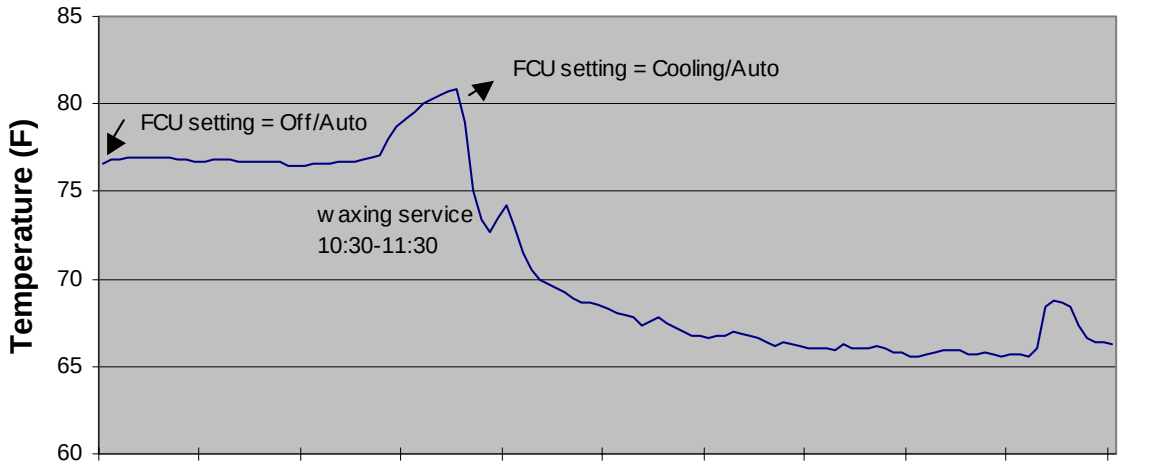


Figure 2. Relative Humidity in Room 18 on June 20, 2000

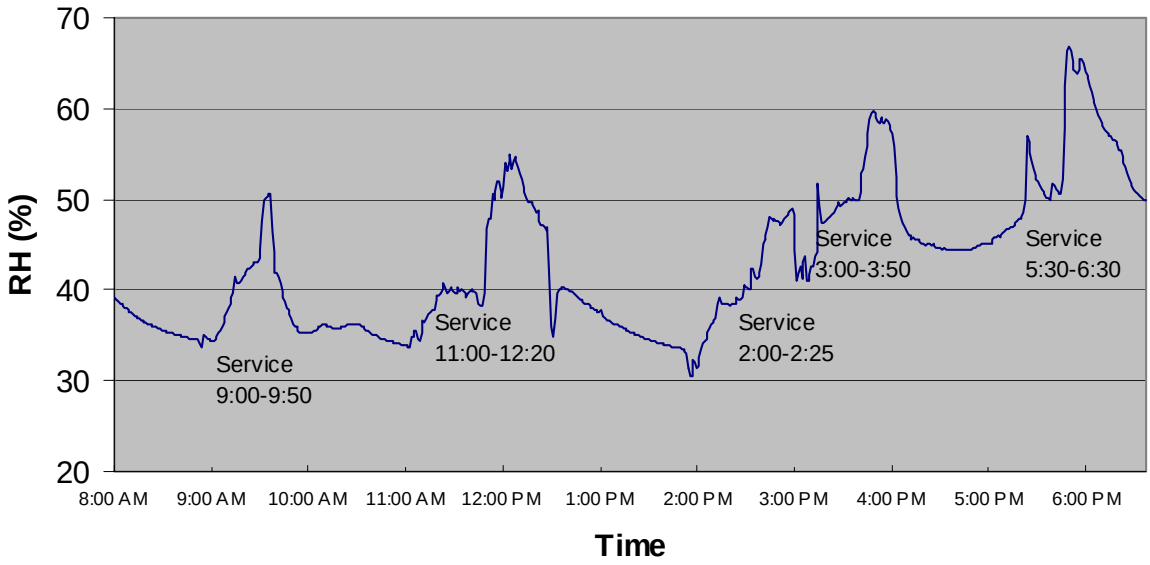
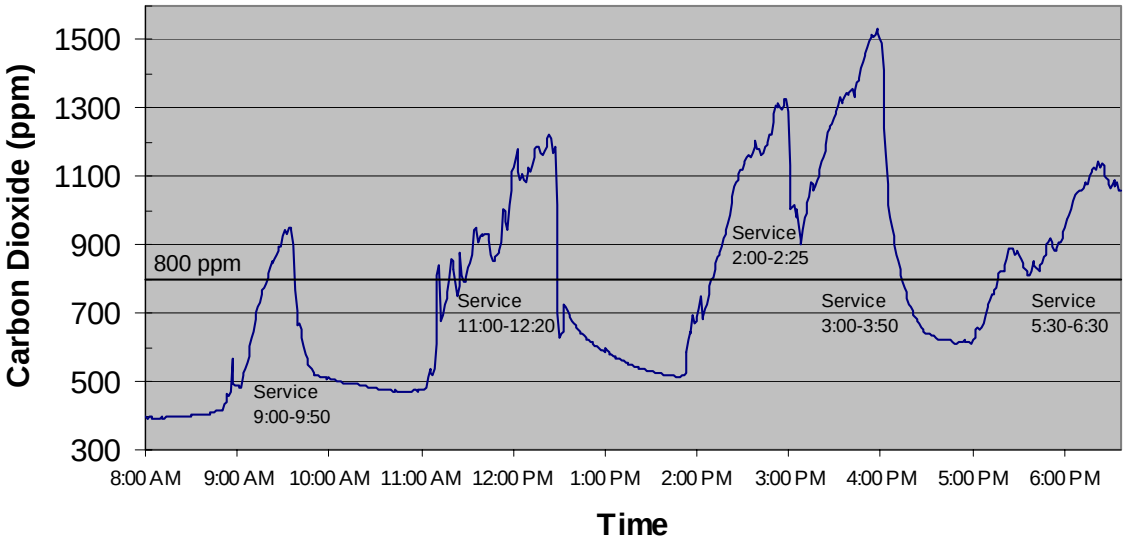


Figure 3. Carbon Dioxide Concentrations in Room 18 on June 20, 2000



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Occupational Safety and Health Concerns

Call NIOSH at:
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www.cdc.gov/niosh

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